APPENDIX D
CONSULTATION CORRESPONDENCE

D CONSULTATION CORRESPONDENCE

The Endangered Species Act of 1973, as amended; the Magnuson-Stevens Fisheries 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 prior to taking action that may affect threatened or endangered species, essential fish habitat, or historic and archaeological resources, respectively. This appendix contains consultation documentation.

Table D-1 provides a list of the consultation documents sent between the U.S. Nuclear Regulatory Commission (NRC) and other agencies. The NRC staff is required to consult with these agencies based on the National Environmental Policy Act of 1969 (NEPA) requirements.

Table D-1. Consultation Correspondence

Author	Recipient	Date of Letter/Email
Simon, B., Massachusetts Historical Commission	Holian B., NRC	March 3, 2010 (ML100880129)
Pham, B., NRC	Nelson, R., Advisory Council on Historic Preservation	July 16, 2010 (ML101760128)
Pham, B., NRC	Kurkul, P., National Marine Fisheries Service (NMFS), Northeast Region	July 16, 2010 (ML101760221)
Pham, B., NRC	Muzzey, E., New Hampshire Division of Historical Resources	July 16, 2010 (ML101790273)
Pham, B., NRC	Moriarty, M., U.S. Fish and Wildlife Service (USFWS), Northeast Region	July 16, 2010 (ML101790278)
Feighner, E., New Hampshire Division of Historical Resources	Pham, B., NRC	July 27, 2010 (ML102160299)
Kurkul, P., NMFS, Northeast Region	Pham, B., NRC	August 5, 2010 (ML102240108)
Pham, B., NRC	Coppola, M., New Hampshire Natural Heritage Bureau	August 26, 2010 (ML102290417)
Chapman, T., USFWS, Northeast Region	Pham, B., NRC	September 1, 2010 (ML102630180)
Coppola, M., New Hampshire Natural Heritage Bureau	Susco, J., NRC	September 7, 2010 (ML102520087)
Coppola, M., New Hampshire Natural Heritage Bureau	Susco, J., NRC	September 13, 2010 (ML102600341)

D.1 Consultation Correspondence

The following pages contain copies of the letters listed in Table D-1.

The Commonwealth of Massachusetts
William Francis Galvin, Secretary of the Commonwealth
Massachusetts Historical Commission

March 3, 2010

Brian Holian
Director
Division of License Renewal
Office of Nuclear Reactor Regulation
Nuclear Regulatory Commission
Washington, D.C. 20555-0001

RE: Seabrook Nuclear Power Station License Renewal Application, Tewksbury 345 kV Transmission Line to Ward Hill Substation, Amesbury, Merrimac, West Newbury, Groveland, Georgetown, Boxford, Haverhill, MA. MHC #RC.48153.

Dear Mr. Holian:

Staff of the Massachusetts Historical Commission (MHC), office of the Massachusetts State Historic Preservation Officer (SHPO), have reviewed a Project Notification Form (PNF) and additional information for the proposed project referenced above and have the following comments.

MHC understands that the proposed license renewal for the Seabrook, New Hampshire Nuclear Power Plant, including existing 345 kV transmission lines in Massachusetts, proposes no new construction, demolition or refurbishment activities. Because no new construction is proposed, the MHC has no concerns.

These comments are offered to assist in compliance with Section 106 of the National Historic Preservation Act of 1966, as amended (36 CFR 800). If you have any questions please contact Jonathan K. Patton at this office.

Sincerely,

Brona Simon

Brona Simon
State Historic Preservation Officer
Executive Director
Massachusetts Historical Commission

xc: Richard Cliche, NextEra Energy Seabrook, LLC
Dennis L. Egan, NRC Region 1
New Hampshire Division of Historical Resources

220 Morrissey Boulevard, Boston, Massachusetts 02125
(617) 727-8470 • Fax: (617) 727-5128
www.sec.state.ma.us/mhc

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

July 16, 2010

Mr. Reid Nelson, Director
Advisory Council on Historic Preservation
Office of Federal Agency Programs
1100 Pennsylvania Ave, NW, Suite 803
Washington, DC 20004

SUBJECT: SEABROOK STATION LICENSE RENEWAL APPLICATION REVIEW

Dear Mr. Nelson:

The U.S. Nuclear Regulatory Commission (NRC or the staff) is reviewing an application submitted by NextEra Energy Seabrook, LLC, for the renewal of the operating license for Seabrook Station, Unit 1 (Seabrook Station). Seabrook Station is located 13 miles south of Portsmouth, NH. The application for renewal was submitted by NextEra Energy Seabrook in a letter dated May 25, 2010, pursuant to Title 10 of the *Code of Federal Regulations* Part 54 (10 CFR Part 54).

The NRC has established that, as part of the staff's review of any nuclear power plant license renewal application, a site-specific Supplemental Environmental Impact Statement (SEIS) to its *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*, NUREG-1437, will be prepared under 10 CFR Part 51, the NRC's regulation that implements the National Environmental Policy Act (NEPA) of 1969, as amended. The SEIS will include an analysis of pertinent environmental issues, and in accordance with 36 CFR 800.8(c), will include analyses of potential impacts to historic and cultural resources. The staff also plans to contact the Massachusetts and New Hampshire state historic preservation officers during its review.

The staff plans to hold two public environmental scoping meetings on August 19, 2010, at the Galley Hatch Conference Center, 815 Lafayette Road, Hampton, NH 03842. The first meeting will convene at 1:30 p.m. and will continue until 3:30 p.m., as necessary. The second meeting will convene at 7:00 p.m., with a repeat of the overview portions of the first meeting, and will continue until 9:00 p.m., as necessary. You and your staff are invited to attend. Your office will receive a copy of the draft EIS along with a request for comments. The anticipated publication date for the draft EIS is May 2011.

The Seabrook Station license renewal application is available at:

http://www.nrc.gov/reactors/operating/licensing/renewal/applications/seabrook.html.

R. Nelson -2-

If you have any questions concerning the staff's review of this license renewal application, please contact Mr. Jeremy Susco, Project Manager, at (301) 415-2927 or by e-mail at Jeremy.Susco@nrc.gov.

Sincerely,

Bo Pham, Chief
Projects Branch 1
Division of License Renewal
Office of Nuclear Reactor Regulation

Docket No. 50-443

cc: Distribution via Listserv

R. Nelson - 2 -

If you have any questions concerning the staff's review of this license renewal application, please contact Mr. Jeremy Susco, Project Manager, at (301) 415-2927 or by e-mail at Jeremy.Susco@nrc.gov.

Sincerely,

/RA/

Bo Pham, Chief
Projects Branch 1
Division of License Renewal
Office of Nuclear Reactor Regulation

Docket No. 50-443

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NAME	JSusco	IKing	MSpencer	B. Pham
DATE	06/29/10	06/28/10	07/01/10	07/16/10

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

July 16,2010

Ms. Patricia Kurkul, Regional Administrator
Northeast Regional Office
NOAA Fisheries Service
55 Great Republic Drive
Gloucester, MA 01930-2276

SUBJECT: REQUEST FOR LIST OF PROTECTED SPECIES AND ESSENTIAL FISH HABITAT WITHIN THE AREA UNDER EVALUATION FOR THE SEABROOK STATION LICENSE RENEWAL APPLICATION REVIEW

Dear Ms. Kurkul:

The U.S. Nuclear Regulatory Commission (NRC or the staff) is reviewing an application submitted by NextEra Energy Seabrook, LLC, for the renewal of the operating license for Seabrook Station, Unit 1 (Seabrook Station). Seabrook Station is located 13 miles south of Portsmouth, NH. The application for renewal was submitted by NextEra Energy Seabrook, LLC, in a letter dated May 25, 2010, pursuant to Title 10 of the *Code of Federal Regulations* Part 54 (10 CFR Part 54). The NRC has established that, as part of the staff's review of any nuclear power plant license renewal application, a site-specific Supplemental Environmental Impact Statement (SEIS) to its *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*, NUREG-1437, will be prepared under 10 CFR Part 51, the NRC's regulation that implements the National Environmental Policy Act (NEPA) of 1969, as amended. The SEIS includes an analysis of pertinent environmental issues, including endangered or threatened species and impacts to marine resources and habitat. This letter is being submitted under the provisions of the Endangered Species Act of 1973, as amended, and the Fish and Wildlife Coordination Act of 1934, as amended, and the Sustainable Fisheries Act of 1996.

NextEra Energy Seabrook, LLC, stated that it has no plans to alter current operations over the license renewal period and that Seabrook Station, operating under a renewed license, would use existing plant facilities and transmission lines and would not require additional construction or disturbance of new areas. According to NextEra Energy Seabrook, LLC, any maintenance activities would be limited to previously disturbed areas. The site consists of 889 acres divided into two lots. Lot 1 is approximately 109 acres, is mostly developed, and holds most of the operating facility. Lot 2 is approximately 780 acres and consists mainly of natural areas available for wildlife resources. The natural areas are characterized by broad open areas of level tidal marsh veined with man-made linear drainage ditches and tidal creeks. Wooded islands and peninsulas rise from the marsh to elevations of 20 to 30 feet above sea level. The site is on a peninsula of land, which is bordered on the north by the Browns River and on the south by Hunts Island Creek. Estuarine marshlands bound the site to the east. It is estimated that approximately 300 acres of the site are upland and 600 acres are marsh/wetland areas. Please see the maps in Enclosures 1, 2, and 3 for further detail.

Seabrook Station is a single unit, pressurized-water reactor plant. Seabrook Station employs a once-through heat dissipation system designed to remove waste heat from the plant. Its circulating water system provides cooling water to the main condensers to remove the heat that

is rejected by the turbine cycle and auxiliary system and to the plant's service water system. Water for these systems is carried to and from the Atlantic Ocean to the plant through long tunnels drilled through the underlying bedrock. The tunnels are hydraulically connected to the ocean by way of concrete shafts that extend approximately 6000 feet offshore, with the intake and discharge points approximately 60 feet below sea level. Please see Enclosure 4 for a drawing of the system. During normal operations, the circulating water system provides a continuous flow of approximately 390,000 gallons per minute (gpm) to the main condenser and 21,000 gpm to the service water system. Fresh water is purchased from the Town of Seabrook, and sanitary waste water is discharged back to the town system.

As part of the SEIS preparation, the applicable transmission line corridors will be reviewed. The Seabrook Station 345 kilovolt (kV) switchyard is adjacent to the plant on the north side of the property. From here, three 345 kV transmission lines connect Seabrook Station to the New England electric grid. These lines deliver power to three substations: at Scobie Pond, near Derry, New Hampshire; at Tewksbury, Massachusetts; and at Newington, New Hampshire. The transmission lines include approximately 86 miles of corridor with approximately 1,061 acres of right-of-way in New Hampshire and 662 acres of right-of-way in Massachusetts for the specific purpose of connecting Seabrook Station to the transmission system. Please see the map in Enclosure 5 for further detail.

To support the SEIS preparation process and to ensure compliance with Section 7 of the Endangered Species Act, the NRC requests information on Federally listed, proposed, and candidate species and critical habitat that may be in the vicinity of Seabrook Station and its associated transmission line rights-of-way. In addition, please provide any information you consider appropriate under the provisions of the Fish and Wildlife Coordination Act. Also in support of the SEIS preparation and to ensure compliance with Section 305 of the Magnuson-Stevens Fishery Conservation and Management Act, the NRC requests a list of essential fish habitat that has been designated in the vicinity of Seabrook Station.

The staff plans to hold two public environmental scoping meetings on August 19, 2010, at the Galley Hatch Conference Center, 815 Lafayette Road, Hampton, NH 03842. The first meeting will convene at 1:30 p.m. and will continue until 3:30 p.m., as necessary. The second meeting will convene at 7:00 p.m., with a repeat of the overview portions of the first meeting, and will continue until 9:00 p.m., as necessary. In addition, during the week of October 4, 2010, the staff plans to conduct a site audit at Seabrook Station. You and your staff are invited to attend both the site audit and the public meetings. Your office will receive a copy of the draft SEIS along with a request for comments. The anticipated publication date for the draft SEIS is May 2011.

The Seabrook Station license renewal application is available at:

http://www.nrc.gov/reactors/operating/licensing/renewal/applications/seabrook.html.

If you have any questions concerning the staff's review of this license renewal application, please contact Mr. Jeremy Susco, Project Manager, at (301) 415-2927 or by e-mail at Jeremy.Susco@nrc.gov.

Sincerely,

Bo Pham, Chief
Projects Branch 1
Division of License Renewal
Office of Nuclear Reactor Regulation

Docket No. 50-443

Enclosures:
1. Area Map, 50-mile radius
2. Area Map, 6-mile radius
3. Site Area Map
4. Intake/Discharge Tunnels and Shafts Diagram
5. Transmission Line Map

cc w/encls: Distribution via Listserv

P. Kurkul - 3 -

If you have any questions concerning the staff's review of this license renewal application, please contact Mr. Jeremy Susco, Project Manager, at (301) 415-2927 or by e-mail at Jeremy.Susco@nrc.gov.

Sincerely,

/RA/

Bo Pham, Chief
Projects Branch 1
Division of License Renewal
Office of Nuclear Reactor Regulation

Docket No. 50-443

Enclosures:
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NAME	JSusco	IKing	MSpencer	BPham
DATE	07/01/10	06/30/10	07/07/10	07/16/10

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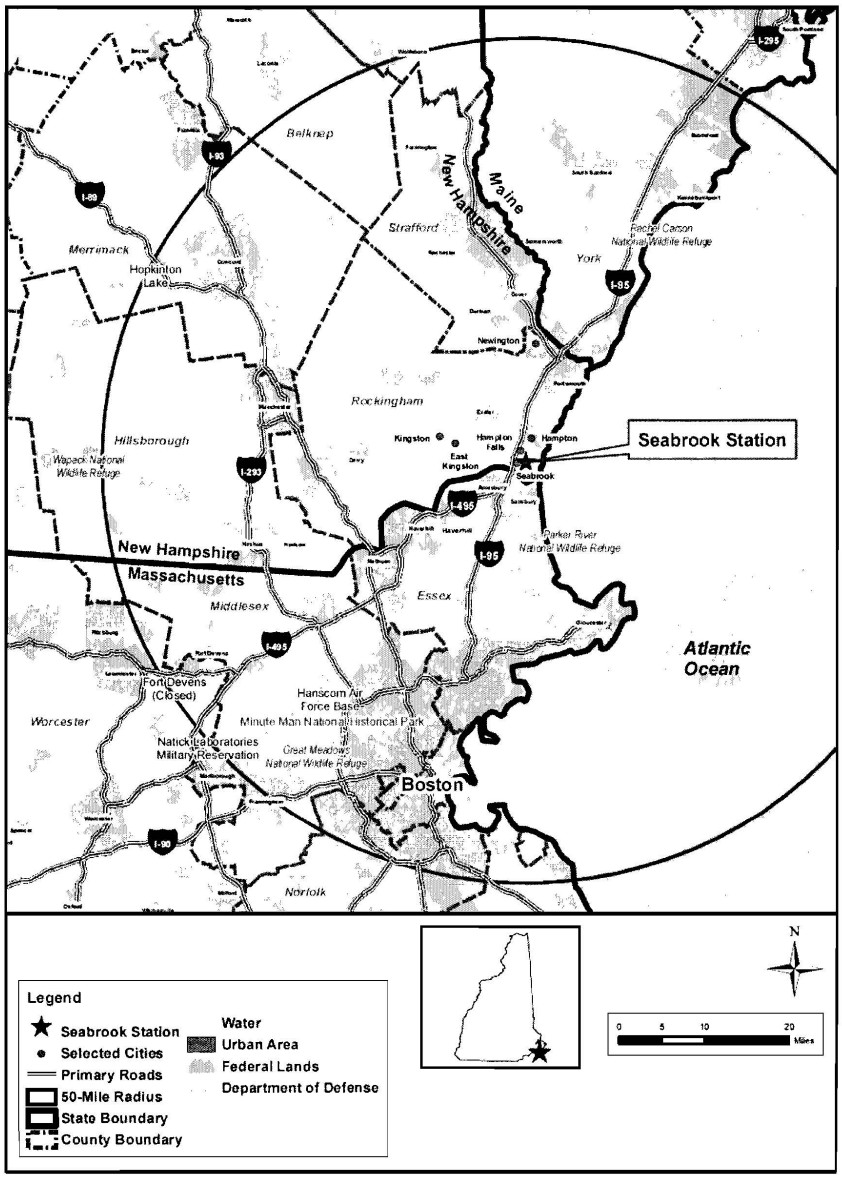
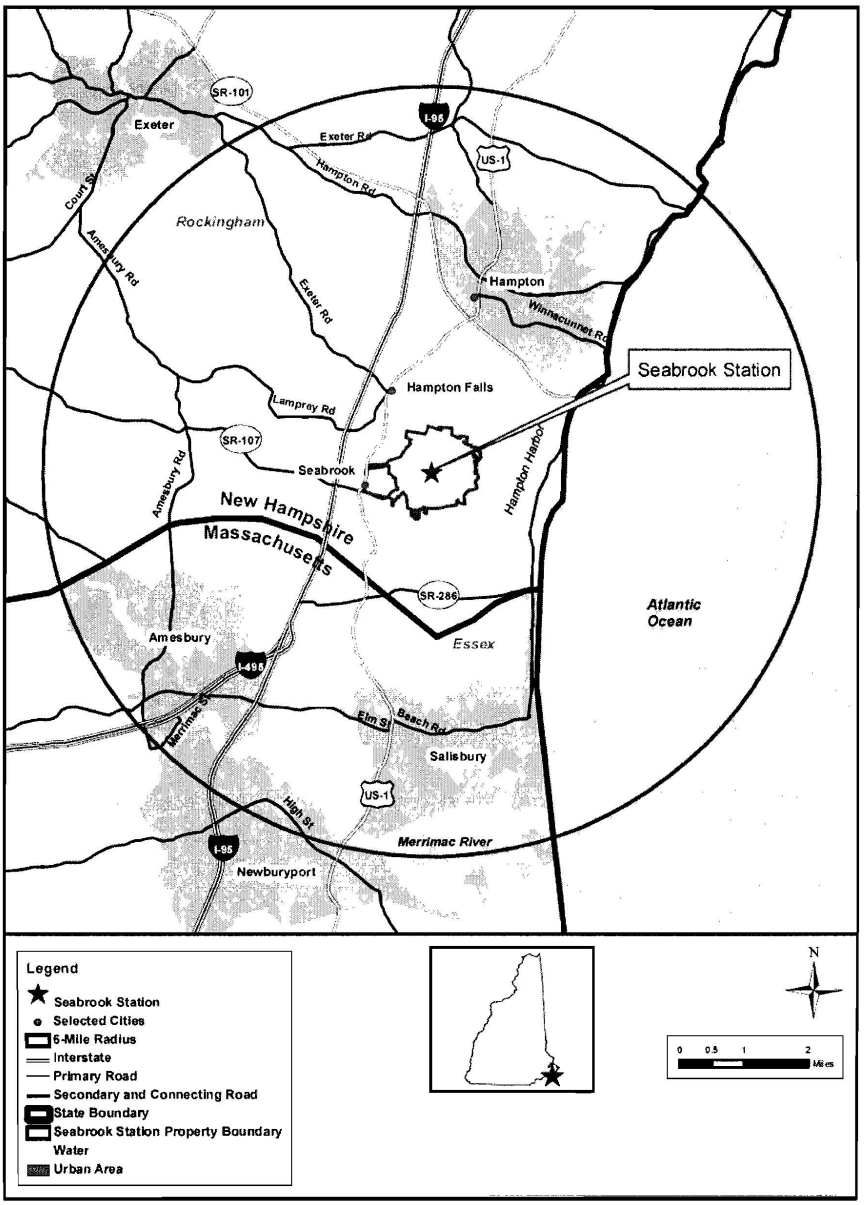
Area Map, 50-Mile Radius



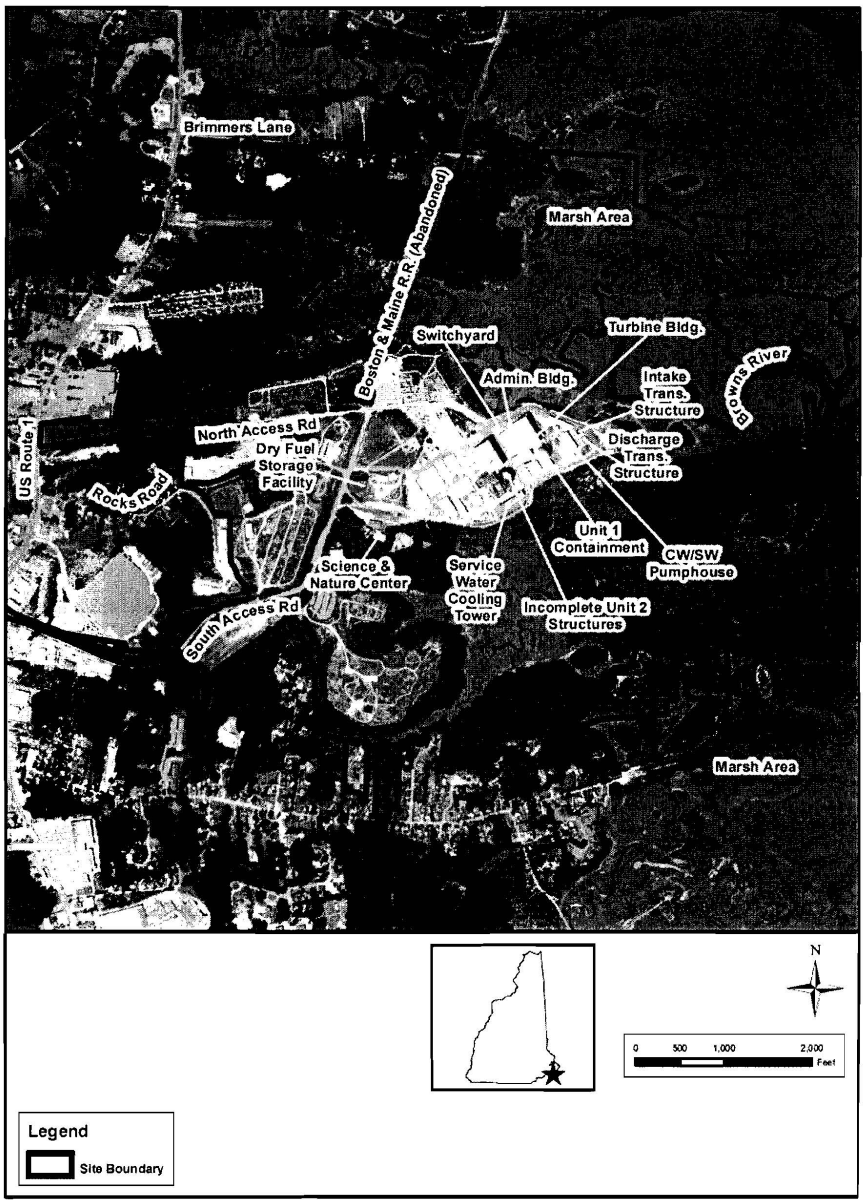
ENCLOSURE 1

Area Map, 6-Mile Radius



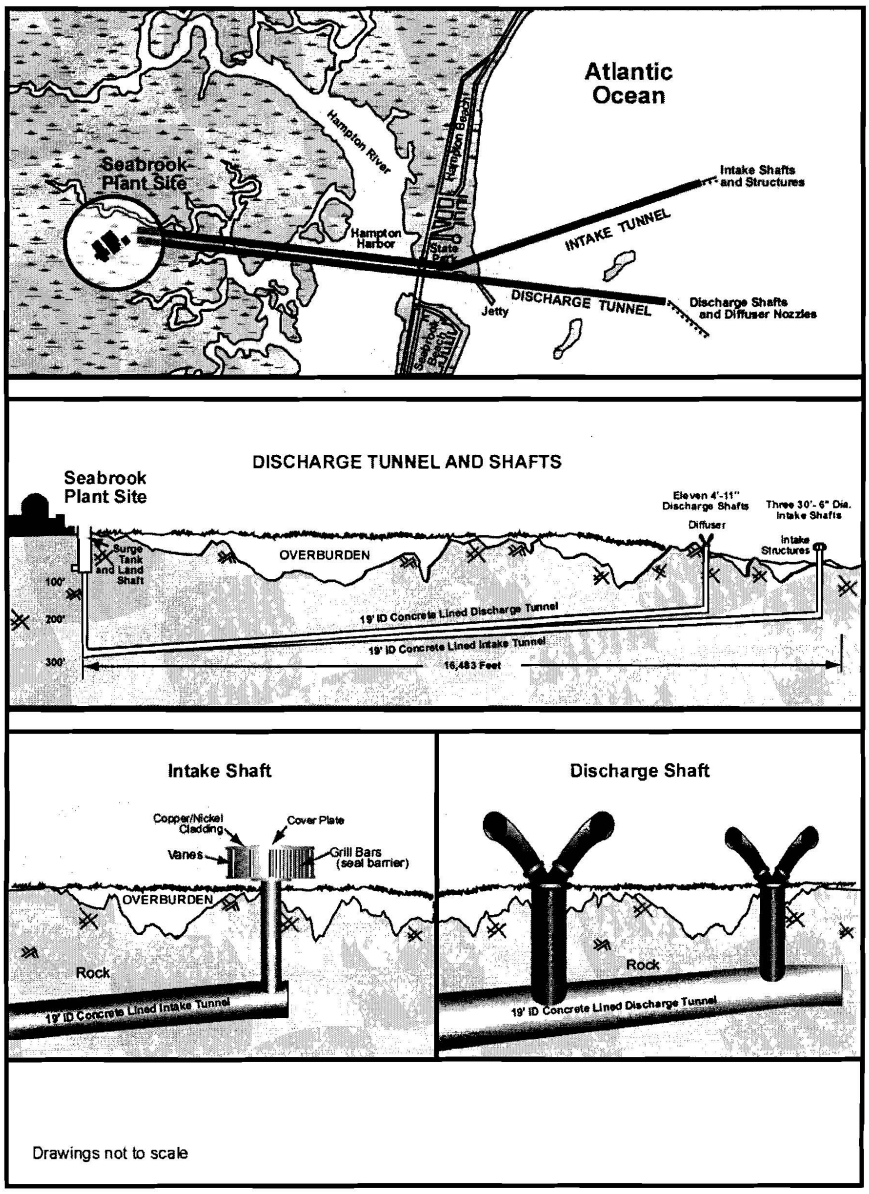
ENCLOSURE 2

Site Area Map



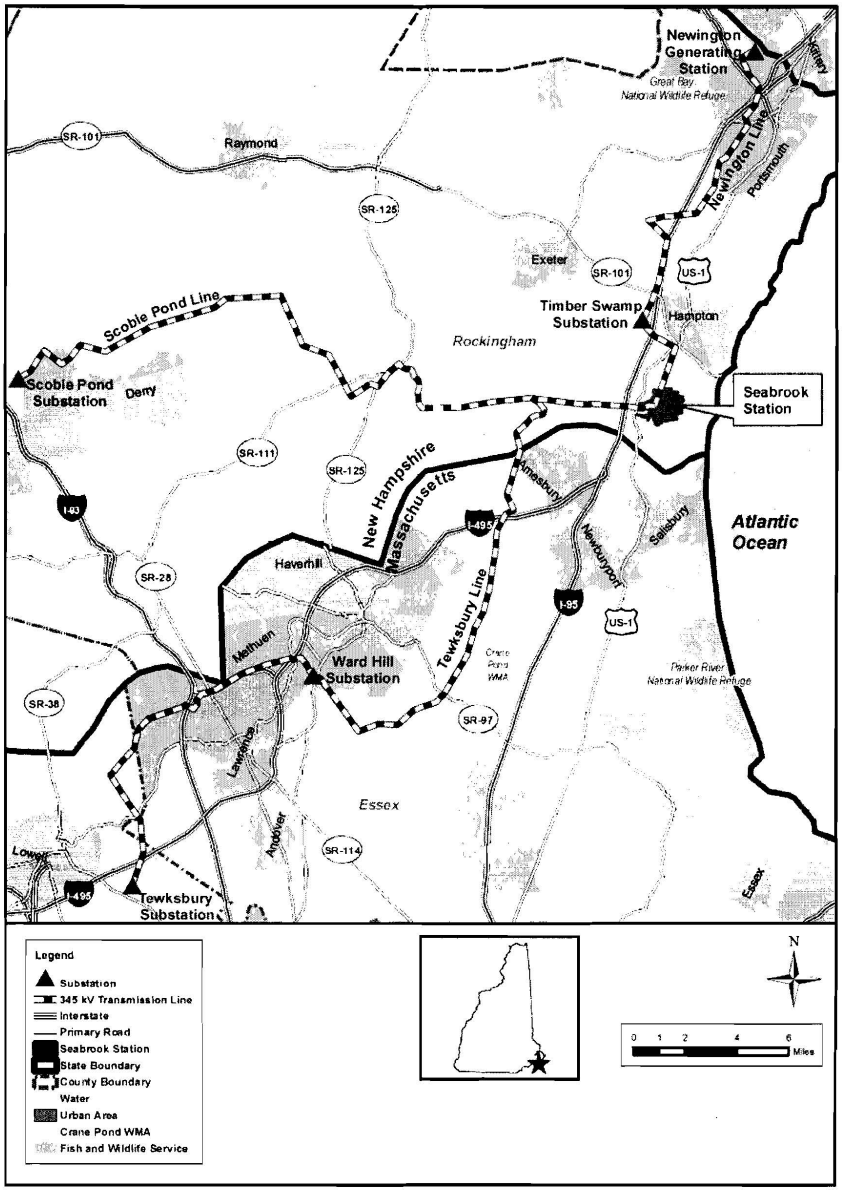
ENCLOSURE 3

Intake/Discharge Tunnels and Shafts Diagram



ENCLOSURE 4

Transmission Line Map



ENCLOSURE 5

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

July 16, 2010

Elizabeth H. Muzzey, Director and
State Historic Preservation Officer
New Hampshire Division of Historical
Resources
19 Pillsbury Street
2nd Floor
Concord, NH 03301-3570

SUBJECT: SEABROOK STATION LICENSE RENEWAL APPLICATION REVIEW (R&C # 863)

Dear Ms. Muzzey:

The U.S. Nuclear Regulatory Commission (NRC or the staff) is reviewing an application submitted by NextEra Energy Seabrook, LLC, for the renewal of the operating license for Seabrook Station, Unit 1 (Seabrook Station). Seabrook Station is located 13 miles south of Portsmouth, NH. The application for renewal was submitted by NextEra Energy Seabrook, LLC, in a letter dated May 25, 2010, pursuant to Title 10 of the *Code of Federal Regulations* Part 54 (10 CFR Part 54). The NRC has established that, as part of the staff's review of any nuclear power plant license renewal application, a site-specific Supplemental Environmental Impact Statement (SEIS) to it *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*, NUREG-1437, will be prepared under 10 CFR Part 51, the NRC's regulation that implements the National Environment Policy Act of 1969, as amended. The SEIS includes an analysis of pertinent environmental issues, and in accordance with 36 CFR 800.8(c), will include analyses of potential impacts to historic and cultural resources.

In the context of the National Historic Preservation Act of 1966, as amended, the staff has determined that the area of potential effect (APE) for a license renewal action is the area at the power plant site and its immediate environs that may be impacted by post-license renewal land-disturbing operations or projected refurbishment activities associated with the proposed action. The APE may extend beyond the immediate environs in those instances where post-license renewal land-disturbing operations or projected refurbishment activities specifically related to license renewal may potentially have an effect on known or proposed historic sites. This determination is made irrespective of ownership or control of the lands of interest.

NextEra Energy Seabrook, LLC, stated that it has no plans to alter current operations over the license renewal period and that Seabrook Station, operating under a renewed license, would use existing plant facilities and transmission lines and would not require additional construction or disturbance of new areas. According to NextEra Energy Seabrook, LLC, any maintenance activities would be limited to previously disturbed areas. Please see the enclosed maps and pictures, which show the area under review.

The staff plans to hold two public environmental scoping meetings on August 19, 2010, at the Galley Hatch Conference Center, 815 Lafayette Road, Hampton, NH 03842. The first meeting will convene at 1:30p.m. and will continue until 3:30p.m., as necessary. The second meeting will convene at 7:00p.m., with a repeat of the overview portions of the first meeting, and will

continue until 9:00p.m., as necessary. In addition, during the week of October 4, 2010, the staff plans to conduct a site audit at Seabrook Station. You and your staff are invited to attend both the site audit and the public meetings. Your office will receive a copy of the draft SEIS along with a request for comments. The anticipated publication date for the draft SEIS is May 2011.

The Seabrook Station license renewal application is available at: http://www.nrc.gov/reactors/operating/licensing/renewal/applications/seabrook.html.

If you have any questions concerning the staff's review of this license renewal application, please contact Mr. Jeremy Susco, Project Manager, at (301) 415-2927 or by e-mail at jeremy.susco@nrc.gov.

Sincerely,

Bo Pham, Chief
Projects Branch 1
Division of License Renewal
Office of Nuclear Reactor Regulation

Docket No. 50-443

Enclosures:
1. Area Map, 50-mile radius
2. Area Map, 6-mile radius
3. Site Area Map
4. Transmission Line Map

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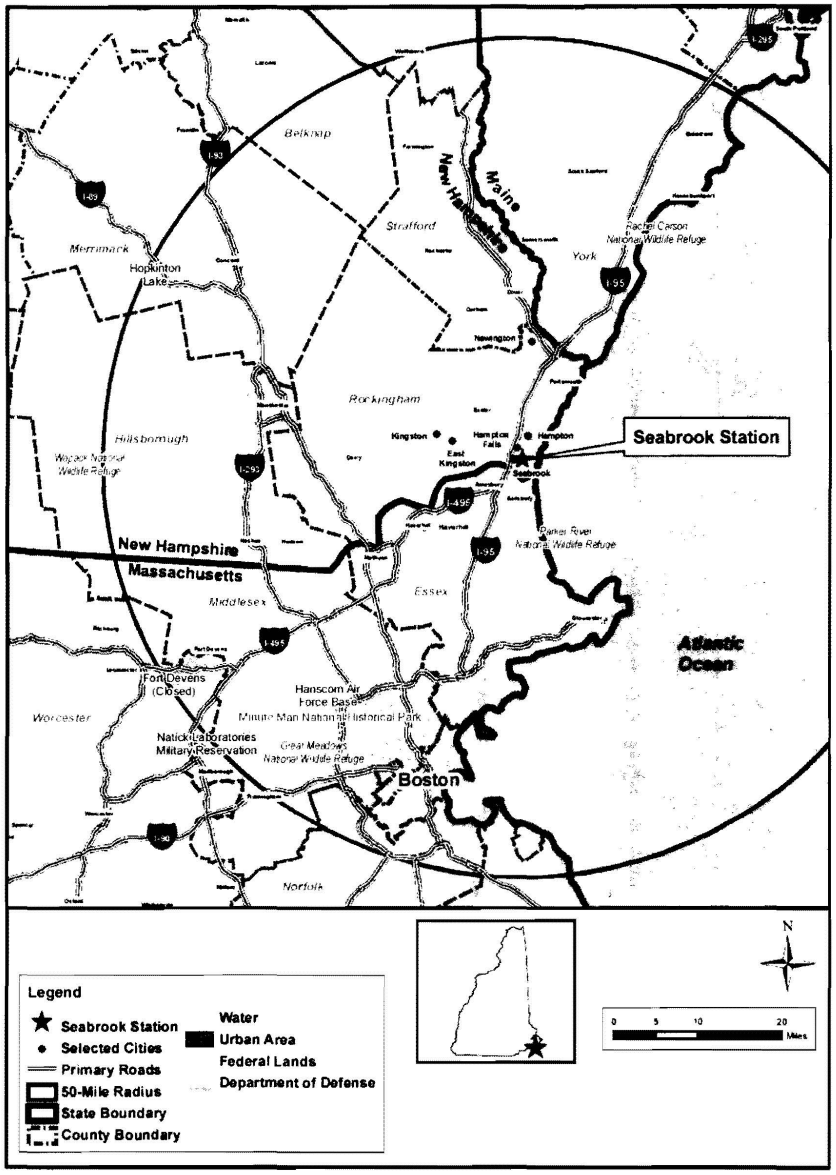
Area Map, 50-Mile Radius



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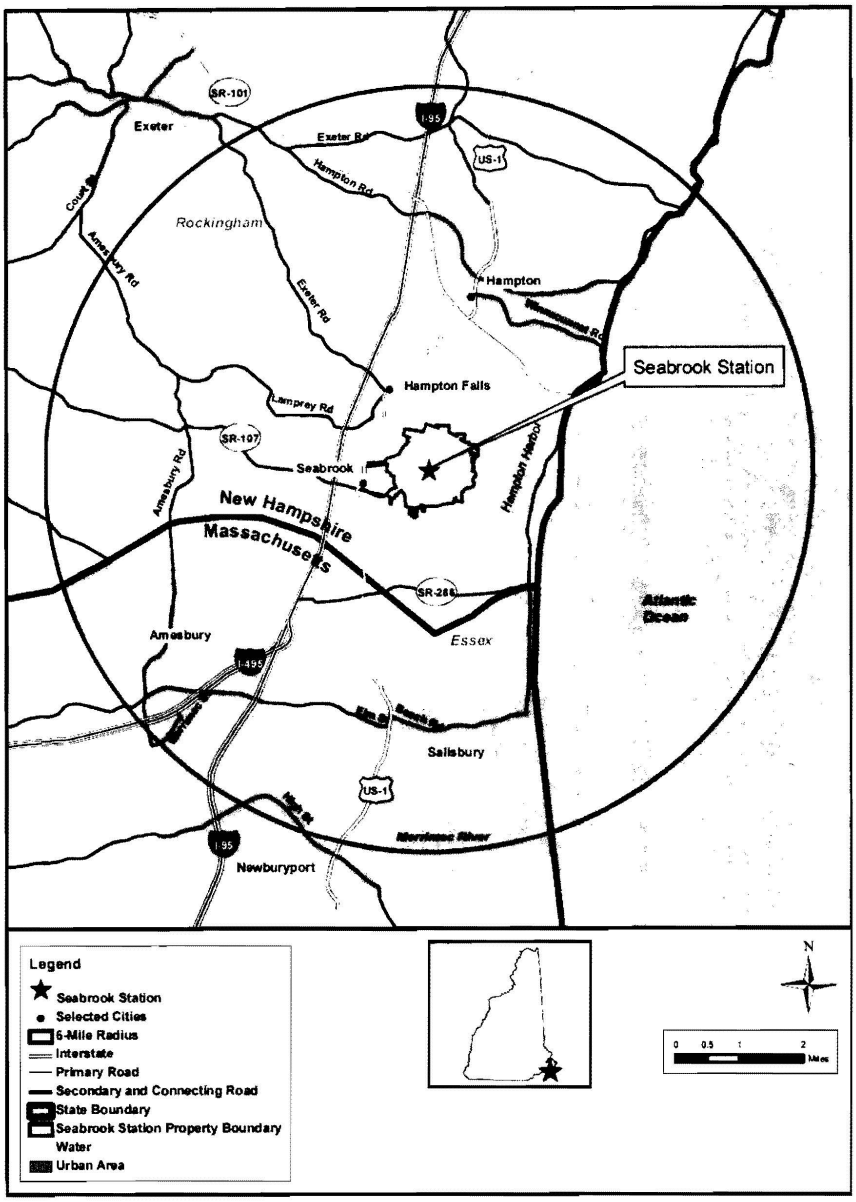
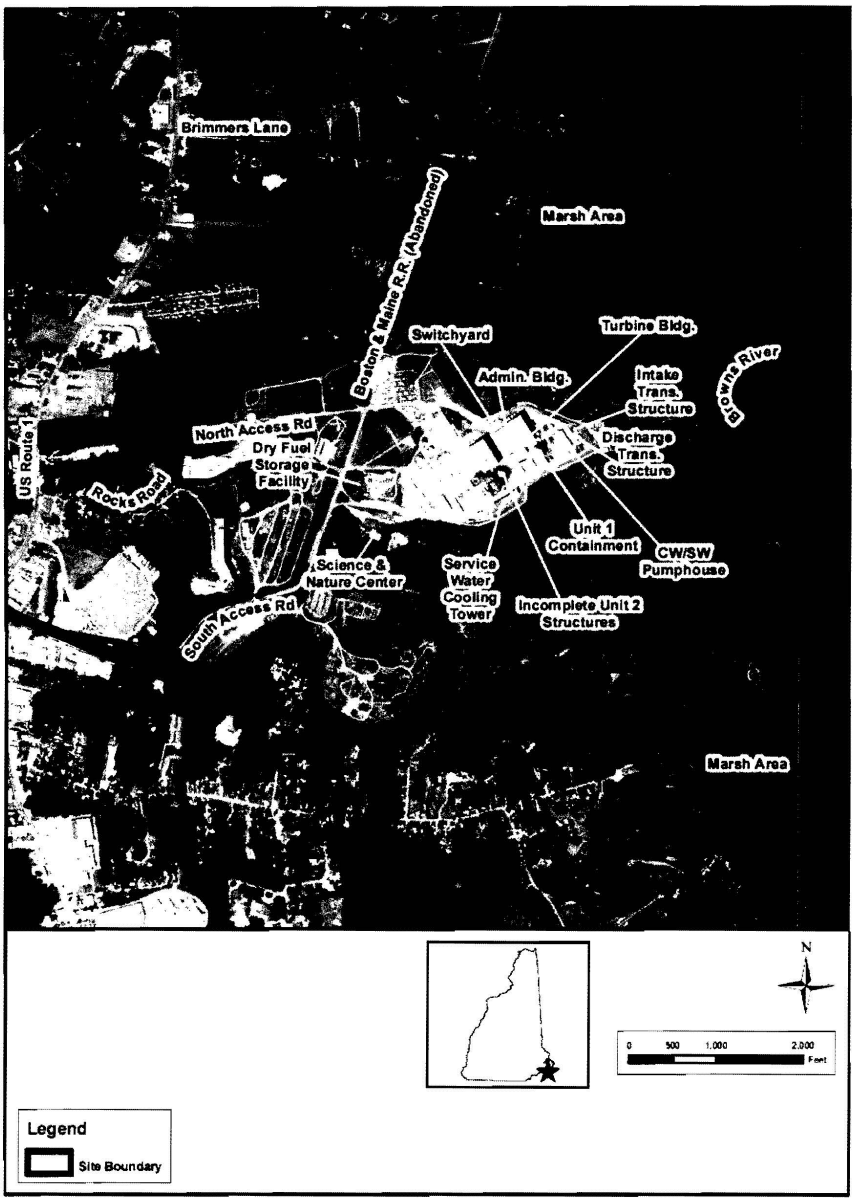
Area Map, 6-Mile Radius



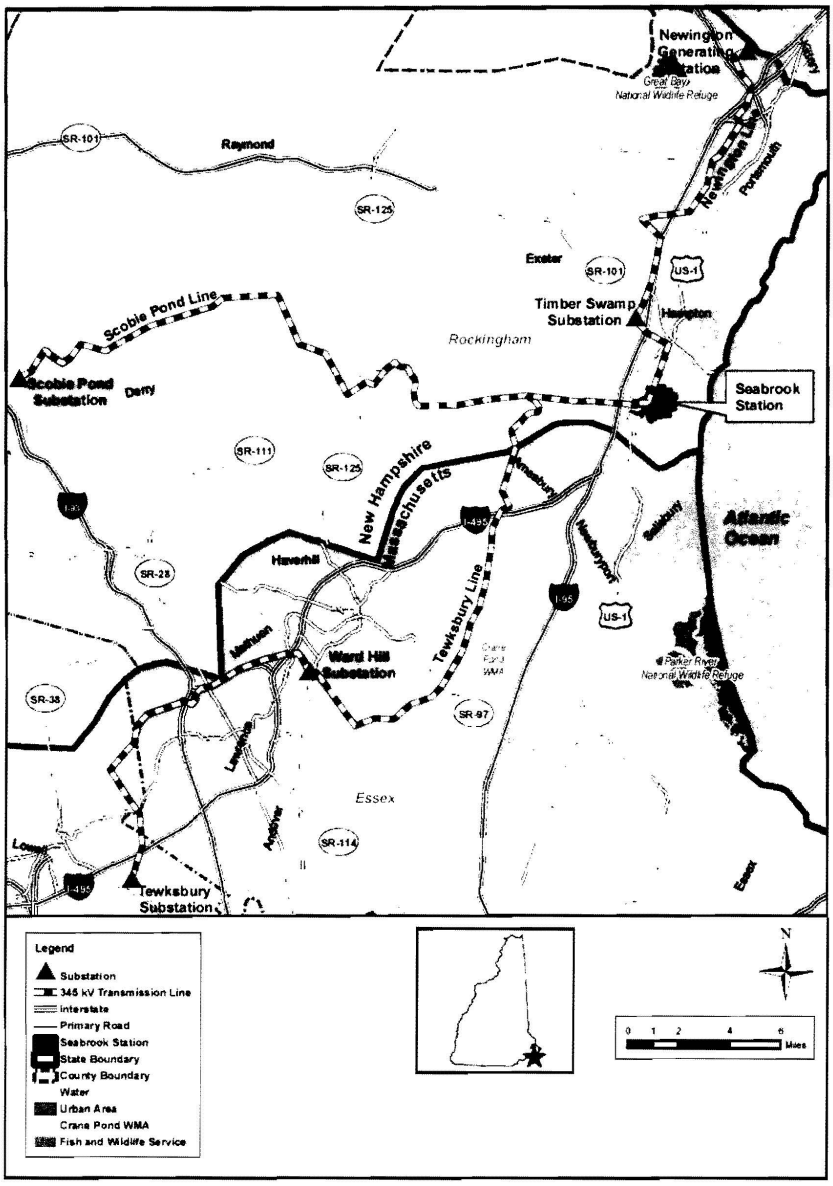
ENCLOSURE 2

Site Area Map



ENCLOSURE 3

Transmission Line Map



ENCLOSURE 4

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Sincerely,

/RA/

Bo Pham, Chief
Projects Branch 1
Division of License Renewal
Office of Nuclear Reactor Regulation

Docket No. 50-443

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ADAMS Accession No: ML101790273

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NAME	JSusco	IKing	CKanatas (NLO)	BPham
DATE	07/01/10	06/30/10	07/07/10	07/16/10

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Letter to E. Muzzey from B. Pham dated July, 16, 2010

SUBJECT: SEABROOK STATION LICENSE RENEWAL APPLICATION REVIEW (R&C # 863)

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

July 16, 2010

Mr. Marvin Moriarty, Regional Director
Northeast Regional Office
U.S. Fish and Wildlife Service
300 Westgate Center Drive
Hadley, MA 01035-9587

SUBJECT: REQUEST FOR LIST OF PROTECTED SPECIES WITHIN THE AREA UNDER EVALUATION FOR THE SEABROOK STATION LICENSE RENEWAL APPLICATION REVIEW

Dear Mr. Moriarty:

The U.S. Nuclear Regulatory Commission (NRC or the staff) is reviewing an application submitted by NextEra Energy Seabrook, LLC, for the renewal of the operating license for Seabrook Station, Unit 1 (Seabrook Station). Seabrook Station is located 13 miles south of Portsmouth, NH. The application for renewal was submitted by NextEra Energy Seabrook, LLC, in a letter dated May 25, 2010, pursuant to Title 10 of the *Code of Federal Regulations* Part 54 (10 CFR Part 54). The NRC has established that, as part of the staff's review of any nuclear power plant license renewal application, a site-specific Supplemental Environmental Impact Statement (SEIS) to its *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*, NUREG-1437, will be prepared under 10 CFR Part 51, the NRC's regulation that implements the National Environmental Policy Act of 1069, as amended. The SEIS includes an analysis of pertinent environmental issues, including endangered or threatened species and impacts to fish and wildlife. This letter is being submitted under the provisions of the Endangered Species Act of 1973, as amended, and the Fish and Wildlife Coordination Act of 1934, as amended.

NextEra Energy Seabrook, LLC, stated that it has no plans to alter current operations over the license renewal period and that Seabrook Station, operating under a renewed license, would use existing plant facilities and transmission lines and would not require additional construction or disturbance of new areas. According to NextEra Energy Seabrook, LLC, any maintenance activities would be limited to previously disturbed areas. The site consists of 889 acres divided into two lots. Lot 1 is approximately 109 acres, is mostly developed, and holds most of the operating facility. Lot 2 is approximately 780 acres and consists mainly of natural areas available for wildlife resources. The natural areas are characterized by broad open areas of level tidal marsh veined with man-made linear drainage ditches and tidal creeks. Wooded islands and peninsulas rise from the marsh to elevations of 20 to 30 feet above sea level. The site is on a peninsula of land, which is bordered on the north by the Browns River and on the south by Hunts Island Creek. Estuarine marshlands bound the site to the east. It is estimated that approximately 300 acres of the site are upland and 600 acres are marsh/wetland areas. Please see the maps in Enclosures 1, 2, and 3 for further detail.

Seabrook Station is a single unit, pressurized-water reactor plant. Seabrook Station employs a once-through heat dissipation system designed to remove waste heat from the plant. Its circulating water system provides cooling water to the main condensers to remove the heat that is rejected by the turbine cycle and auxiliary system and to the plant's service water system.

Water for these systems is carried to and from the Atlantic Ocean to the plant through long tunnels drilled through the underlying bedrock. The tunnels are hydraulically connected to the ocean by way of concrete shafts that extend approximately 6000 feet offshore, with the intake and discharge points approximately 60 feet below sea level. Please see Enclosure 4 for a drawing of the system. During normal operations, the circulating water system provides a continuous flow of approximately 390,000 gallons per minute (gpm) to the main condenser and 21,000 gpm to the service water system. Fresh water is purchased from the Town of Seabrook, and sanitary waste water is discharged back to the town system.

As part of the SEIS preparation, the applicable transmission line corridors will be reviewed. The Seabrook Station 345 kilovolt (kV) switchyard is adjacent to the plant on the north side of the property. From here, three 345 kV transmission lines connect Seabrook Station to the New England electric grid. These lines deliver power to three substations: at Scobie Pond, near Derry, New Hampshire; at Tewksbury, Massachusetts; and at Newington, New Hampshire. The transmission lines include approximately 86 miles of corridor with approximately 1,061 acres of right-of-way in New Hampshire and 662 acres of right-of-way in Massachusetts for the specific purpose of connecting Seabrook Station to the transmission system. Please see the map in Enclosure 5 for further detail.

To support the SEIS preparation process and to ensure compliance with Section 7 of the Endangered Species Act, the NRC requests a list of species and information on protected, proposed, and candidate species and critical habitat that may be in the vicinity of Seabrook Station and its associated transmission line rights-of-way. In addition, please provide any information you consider appropriate under the provisions of the Fish and Wildlife Coordination Act.

The staff plans to hold two public environmental scoping meetings on August 19, 2010, at the Galley Hatch Conference Center, 815 Lafayette Road, Hampton, NH 03842. The first meeting will convene at 1:30p.m. and will continue until 3:30p.m., as necessary. The second meeting will convene at 7:00p.m., with a repeat of the overview portions of the first meeting, and will continue until 9:00p.m., as necessary. In addition, during the week of October 4, 2010, the staff plans to conduct a site audit at Seabrook Station. You and your staff are invited to attend both the site audit and the public meetings. Your office will receive a copy of the draft SEIS along with a request for comments. The anticipated publication date for the draft SEIS is May 2011.

The Seabrook Station license renewal application is available at:

http://www.nrc.gov/reactors/operating/licensing/renewal/applications/seabrook.html.

If you have any questions concerning the staff's review of this license renewal application, please contact Mr. Jeremy Susco, Project Manager, at (301) 415-2927 or jeremy.susco@nrc.gov.

Sincerely,

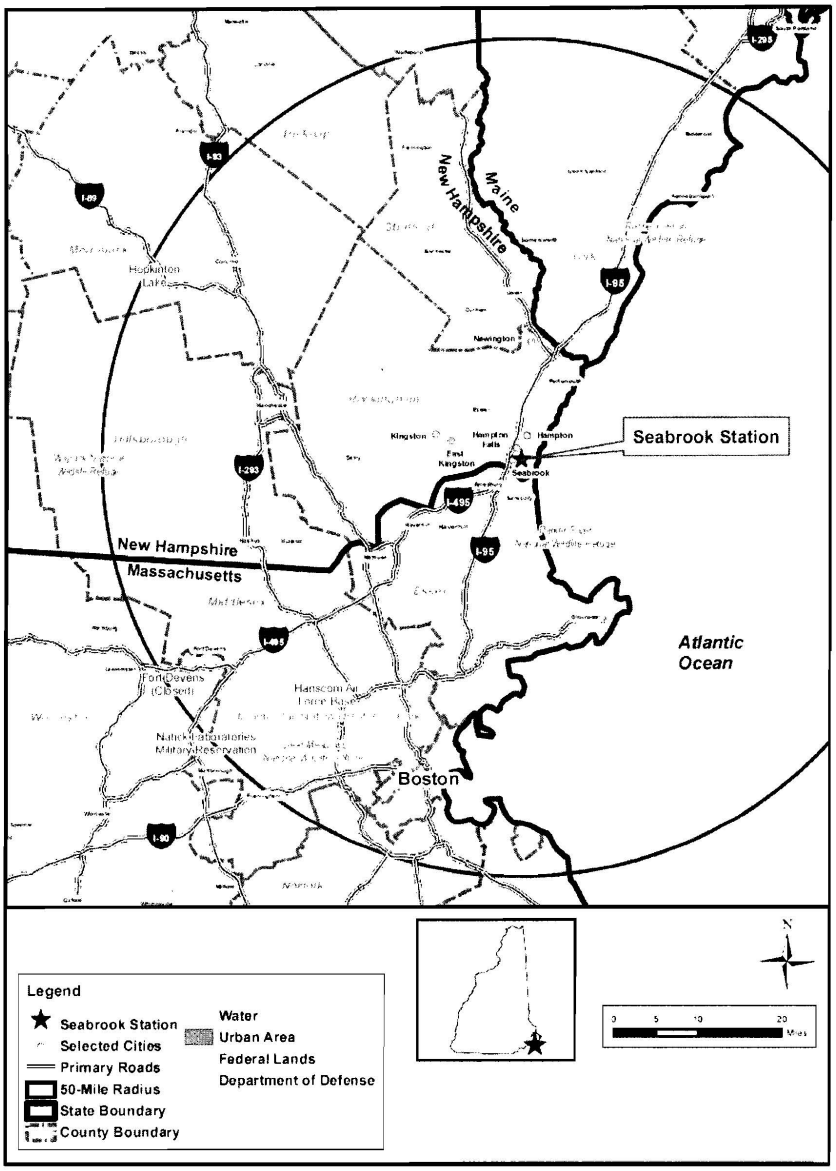
Bo Pham, Chief
Projects Branch 1
Division of License Renewal
Office of Nuclear Reactor Regulation

Docket No. 50-443

Enclosures:
1. Area Map, 50-mile radius
2. Area Map, 6-mile radius
3. Site Area Map
4. Intake/Discharge Tunnels and Shafts Diagram
5. Transmission Line Map

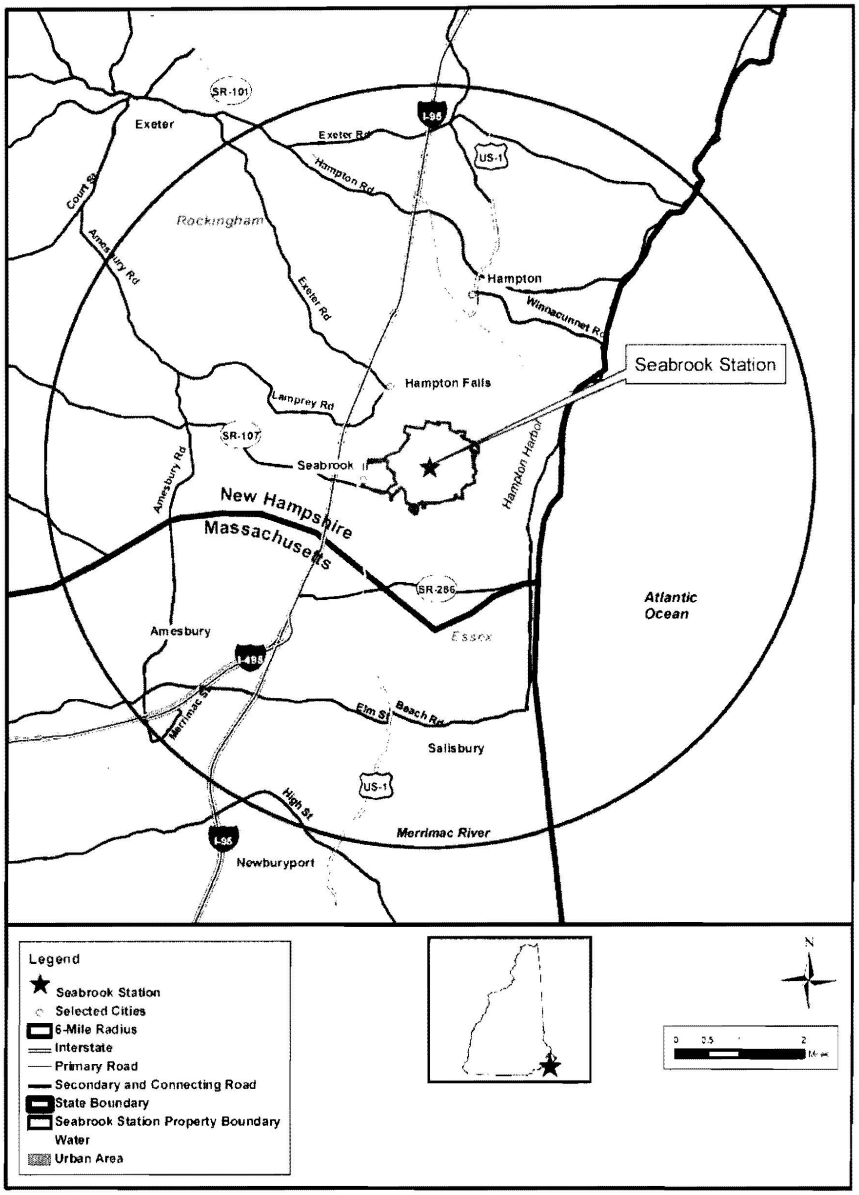
cc w/encls. Distribution via Listserv

Area Map, 50-Mile Radius



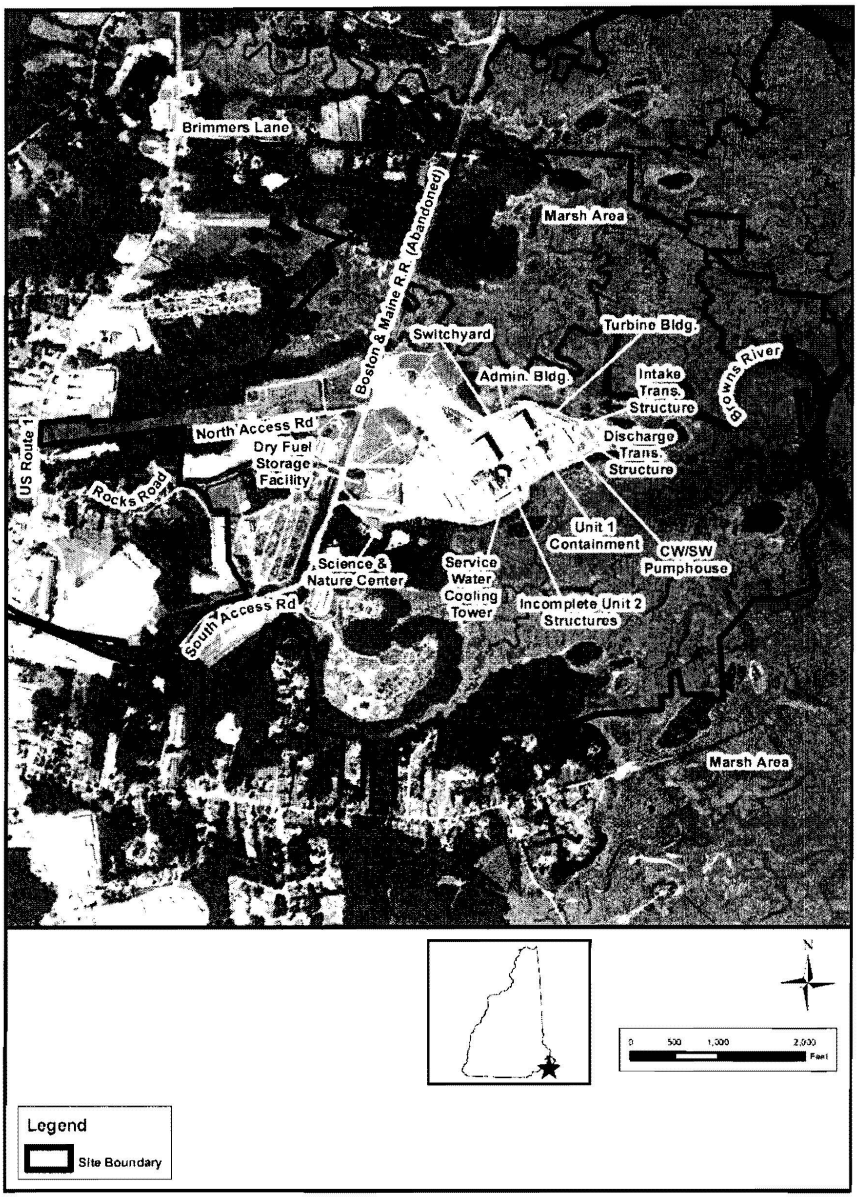
ENCLOSURE 1

Area Map, 6-Mile Radius



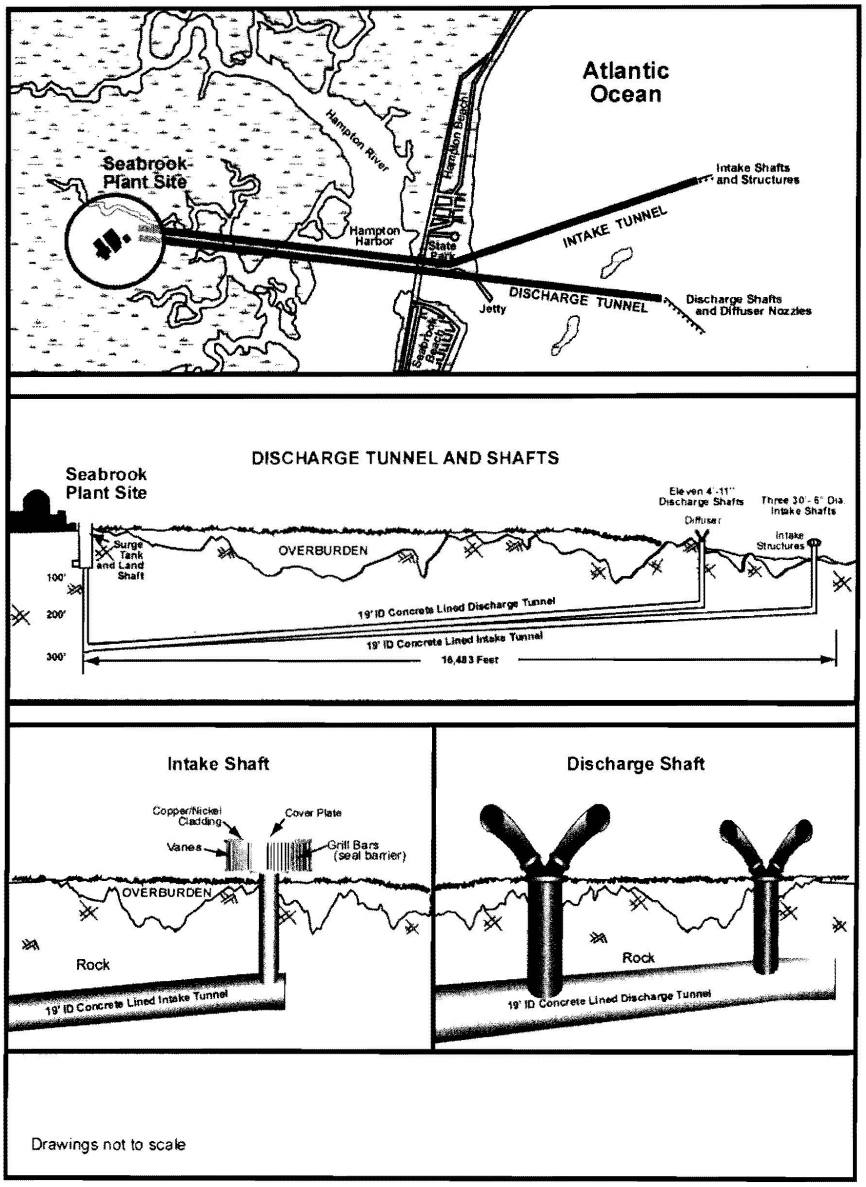
ENCLOSURE 2

Site Area Map



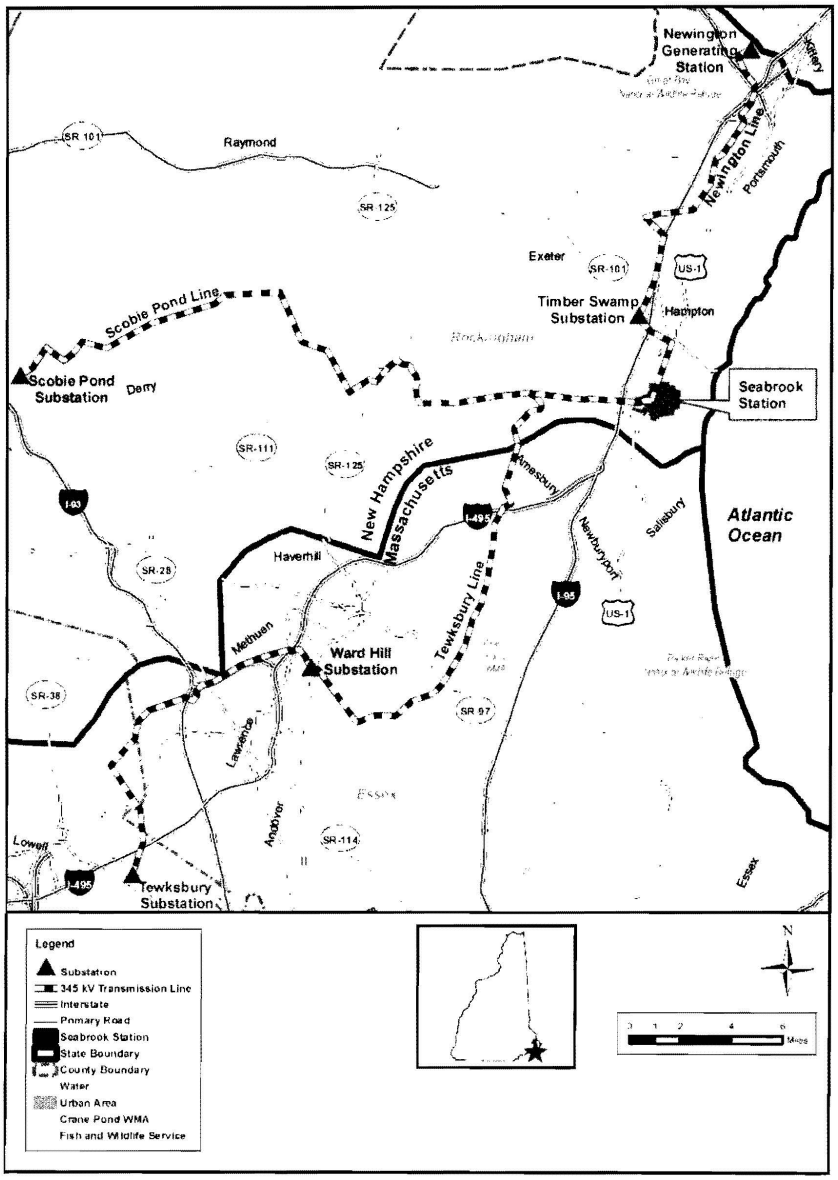
ENCLOSURE 3

Intake/Discharge Tunnels and Shafts Diagram



ENCLOSURE 4

Transmission Line Map



ENCLOSURE 5

The Seabrook Station license renewal application is available at:

http://www.nrc.gov/reactors/operating/licensing/renewal/applications/seabrook.html.

If you have any questions concerning the staff's review of this license renewal application, please contact Mr. Jeremy Susco, Project Manager, at (301) 415-2927 or jeremy.susco@nrc.gov.

Sincerely,

/RA/

Bo Pham, Chief
Projects Branch 1
Division of License Renewal
Office of Nuclear Reactor Regulation

Docket No. 50-443

Enclosures:
1. Area Map, 50-mile radius
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ADAMS Accession No: ML101790278

OFFICE	PM:RPB1:DLR	LA:DLR	OGC	BC:RPB1:DLR
NAME	JSusco	SFigueroa	CKanatas (NLO)	B. Pham
DATE	07/01/10	07/12/10	07/07/10	07/16/10

OFFICIAL RECORD COPY

Letter to M. Moriarty from B. Pham dated July, 16, 2010

SUBJECT: REQUEST FOR LIST OF PROTECTED SPECIES WITHIN THE AREA UNDER EVALUATION FOR THE SEABROOK STATION LICENSE RENEWAL APPLICATION REVIEW

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NEW HAMPSHIRE DIVISION OF HISTORICAL RESOURCES
State of New Hampshire, Department of Cultural Resources
19 Pillsbury Street, Concord, NH 03301-3570
TDD Access: Relay NH 1-800-735-2964
www.nh.gov/nhdhr
603-271-3483
603-271-3558
FAX 603-271-3433
preservation@dcr.nh.gov

July 27, 2010

Bo Pham, Chief
Projects Branch 1
Division of License Renewel
Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Re: Seabrook Station License Renewal Application Review (R&C #863)

Dear Mr. Pham:

Thank you for your letter of July 16th 2010 that defines the area of potential effect (APR) for this license renewal action and that states that NextEra Energy Seabrook, LLC does not plan to alter current operations.

The Division looks forward to continued consultation on this project and review of the draft SEIS.

Sincerely,

Edna Feighner

Edna Feighner
NH Division of Historical Resources
Archaeologist/Review and Compliance Coordinator

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
NORTHEAST REGION
55 Great Republic Drive
Gloucester, MA 01930-2276

AUG - 5 2010

Bo Pham, Chief
Projects Branch 1
Division of License Renewal
Office of Nuclear Reactor Regulation
Nuclear Regulatory Commission
Washington, DC 20555-0001

Re: Renewal application for Seabrook Station, Seabrook, New Hampshire

Dear Mr. Pham:

The National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NMFS) has received your letter, dated July 16, 2010, regarding the request for a list of protected species and Essential Fish Habitat (EFH) within the area under evaluation for the Seabrook Station license renewal application review. The applicant (NextEra Energy Seabrook, LLC) proposes to maintain current operations over the license renewal period at the Seabrook Station. The renewed license would use existing plant facilities and transmission lines and would not require additional construction or disturbance of new areas. In addition, any maintenance activities would be limited to previously disturbed areas.

The Magnuson-Stevens Fishery Conservation and Management Act (MSA) and the Fish and Wildlife Coordination Act require federal agencies to consult with one another on projects such as this. Insofar as a project involves EFH, as this project does, this process is guided by the requirements of our EFH regulation at 50 CFR 600.905, which mandates the preparation of EFH assessments and generally outlines each agency's obligations in this consultation procedure.

The required contents of an EFH assessment include: 1) a description of the action; 2) an analysis of the potential adverse effects of the action on EFH and the managed species; 3) the federal agency's conclusion regarding the effects of the action on EFH; and 4) proposed mitigation, if applicable. Other information that should be contained in the EFH assessment, if appropriate, includes: 1) the results of on-site inspections to evaluate the habitat and site-specific effects; 2) the views of recognized experts on the habitat or the species that may be affected; 3) a review of pertinent literature and related information; and 4) an analysis of alternatives to the action that could avoid or minimize the adverse effects on EFH. Upon submittal of an EFH

assessment by the federal action agency, the NMFS will provide conservation recommendations for the proposed project, as necessary.

Additionally, we are providing the following discussion of living marine resources within estuarine and marine waters in the Gulf of Maine near Seabrook, the Hampton-Seabrook Harbor, and the associated brackish marsh habitats.

General Information

The marine and estuarine waters in the area of Seabrook and the Hampton-Seabrook Harbor support a highly productive ecosystem, and the habitats within this area support a number of important living marine resources. A large recreational fishery for soft-shell clam exists in the harbor, including the middle-ground sand flat adjacent to Seabrook Harbor and the Blackwater River. Beds of blue mussels are also present in the harbor. In addition, the Gulf of Maine near Seabrook and in the outer portions of the Hampton-Seabrook Harbor supports a recreational and commercial fishery for American lobster. The dominant demersal species in the Gulf of Maine waters near Seabrook include winter flounder, windowpane flounder and longhorn sculpin (NAI 2009), and the dominant pelagic species include Atlantic herring, Atlantic mackerel, pollock, and blueback herring (NAI 1998).

Several diadromous fish species use the Hampton-Seabrook Harbor and the Blackwater River for their seasonal migration runs, including blueback herring, alewife, and rainbow smelt. Blueback herring and alewife adults typically leave freshwater streams and rivers and return to estuarine/marine waters during summer months, juveniles can be found migrating out of streams and rivers as late as October and early November (Collette and Klein-MacPhee 2002). Rainbow smelt adults begin their migration into estuaries and harbors in late fall/winter and enter freshwater streams to spawn in March or April; larvae are carried into the brackish water in May (Collette and Klein-MacPhee 2002). Due to declines in the populations of alewife, blueback herring, and rainbow smelt, these species have been classified as "species of concern" by NMFS. "Species of Concern" are those species about which NMFS has some concerns regarding status and threats, but for which insufficient information is available to indicate a need to list the species under the Endangered Species Act of 1973, as amended (ESA). Although the "species of concern" status does not carry any procedural or substantive protections under the ESA, concerns regarding their status and threats warrant proactive attention and conservation action.

The Hampton-Seabrook Harbor estuary has been identified as a highly productive nursery ground for several species, including winter flounder. For example, winter flounder was reported to be the most abundant fishfish in the Hampton-Seabrook estuary during the summer and fall, and young-of-year and age-1 flounder were most prevalent (Fairchild et al. 2008). In addition, the New Hampshire Fish and Game Department's 2006 estuarine survey of juvenile fish reported the seine collection stations in Hampton-Seabrook Harbor to have some of the highest catch numbers for all species out of the fifteen stations sampled in this state program (NHFG 2007). The catch per unit effort for juvenile winter flounder in the harbor was the highest for all seine stations, including Little Harbor, Piscataqua River, and Little Bay/Great Bay.

Essential Fish Habitat
The marine waters off Seabrook and the Hampton-Seabrook estuary have been designated as EFH under the MSA for a number of federally-managed species. These include Atlantic cod, whiting, red hake, winter flounder, ocean pout, Atlantic pout, Atlantic halibut, Atlantic sea scallop, monkfish, Atlantic butterfish, and Atlantic mackerel (all life stages); Atlantic herring, yellow flounder, windowpane flounder, American plaice, long-finned and short-finned squid, scup, and surf clam (juveniles and adults); haddock and pollock (juveniles); redfish (larvae, juveniles and adults); and bluefin tuna (adults).

Fish and Wildlife Coordination Act
As discussed above, the Hampton-Seabrook estuary supports a large population of soft-shell clam and blue mussel. The New Hampshire Department of Fish and Game has produced maps depicting large and established shellfish beds in the middle-ground sand flat adjacent to the Seabrook anchorage area and the shoals adjacent to the Hampton anchorage and the entrance channel. The American lobster is known to utilize the rocky habitat within the channel entrance and jetties. In addition, a number of species of finfish use the Hampton-Seabrook estuary for various stages of their life history, such as for spawning migrations by blueback herring, alewife, and rainbow smelt.

Impingement and Entrainment
The source water for the Seabrook Station cooling water is in the western Gulf of Maine, located approximately 17,000 feet offshore in about 60 feet of water via three concrete intake structures. During normal operations, approximately 410,000 gallons of water per minute is pumped into Seabrook Station (NextEra 2010). Seabrook Station has been monitoring potential environmental impacts in the Hampton-Seabrook areas since 1975, including entrainment of eggs and larvae, impingement of juvenile and adult fish, and impacts associated with offshore thermal discharge of water. In 2008, an estimated 791 million eggs and 334 million fish larvae were entrained, and an estimated 17,932 fish were impinged within the cooling intake structures (NAI 2009). The majority of fish impinged at Seabrook Station are young-of-year and age-1, demersal species taken during the spring and fall, presumably when these young fish migrate between the Hampton-Seabrook Harbor nursery grounds and offshore waters. Because of the connections between the offshore and inshore environments in the life history of a number of estuarine-dependent species, the impingement and entrainment impact to fish from the offshore water intake structures also affects the productivity within the Hampton-Seabrook estuary.

Summary
The marine and estuarine waters in the area of Seabrook and the Hampton-Seabrook Harbor support a highly productive ecosystem the habitats within this area support a number of important living marine resources. Specific issues of concern related to the license renewal application review include the impingement and entrainment of fishery resources resulting from the intake of water for cooling purposes. Based on data collected for the Seabrook Station environmental monitoring program, an evaluation of impacts from the proposed action should be conducted and alternatives which avoid and minimize the adverse effect to fishery resources should be considered. We look forward to reviewing your EFH assessment of this activity. Should you have any questions about this information, please contact Michael Johnson at 978-281-9131 or at the letterhead address of this letter.

Endangered Species Act
Several species of sea turtle and whales are listed as threatened or endangered under the ESA. Federally endangered Northern right whales (*Eubalaena glacialis*), humpback (*Megaptera novaeangliae*), and fin whales (*Balaenoptera physalus*) are found seasonally off the coast of New Hampshire. However, as these species are typically found in deeper offshore waters, none of these species are likely to occur in the vicinity of the Seabrook facility or the facility's intake or discharge.

Sea turtles are also seasonally present off the coast of New Hampshire, and occasional individuals may occur in the vicinity of the Seabrook facility. The sea turtles in these waters are most likely to be endangered leatherback sea turtles (*Dermochelys coriacea*) or threatened loggerhead (*Caretta caretta*) sea turtles. Endangered Kemp's ridley (*Lepidochelys kempi*) sea turtles would be less likely to be present in these waters. Sea turtle species are typically present off the coast of New Hampshire between June and October.

Technical Assistance for Candidate Species
Candidate species are those petitioned species that are actively being considered for listing as endangered or threatened under the ESA, as well as those species for which NMFS has initiated an ESA status review that it has announced in the *Federal Register*.

Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) occur in the coastal waters of New Hampshire and are likely to occur in the vicinity of the Seabrook facility. In 2006, NMFS initiated a status review for Atlantic sturgeon to determine if listing as threatened or endangered under the ESA is warranted. The Status Review Report was published on February 23, 2007. NMFS is currently considering the information presented in the Status Review Report to determine if any listing action pursuant to the ESA is warranted at this time. If it is determined that listing is warranted, a final rule listing the species could be published within a year from the date of publication of the listing determination or proposed rule. Currently, NMFS expects to publish a finding as to whether any listing action is appropriate by the Fall of 2010. As a candidate species, Atlantic sturgeon receive no substantive or procedural protection under the ESA; however, NMFS recommends that project proponents consider implementing conservation actions to limit the potential for adverse effects on Atlantic sturgeon from any proposed project. Please note that once a species is proposed for listing the conference provisions of the ESA apply (see 50 CFR 402.10). As the listing status for this species may change, NMFS recommends that NRC obtain updated status information from NMFS prior to the completion of any NEPA documentation.

Marine Mammal Protection Act
Several species of marine mammals are common residents or occasional visitors to the waters of New Hampshire, including gray seals, harbor seals, and harbor porpoise. All marine mammals receive protection under the Marine Mammal Protection Act (MMPA) of 1972, as amended. The MMPA prohibits, with certain exceptions, the take of marine mammals in U.S. waters and by U.S. citizens on the high seas, and the importation of marine mammals and marine mammal products into the U.S. NMFS may issue permits under MMPA Section 104 (16 U.S.C. 1374) to persons that authorize the taking or importing of specific species of marine mammals. As you

may know, an MMPA permit has been issued for the Seabrook facility in the past. It is recommended that the applicant and/or the NRC discuss permitting needs with NMFS' Office of Protected Resources Permits, Conservation, & Education Division (301-713-2289) to determine if any additional coordination under the MMPA is necessary.

Section 7 Consultation
Under Section 7(a)(2) of the ESA, each Federal agency is required to insure that any action they authorize, fund or carry out is not likely to jeopardize the continued existence of any endangered species or threatened species. The renewal of the operating license for the Seabrook facility by the NRC would be a federal action requiring section 7 consultation.

We encourage NRC and the applicant to work with NMFS throughout the relicensing process as environmental documentation is developed to identify and evaluate the potential for impacts to the species under NMFS' jurisdiction. Informal discussions can greatly facilitate consultation. Should you have any questions regarding these comments as they relate to ESA matters, please contact Julie Crocker of my staff at (978)282-8480 or Julie.Crocker@Noaa.gov.

Sincerely,

Patricia A. Kurkul
Regional Administrator

CC: Crocker - F/NER3
Johnson, Chiarella - F/NER4

References

Collette BB, Klein-MacPhee G, editors. 2002. Bigelow and Schroeder's fishes of the Gulf of Maine. 3rd ed. Washington (DC): Smithsonian Institution Press. 748 p.

Fairchild EA, Sulikowski J, Rennels N, Howell WH, Gurshin CWD. 2008. Distribution of winter flounder, *Pseudopleuronectes americanus*, in the Hampton-Seabrook estuary, New Hampshire: observations from a field study. Estuaries and Coasts 31: 1158-1173.

NAI (Normandeau Associates, Inc.). 1998. Seabrook Station 1996 Environmental Monitoring in the Hampton-Seabrook Area: A characterization of environmental conditions. Prepared for Northeast Utilities Service Company.

NAI (Normandeau Associates, Inc.). 2009. Seabrook Station 2008 Environmental Monitoring in the Hampton-Seabrook area: A characterization of environmental conditions. Prepared for Nextera Energy Seabrook, LLC.

Nextera (Nextera Energy Seabrook, LLC.). 2010. Final applicant's environmental report-operating license renewal stage, Seabrook Station, Unit 1, Docket No. 05000443, License No. NPF-86.

NHFG (New Hampshire Fish and Game Department). 2007. Marine fisheries investigations, project I: anadromous fish investigations. Job 9: estuarine survey of juvenile finfish.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

August 26, 2010

Ms. Melissa Coppola
Endangered Species Reviewer
New Hampshire Natural Heritage Bureau
Department of Resources and Economic Development
P.O. Box 1856
Concord, NH 03302-1856

SUBJECT: SEABROOK STATION LICENSE RENEWAL APPLICATION REVIEW REQUEST FOR LIST OF STATE-PROTECTED SPECIES AND IMPORTANT HABITATS WITHIN THE AREA UNDER EVALUATION FOR THE SEABROOK STATION LICENSE RENEWAL APPLICATION REVIEW (NHB10-2146)

Dear Ms. Coppola:

The U.S. Nuclear Regulatory Commission (NRC or the staff) is reviewing an application submitted by NextEra Energy Seabrook, LLC, for the renewal of the operating license for Seabrook Station, Unit 1 (Seabrook Station). Seabrook Station is located 13 miles south of Portsmouth, NH. The application for renewal was submitted by NextEra Energy Seabrook, LLC, in a letter dated May 25, 2010, pursuant to Title 10 of the *Code of Federal Regulations* Part 54 (10 CFR Part 54). The NRC has established that, as part of the staff's review of any nuclear power plant license renewal application, a site-specific Supplemental Environmental Impact Statement (SEIS) to its *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*, NUREG-1437, will be prepared under 10 CFR Part 51, the NRC's regulation that implements the National Environmental Policy Act of 1969, as amended. The SEIS includes an analysis of pertinent environmental issues, impacts to endangered or threatened species, impacts to marine resources and habitats, and impacts to other fish and wildlife. This letter is being submitted under the provisions of the Fish and Wildlife Coordination Act of 1934, as amended, and to help the NRC meet its requirements under the Endangered Species Act of 1973, as amended.

NextEra Energy Seabrook, LLC, stated that it has no plans to alter current operations over the license renewal period and that Seabrook Station, operating under a renewed license, would use existing plant facilities and transmission lines and would not require additional construction or disturbance of new areas. According to NextEra Energy Seabrook, LLC, any maintenance activities would be limited to previously disturbed areas. The site consists of 889 acres divided into two lots. Lot 1 is approximately 109 acres, is mostly developed, and holds most of the operating facility. Lot 2 is approximately 780 acres and consists mainly of natural areas available for wildlife resources. The natural areas are characterized by broad open areas of level tidal marsh veined with man-made linear drainage ditches and tidal creeks. Wooded islands and peninsulas rise from the marsh to elevations of 20 to 30 feet above sea level. The site is on a peninsula of land, which is bordered on the north by the Browns River and on the south by Hunts Island Creek. Estuarine marshlands bound the site to the east. It is estimated that approximately 300 acres of the site are upland and 600 acres are marsh/wetland areas. Please see the maps in Enclosures 1, 2, and 3 for further detail.

Seabrook Station is a single unit, pressurized-water reactor plant. Seabrook Station employs a once-through heat dissipation system designed to remove waste heat from the plant. Its circulating water system provides cooling water to the main condensers to remove the heat that is rejected by the turbine cycle and auxiliary system and to the plant's service water system. Water for these systems is carried to and from the Atlantic Ocean to the plant through long tunnels drilled through the underlying bedrock. The tunnels are hydraulically connected to the ocean by way of concrete shafts that extend approximately 6000 feet offshore, with the intake and discharge points approximately 60 feet below sea level. Please see Enclosure 4 for a drawing of the system. During normal operations the circulating water system provides a continuous flow of approximately 390,000 gallons per minute (gpm) to the main condenser and 21,000 gpm to the service water system. Fresh water is purchased from the Town of Seabrook, and sanitary waste water is discharged back to the town system.

As part of the SEIS preparation, the applicable transmission line corridors will be reviewed. The Seabrook Station 345 kilovolt (kV) switchyard is adjacent to the plant on the north side of the property. From here, three 345 kV transmission lines connect Seabrook Station to the New England electric grid. These lines deliver power to three substations: at Scobie Pond, near Derry, New Hampshire; at Tewksbury, Massachusetts; and at Newington, New Hampshire. The transmission lines include approximately 86 miles of corridor with approximately 1,061 acres of right-of-way in New Hampshire and 662 acres of right-of-way in Massachusetts for the specific purpose of connecting Seabrook Station to the transmission system. Please see the map in Enclosure 5 for further detail.

To support the SEIS preparation process, the NRC requests a list of rare plants, rare animals, and exemplary communities that may be in the vicinity of Seabrook Station (Enclosure 3) and its associated transmission line rights-of-way (Enclosure 5). Please see our database check request form (Enclosure 6) as well. In addition, during the week of October 4, 2010, the staff plans to conduct a site audit at Seabrook Station. You and your staff are invited to attend both the site audit. Your office will receive a copy of the draft SEIS along with a request for comments. The anticipated publication date for the draft SEIS is May 2011. In addition, please provide any information you consider appropriate under the provisions of the Fish and Wildlife Coordination Act.

The Seabrook Station license renewal application is available at:

http://www.nrc.gov/reactors/operating/licensing/renewal/applications/seabrook.html.

M. Coppola - 3 -

If you have any questions concerning the staff's review of this license renewal application, please contact Mr. Jeremy Susco, Project Manager, at (301) 415-2927 or by e-mail at Jeremy.Susco@nrc.gov.

Sincerely,

for

Bo Pham, Chief
Projects Branch 1
Division of License Renewal
Office of Nuclear Reactor Regulation

Docket No. 50-443

Enclosures:
1. Area Map, 50-mile radius
2. Area Map, 6-mile radius
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5. Transmission Line Map
6. Database Check Request Form

cc w/encls: Distribution via Listserv

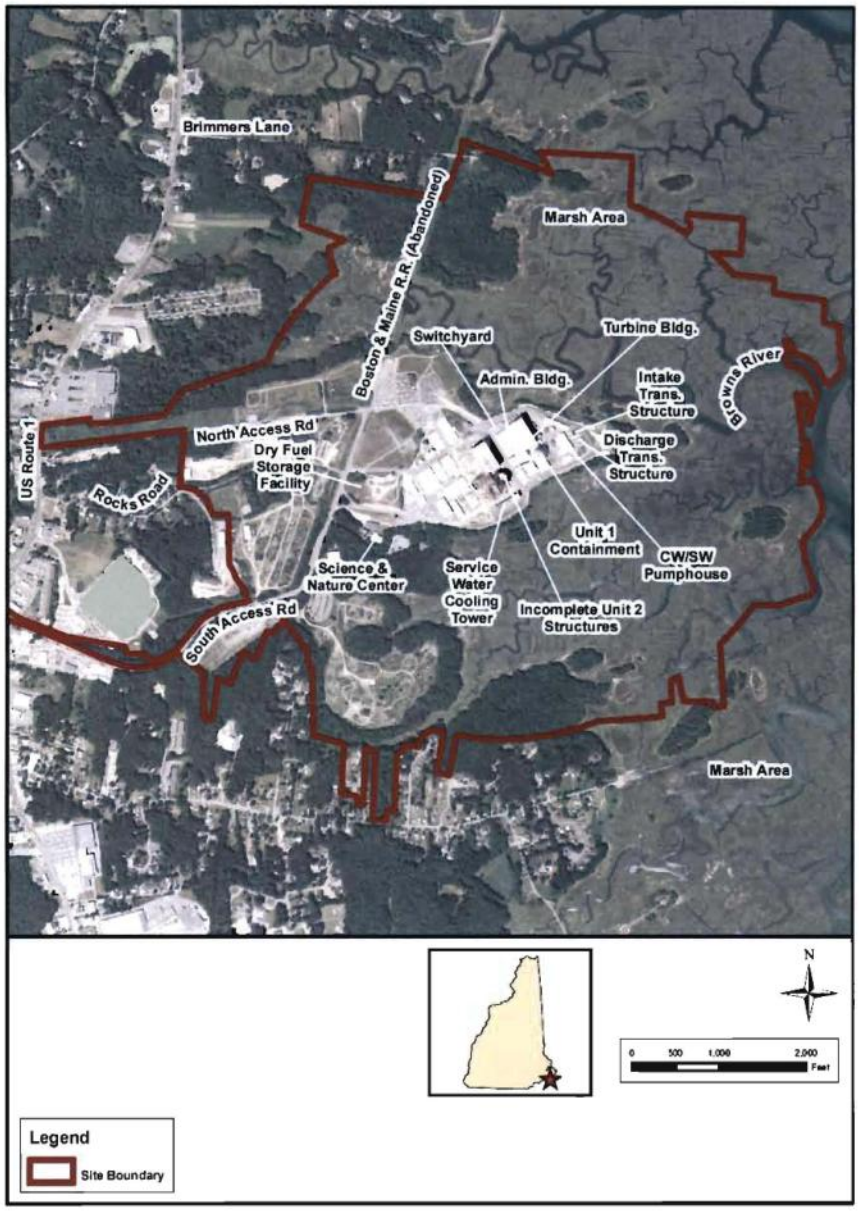
Area Map, 50-Mile Radius

ENCLOSURE 1

Area Map, 6-Mile Radius

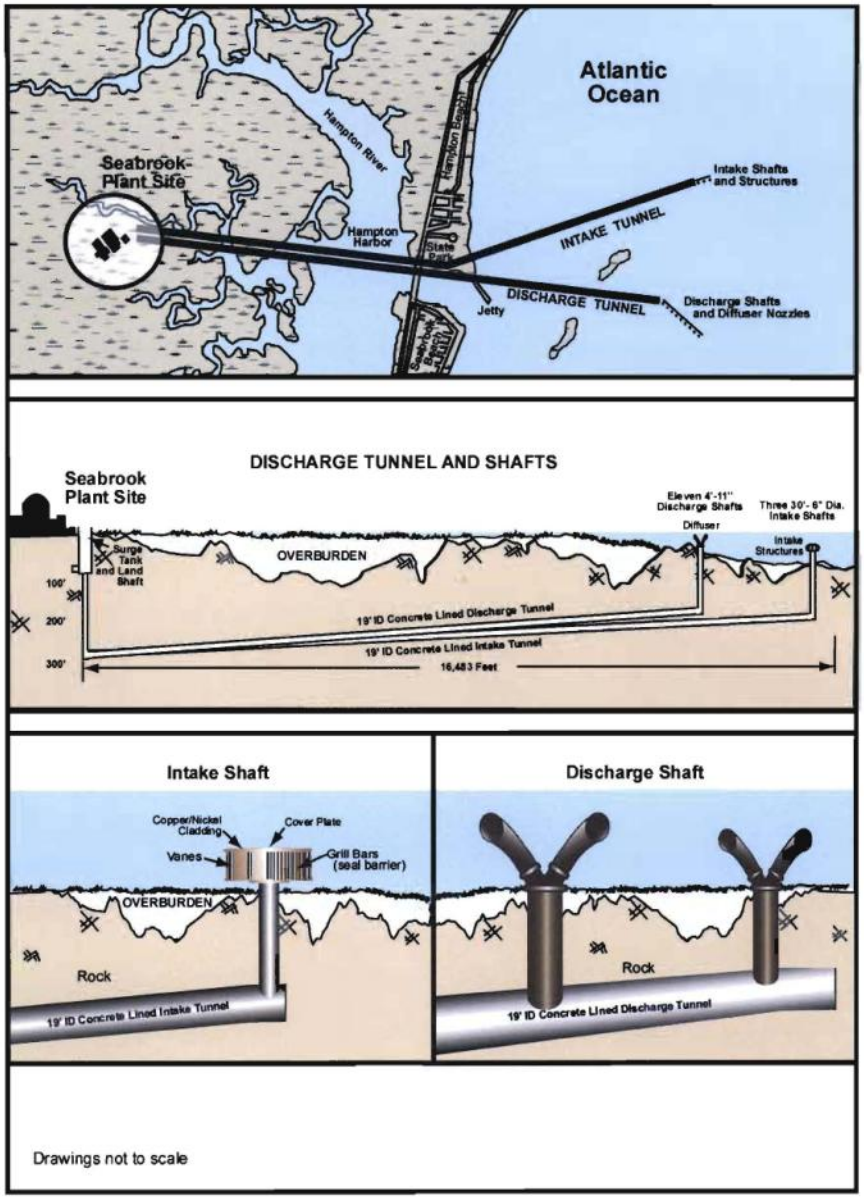
ENCLOSURE 2

Site Area Map



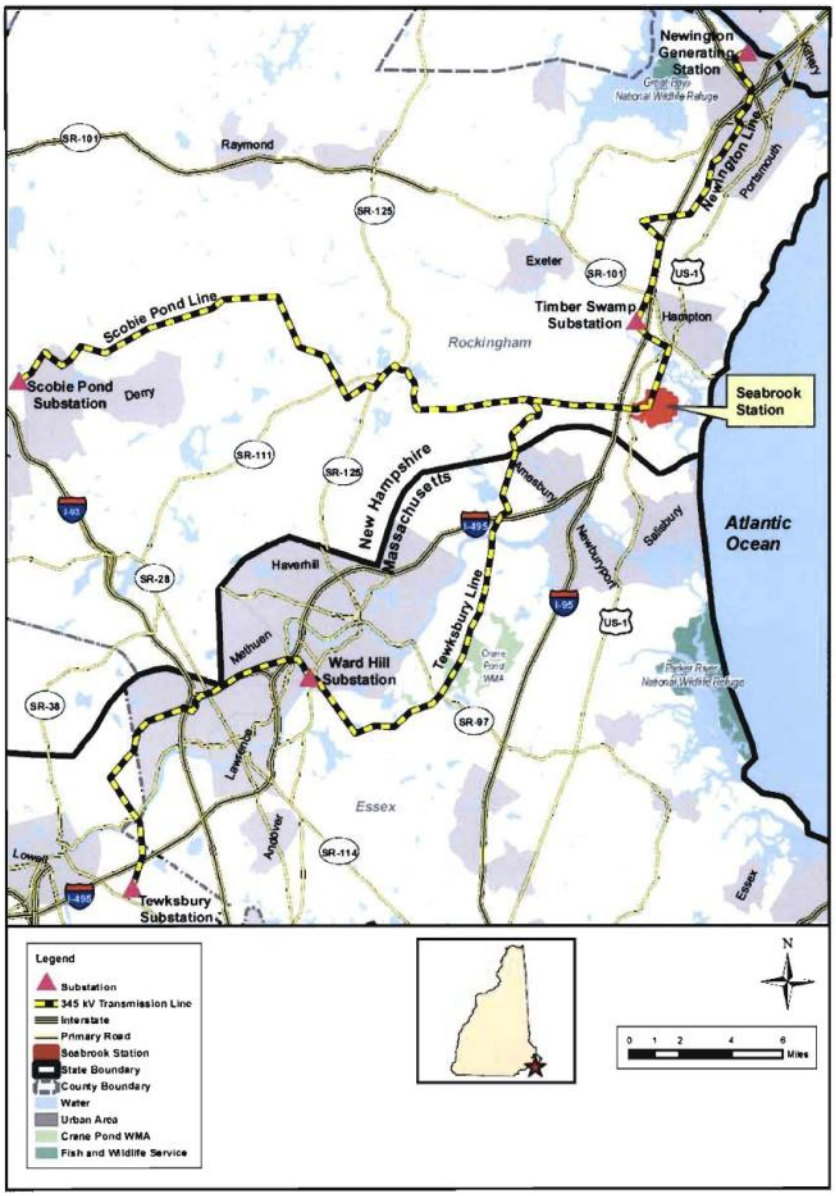
ENCLOSURE 3

Intake/Discharge Tunnels and Shafts Diagram



ENCLOSURE 4

Transmission Line Map



ENCLOSURE 5

Request for a NH Natural Heritage Bureau database check

The NH Natural Heritage Bureau (NHB) maintains a database of known locations of rare species and exemplary natural communities. Federal, state, and local agencies may require a check of this database to determine whether proposed projects could impact rare species. This form should be used to request this type of database check.

NHB will send the results directly to you. It is your responsibility to provide a copy to whatever permitting agency you are dealing with. Information you provide on this form must agree with what you provide in a permit application, or else the NHB check will not be considered to be valid, resulting in delays.

Requested by: Name: Jeremy Susco
Organization: U.S. Nuclear Regulatory Commission
Phone number: (301) 415-2927 E-mail address: jeremy.susco@nrc.gov
Mailing address: 11555 Rockville Pike (Mailstop: O-11F1)
Town: Rockville State: MD Zip: 20852
Internal Project ID (if any):

Project Name (*Enter a short descriptive label*): Seabrook Station License Renewal Application Review

Town: Seabrook, NH Address or Tax Map & Lot #(s): Seabrook Station

Total tract acres (*approximate, e.g., nearest acre for small tracts, 10 acres for large*): 889 acres

Short narrative description of the project (*also check the appropriate descriptive category(s) on page 3*):

License renewal application review for Seabrook Station. In order for the NRC to review Seabrook Station license renewal application, we request a list of rare species and exemplary communities around the plant site and the associated transmission lines. (See the maps enclosed with the letter.)

Maximum **project footprint** (area disturbed during the project). Choose one.

- [ ] New footprint (no existing structure)
- [x] Completely within an existing footprint (repairs, replacement)
- [ ] Expanding an existing footprint (additional area disturbed adjacent to a previously disturbed location)

Primary Agency/Organization to which you will be applying for a permit (choose one):

- [ ] NH Dept. of Environmental Services
- [ ] NH Dept. of Transportation
- [ ] NH Dept. of Resources and Economic Development (e.g., Trails Bureau)
- [ ] NH Dept. of Agriculture, Markets & Food (e.g., Pesticide Control Board)
- [ ] US Dept. of Energy (e.g., NEPA)
- [ ] US Environmental Protection Agency (e.g., NPDES General Permit for Stormwater Discharges)
- [ ] Town or City
- [x] Other: **Permit not applicable**

Name of the Permit Applicant, if different from "Requested by": **U.S. NRC renewed operating license**

I affirm that the landowner, **NextEra Energy Seabrook, LLC** (print landowner's name) *knows that I am making this request and agrees that NHB should release the data.*

Print your name: Jeremy Susco Date: 8/27/2010

A map must be provided, with the site clearly marked. Provide an outline around the maximum area that could be disturbed. Include temporary disturbance (e.g., parking for construction vehicles). Acceptable maps include GIS shapefiles (NH State Plane, NAD 83) or a copy of part of a USGS topographic map (such maps can be printed from the worldwide web, e.g., at www.terraserver-usa.com.) Tax maps cannot be used unless they include one or more clearly marked road intersections. GPS coordinates alone are not accepted.

DES Permit by Notification only: Draw the maximum disturbed area (e.g., a single-house lot). Also place a point or line at the site(s) of the permitted activity (e.g., a point at a culvert installation or a line along a utility corridor).

All requests must include a payment of $25 (check or money order, payable to "Treasurer, State of NH"). To ensure that your payment is properly credited, please provide the following:

Last revised 7 October 2008 Page 1

ENCLOSURE 6

Check Number: _____

Name of Account (as shown in the check's upper left corner):

_____

NH Department of Environmental Services (DES)

Expected Permit Type(s):

- ☐ Standard Dredge and Fill for Wetland Impacts
- ☐ Standard Dredge and Fill for Shoreland Impacts
- ☐ Minimum Impact Expedited
- ☐ Minimum Impact Agriculture
- ☐ Permit by Notification
- ☐ Seasonal Dock Notification for Lakes and Ponds
- ☐ Notification of Forest Management or Timber Harvest
- ☐ Notification of Routine Roadway & Railway Maintenance
- ☐ Notification of Trail Development Activities
- ☐ Alteration of Terrain
- ☐ Shoreland Permit
- ☒ No permits anticipated

To expedite review of possible impacts on wildlife species, please answer the following questions:

Will one or more culverts be installed on perennial streams?

- ☐ Yes
- ☒ No
- ☐ Don't Know

If "Yes", what type of culvert(s) is planned?

- ☐ Pipe with interior corrugations
- ☐ Box or elliptical
- ☐ Bridge or span
- ☐ Other or Don't know

Note: DES and the NH Fish & Game Department recommend the use of open-bottomed culverts or bridges at all perennial stream crossings.

Are there vernal pools on the property?

- ☐ Yes
- ☐ No
- ☒ Don't Know

Requests can be submitted by e-mail, fax, or mail:

E-mail: nhbreview@dred.state.nh.us

Fax: (603) 271-6488, Attn: NHB Review

Mail: NHB Review
PO Box 1856
172 Pembroke Road
Concord, NH 03302-1856

Requests will be processed within 5-10 business days of receipt of payment. Results will be e-mailed if an e-mail address is provided above, otherwise mailed (results will not be faxed). Call (603) 271-2215 x 323 with questions.

Last revised 7 October 2008 Page 2

Note: Landowners can ask for a check of the database for their property without paying a fee, using a separate Landowner Request Form. However, the results of this type of check are limited to NHB records within property boundaries, and cannot be used for permit or regulatory requirements.

In response to this request, NHB will send you a letter reporting on any known occurrences of rare species or exemplary natural communities in the vicinity of the project. Further review of the project may be needed to assess whether impacts will actually occur, and what if any steps could be taken to reduce those impacts. This review may involve the agency or organization issuing the permit, NHB staff (consulting on rare plants and natural communities), the NH Fish & Game Department, which has jurisdiction over wildlife in NH, and/or the U.S. Fish & Wildlife Service, which has jurisdiction over federally listed species.

Choose as many categories as necessary to describe this project.

Include at least one selection that covers the full extent of the project (maximum area subject to disturbance). For example: "**Buildings and Related Structures** - Residential subdivision" even if only applying for a culvert crossing within the planned subdivision.

Bank Stabilization
- ☐ Bio-engineered restoration
- ☐ Repair bank erosion
- ☐ Retaining wall
- ☐ Rip-rap
- ☐ Stabilize by vegetation

Shoreland Construction / Alteration
- ☐ Beach
- ☐ Boathouse
- ☐ Boat lift
- ☐ Breakwater
- ☐ Boat launch
- ☐ Boat yard
- ☐ Breakwater/dock
- ☐ Bulkhead
- ☐ Canopy, seasonal
- ☐ Channel dredge
- ☐ Dock (permanent)
- ☐ Dock (seasonal)
- ☐ Dock (tidal)
- ☐ Boatslip
- ☐ Dam
- ☐ Marina
- ☐ Personal water craft lift
- ☐ Pilings
- ☐ Rock removal
- ☐ Steps in the bank
- ☐ Seawall
- ☐ Construction requiring Shoreland Permit

Buildings and Related Structures
- ☐ Apartment/condominium complex
- ☐ Campground
- ☐ Mobile home park
- ☒ Multiple commercial buildings
- ☐ Parking lot only
- ☐ Residential subdivision
- ☐ Single commercial building lot
- ☐ Single residential building lot

Roads, Driveways, Bridges
- ☐ Bridge
- ☐ Culvert(s)
- ☐ Driveway only
- ☐ Foot bridge
- ☐ Guardrail installation
- ☐ Road construction
- ☐ Sidewalk construction
- ☐ Temporary crossing
- ☐ Traffic signal work

Railroads, Transmission lines, Pipelines
- ☐ Pipeline
- ☐ Power station
- ☐ Railroad line
- ☐ Submarine Cable
- ☒ Transmission line
- ☒ Utility crossing

Recreation
- ☐ Swim area
- ☐ Recreational facility
- ☐ Trail Bridge
- ☐ Trails
- ☐ Walkway
- ☐ Athletic fields

Forestry and Agricultural Activities
- ☐ Pasture
- ☐ Pond
- ☐ Timber harvest

Chemical and Biological Control Applications
- ☐ Aquatic weed control
- ☐ Biological control application
- ☐ Biosolid application
- ☐ Herbicide application
- ☐ Pesticide application

Tower Construction
- ☐ Telecommunications tower
- ☐ Weather station
- ☐ Wind power construction

Water/Wastewater
- ☐ Detention pond
- ☐ Ditch
- ☐ Hydro Raking
- ☐ Pond
- ☐ Sediment removal
- ☐ Septic system
- ☐ Stormwater treatment

Last revised 7 October 2008 Page 3

- [ ] Stream restoration
- [ ] Treatment swale
- [ ] Wastewater facility
- [x] Water intake
- [ ] Water storage tank
- [ ] Water supply system
- [ ] Well
- [ ] Wetland creation
- [ ] Wetland restoration

Other

- [ ] Airport improvements
- [ ] Cable
- [ ] Composting facility
- [ ] Contaminant removal
- [ ] Dry hydrant
- [ ] Geotechnical drilling
- [ ] Fish Ladder
- [ ] Gravel operation
- [ ] Landfill
- [ ] Sign installation
- [ ] Storm debris removal

Other: Note that project does not involve any construction beyond what is already on the land, only maintenance and continued operation of the Seabrook Station and associated transmission lines.

M. Coppola - 3 -

If you have any questions concerning the staff's review of this license renewal application, please contact Mr. Jeremy Susco, Project Manager, at (301) 415-2927 or by e-mail at Jeremy.Susco@nrc.gov.

Sincerely,
/RA Almboden for/
Bo Pham, Chief
Projects Branch 1
Division of License Renewal
Office of Nuclear Reactor Regulation

Docket No. 50-443

Enclosures:
1. Area Map, 50-mile radius
2. Area Map, 6-mile radius
3. Site Area Map
4. Intake/Discharge Tunnels and Shafts Diagram
5. Transmission Line Map
6. Database Check Request Form

cc w/encls: Distribution via Listserv

DISTRIBUTION:
HARD COPY:
DLR RF
E-MAIL:
PUBLIC
RidsNrrDlr Resource
RidsNrrDlrRpb1 Resource
RidsNrrDlrRpb2 Resource
RidsNrrDlrRarb Resource
RidsNrrDlrRapb Resource
RidsNrrDlrRasb Resource
RidsNrrDlrRerb Resource
RidsNrrDlrRpob Resource
RidsNrrDraApla Resource

JSusco
RPlasse
BPham
DWrona
EMiller
ICouret, OPA
EDacus, OCA
MSpencer, OGC
WRaymond, RI
DTifft, RI
NMcNamara, RI
NSheehan, RI
DScrenci, RI
JJohnson, RI
ABurritt, RI
ADAMS Accession No: ML102290417

OFFICE	LA:DLR	PM:RPB1:DLR	OGC NLO	BC:RPB1:DLR
NAME	IKing	JSusco	MSpencer w/comments	BPham (Almboden for)
DATE	8/20/10	8/23/10	8/23/10	8/26 /10

OFFICIAL RECORD COPY

United States Department of the Interior

FISH AND WILDLIFE SERVICE

New England Field Office
70 Commercial Street, Suite 300
Concord, NH 03301-5087
http://www.fws.gov/newengland

September 1, 2010

Mr. Bo Pham
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Dear Mr. Pham:

We are in receipt of your July 16, 2010 letter regarding the license renewal application for the Seabrook Station (Station), Unit 1, Seabrook, New Hampshire. The following comments are provided in accordance with section 7 of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531-1543).

The federally-threatened piping plover (*Charadrius melodus*) and federally-endangered roseate tern (*Sterna dougallii*) are known to occur along the coastal beaches and oceanic waters located approximately 2.8 miles east of the Station. According to our records, none of the above-listed species are known to frequent the immediate vicinity of the Station and, therefore, the presence of these species near the power station is unlikely. Furthermore, we are not aware of any instance where these species are being adversely affected through the existing operation of the Station.

Since no expansion of existing facilities is planned and no additional land disturbance is anticipated, we conclude that the license renewal for the Station is not likely to adversely affect federally-listed species subject to the jurisdiction of the U.S. Fish and Wildlife Service, and that formal consultation with us is not required.

Thank you for your coordination. Please contact Mr. Anthony Tur at 603-223-2541 if we can be of further assistance.

Sincerely yours,

Thomas R. Chapman
Supervisor
New England Field Office

Memo

NH Natural Heritage Bureau

To: Jeremy Susco, U.S. NRC
11555 Rockville Pike
Mailstop: O-11F1
Rockville, MD 20852

From: Melissa Coppola, NH Natural Heritage Bureau
Date: 9/7/2010 (valid for one year from this date)
Re: Review by NH Natural Heritage Bureau
NHB File ID: NHB10-2146 Town: Seabrook, NH
Project type: Buildings and Related Structures: Multiple commercial buildings, etc. Location: Seabrook Station, Seabrook, NH
cc: Kim Tuttle, Anthony Tur

As requested, I have searched our database for records of rare species and exemplary natural communities, with the following results.

Comments:

Natural Community	State[1]	Federal	Notes
Brackish marsh	--	--	Threats to these communities are primarily alterations to the hydrology of the wetland (such as ditching or tidal restrictions that might affect the sheet flow of tidal waters across the intertidal flat) and increased input of nutrients and pollutants in storm runoff.
dry Appalachian oak forest	--	--	
High salt marsh	--	--	
intertidal flat	--	--	
Low salt marsh	--	--	

Plant species	State[1]	Federal	Notes
Dwarf Glasswort (*Salicornia bigelovii*)	E	--	Threats are primarily alterations to the hydrology of the wetland, such as ditching or tidal restrictions that might affect the sheet flow of tidal waters across the intertidal flat, activities that eliminate plants, and increased input of nutrients and pollutants in storm runoff.
Erect Knotweed (*Polygonum erectum*)*	E	--	Threats include direct destruction of the plants and loss of habitat.
Large Bur-reed (*Sparganium eurycarpum*)*	T	--	Threats to aquatic species include changes in water quality, e.g., due to pollution and stormwater runoff, and significant changes in water level.
Long-fruited Anemone (*Anemone cylindrica*)*	E	--	This species occurs in dry forests and thin woods. Although historically documented as occurring in NH, no current populations are known.
Missouri Rock Cress (*Boechera missouriensis*)	T	--	This species occurs in rocky ridges and woodlands, dry forests, and thin woods. Threats would include development of its habitat or recreational use that directly

Department of Resources and Economic Development
Division of Forests and Lands
(603) 271-2214 fax: 271-6488

DRED/NHB
PO Box 1856
Concord NH 03302-1856

Memo

NH Natural Heritage Bureau

			impacted the plants.
Orange Horse-gentian (*Triosteum aurantiacum*)	E	--	This species requires periodic disturbance to maintain its open, early-successional habitat. However, activities such as weed control in powerline right-of-ways or heavy recreational use by off-road vehicles could be detrimental.
Perennial Glasswort (*Salicornia ambigua*)	E	--	Primarily vulnerable to changes to the hydrology of its habitat, especially alterations that change water levels. It may also be susceptible to increased pollutants and nutrients carried in stormwater runoff.
Prolific Knotweed (*Polygonum ramosissimum ssp. prolificum*)*	E	--	Threats to estuarine plants are primarily alterations to the hydrology of the wetland, such as ditching or tidal restrictions that might affect the sheet flow of tidal waters across the intertidal flat, activities that eliminate plants, and increased input of nutrients and pollutants in storm runoff.
Robust Knotweed (*Persicaria robustior*)*	E	--	Threats include changes to local hydrology that would affect its habitat. It grows on river or streambanks, pond or lake shores, and in forested swamps.
Salt-marsh Gerardia (*Agalinis maritima*)	E	--	A wildflower that grows in very shallow, briefly flooded forb pannes in the high salt marsh. Threats are primarily alterations to the hydrology of the wetland (such as ditching or tidal restrictions that might affect the sheet flow of tidal waters across the intertidal flat), activities that eliminate plants, and increased input of nutrients and pollutants in storm runoff.
Tall Wormwood (*Artemisia campestris ssp. caudata*)	E	--	This species grows in dry dune systems and is sensitive to disturbances that eliminate its habitat or disturb the natural dynamics of the dune area.
Yellow Thistle (*Cirsium horridulum*)*	E	--	This species usually occurs on uplands adjacent to salt marshes and is threatened by habitat loss due to development.

Vertebrate species	**State**[1]	**Federal**	**Notes**
Blanding's Turtle (*Emydoidea blandingii*)	E	--	Contact the NH Fish & Game Dept (see below).
Common Tern (*Sterna hirundo*)	T	--	Contact the NH Fish & Game Dept (see below).
Horned Lark (*Eremophila alpestris*)	SC	--	Contact the NH Fish & Game Dept (see below).
Osprey (*Pandion haliaetus*)	SC	--	Contact the NH Fish & Game Dept (see below).
Piping Plover (*Charadrius melodus*)	E	T	Contact the NH Fish & Game Dept and the US Fish & Wildlife Service (see below).
Willet (*Catoptrophorus semipalmatus*)	SC	--	Contact the NH Fish & Game Dept (see below).

[1]Codes: "E" = Endangered, "T" = Threatened, "--" = an exemplary natural community, or a rare species tracked by NH Natural Heritage that has not yet been added to the official state list. An asterisk (*) indicates that the most recent report for that occurrence was more than 20 years ago.

Contact for all animal reviews: Kim Tuttle, NH F&G, (603) 271-6544. Contact for federally-listed animals: Anthony Tur, US FWS, at (603) 223-2541.

Department of Resources and Economic Development
Division of Forests and Lands
(603) 271-2214 fax: 271-6488

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Memo

NH Natural Heritage Bureau

A negative result (no record in our database) does not mean that a sensitive species is not present. Our data can only tell you of known occurrences, based on information gathered by qualified biologists and reported to our office. However, many areas have never been surveyed, or have only been surveyed for certain species. For some purposes, including legal requirements for state wetland permits, the fact that no species of concern are known to be present is sufficient. However, an on-site survey would provide better information on what species and communities are indeed present.

Department of Resources and Economic Development
Division of Forests and Lands
(603) 271-2214 fax: 271-6488

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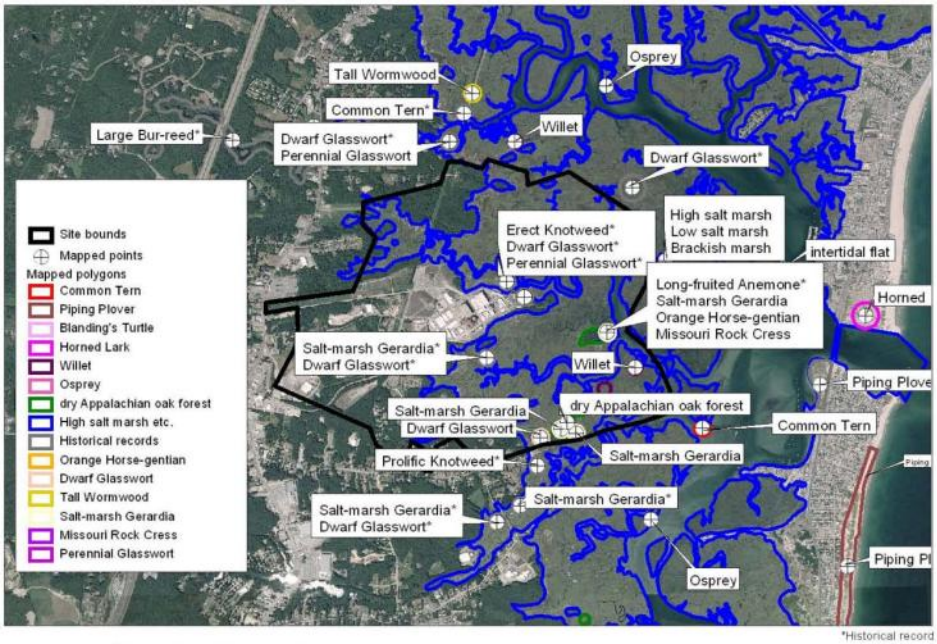
NHB10-2146

NH NATURAL HERITAGE BUREAU

Known locations of rare species and exemplary natural communities

Note: Mapped locations are not always exact. Occurrences that are not in the vicinity of the project are not shown.



NHB10-2146 EOCODE: CE00000005*012*NH

New Hampshire Natural Heritage Bureau - Community Record

Brackish marsh

Legal Status		Conservation Status	
Federal:	Not listed	Global:	Not ranked (need more information)
State:	Not listed	State:	Imperiled due to rarity or vulnerability

Description at this Location

Conservation Rank: Good quality, condition and lanscape context ('B' on a scale of A-D).

Comments on Rank: Rank is for largest area visited (Taylor River). Others were B- (three sites) or C (Seabrook Salt Marsh).

Detailed Description: 1997: A characteristic mix of graminoids includes *Agrostis stolonifera* var. *palustris* (marsh creeping bent-grass), *Spartina patens* (salt-meadow cord-grass), *Juncus gerardii* (salt marsh rush), *Solidago sempervirens* (seaside goldenrod), *Distichlis spicata* (spike-grass), *Juncus arcticus* var. *littoralis* (shore rush), *Elytrigia repens* (quack-grass), *Spartina pectinata* (fresh-water cord-grass, slough-grass), *Carex paleacea* (chaffy salt sedge), *Hierochloe odorata* (sweet grass), *Aster novi-belgii* (New York aster), *Scirpus pungens* (three-square rush), and several other less frequent species. At the Seabrook School area, ephemeral runoff channel/stream entering from west; area dominated by *Lythrum salicaria* (purple loosestrife). Small elevated knoll in middle with *Quercus bicolor* (swamp white oak), *Toxicodendron radicans* (climbing poison ivy), and *Rosa virginiana* (Virginia rose).

General Area: 1997: The Blackwater - Hampton River Estuary contains the majority of the estimated 6200 acres of salt marsh in the state. The Blackwater River portion of the estuary continues south into Salisbury, MA. The estuarine system extends seaward to an imaginary line drawn across Hampton Harbor Inlet and upstream and landward to where ocean-derived salts are less than or equal to 0.5 parts per thousand during the period of average annual low freshwater flow (Cowardin et al. 1979). This estuary is surrounded by moderate levels of residential and commercial development. Several exemplary subtidal and intertidal communities occur in this estuary. Exemplary subtidal communities are ***tidal creek bottom*** and undifferentiated ***saline/brackish subtidal channel/bay bottom***. Exemplary intertidal communities are ***brackish marsh***, ***coastal shoreline strand/swale***, ***saline/brackish intertidal flat***, and high and ***low salt marsh***. Exemplary dry Appalachian oak-hickory forest occurs at the site as "salt marsh islands", forested uplands surrounded by salt marsh. Most of the estuary is unaffected by restricted tidal flow. Other areas are described as having an adequate tidal inlet by the USDA Soil Conservation Service (1994). The largest portions of the estuary determined to have inadequate tidal inlets include the Meadow Pond area, the Taylor River - Drakes River area west of the rail road track, and the Browns River west of the rail road track (USDA Soil Conservation Service 1994). In the last four years, several salt marsh restoration projects have begun in this estuary (Ammann, A.P. pers. comm., 1997).

General Comments: 1997: Tidally flooded by salt water only during spring tides and storm surges. Supports a greater diversity of plants and generally flooded less frequently than the robust forb brackish marsh. Elevationally higher, received more freshwater input, and experienced less frequent tidal flooding than the high salt marsh. Occasionally occurs along the upper margins of the high salt marsh where sufficient fresh water runoff or groundwater discharge flows onto the marsh surface. This hydrologic regime supports brackish marsh species and other species most often found in fresh or salt marshes but tolerant of brackish conditions and able to successfully compete in this environment.

Management Comments:

Location

Survey Site Name: Hampton Harbor

Managed By: ASNH to Properties, Inc. - Pelton

County: Rockingham USGS quad(s): Hampton (4207087)

NHB10-2146 EOCODE: CE00000005*012*NH

Town(s):	Hampton	Lat, Long:	425407N, 0704957W
Size:	3448.9 acres	Elevation:	5 feet

Precision: Within (but not necessarily restricted to) the area indicated on the map.

Directions: Large area more or less framed by Rte. 1 to the west, Rte. 101 to the north, Rte. 1A to the east, and the Massachusetts state line to the south. 1997: Five areas visited. Wrights Island (park at Seabrook Sewage Treatment Plant), Farm Brook (drive to east end of Depot Road and park in lot), two areas at Seabrook School Salt Marsh (park behind the Seabrook Elementary/Middle School off of Walton Road), and Taylor River (along the northern portions of the Taylor River Estuary from Drakes Creek to Tide Mill Creek).

Dates documented

First reported:	1997-07-05	Last reported:	1997-10-06

Nichols, Bill. 1997. Field survey to Blackwater River Salt Marsh on July 5.

Nichols, William F. 2000. Ecological Assessment of Selected Towns in New Hamphire's Coastal Zone. Prepared by NH Natural Heritage Inventory. Concord, NH.

NHB10-2146 EOCODE: CT00000184*015*NH

New Hampshire Natural Heritage Bureau - Community Record

dry Appalachian oak forest

Legal Status		Conservation Status	
Federal:	Not listed	Global:	Not ranked (need more information)
State:	Not listed	State:	Rare or uncommon

Description at this Location

Conservation Rank: Good quality, condition and lanscape context ('B' on a scale of A-D).

Comments on Rank: Rank is for Seabrook Nuclear Power Plant area (not considering the effects of the nuclear power plant). Ranks for other areas are: C (Seabrook School) and C (Beckmans Island).

Detailed Description: 1997: Frequent canopy species were *Quercus rubra* (red oak), *Quercus velutina* (black oak), *Quercus alba* (white oak), and *Carya ovata* (shagbark hickory). Less common were *Pinus strobus* (white pine), *Acer rubrum* (red maple), and *Sassafras albidum* (sassafras). *Juniperus virginiana* (eastern red cedar) was an infrequent canopy associate found along the forest/estuarine edge but generally did not occur in the adjacent forest interior. The shrub layer was variable in cover and composition and included *Gaylussacia baccata* (black huckleberry), *Amelanchier canadensis* (shadbush), *Toxicodendron radicans* (poison ivy), *Rosa virginiana* (Virginia-rose), *Vaccinium corymbosum* (highbush blueberry), *Smilax rotundifolia* (greenbriar), and *Myrica pensylvanica* (bayberry). Forest edges adjacent to the salt marsh were exposed to increased light penetration, wind, and salt spray. These narrow zones were characterized by a well developed shrub layer and scattered halophytic herbs encroaching landward from the high estuarine marsh. Halophytic herbs common along the upper edge of the high marsh that occurred in low abundance beneath the adjacent forest canopy included *Aster novi-belgii* (New York aster), *Elymus virginicus* (Virginia wild rye), *Elytrigia repens* (quack-grass), *Festuca rubra* (red fescue), *Solidago sempervirens* (seaside goldenrod), *Spartina pectinata* (fresh-water cord-grass), and Teucrium canadensis (germander). The diversity and abundance of these herbs rapidly diminished within 5 m (16.5 feet) of the forest/estuarine edge.

General Area: 1997: The Blackwater - Hampton River Estuary contains the majority of the estimated 6200 acres of salt marsh in the state. The Blackwater River portion of the estuary continues south into Salisbury, MA. The estuarine system extends seaward to an imaginary line drawn across Hampton Harbor Inlet and upstream and landward to where ocean-derived salts are less than or equal to 0.5 parts per thousand during the period of average annual low freshwater flow (Cowardin et al. 1979). This estuary is surrounded by moderate levels of residential and commercial development. Several other exemplary subtidal and intertidal communities are found in this estuary. Subtidal communities include the undifferentiated ***saline/brackish subtidal channel/bay bottom*** and ***tidal creek bottom***. Intertidal communities are ***high salt marsh***, ***brackish marsh***, ***coastal shoreline strand/swale***, ***saline/brackish intertidal flat***, and ***low salt marsh***. Within the estuary or in a few instances within selected nearby communities landward, thirty-eight populations of twenty-six rare plants and animals have been documented. Most of the estuary is unaffected by restricted tidal flow.

General Comments: 1997: At Seabrook Nuclear Power Plant area, cellar hole and well on east side along with rare plants, associated with 3-4 exposed ridges running NNE-SSW. Forest is younger on east side.

Management Comments:

Location

Survey Site Name: Hampton Harbor

Managed By: ASNH to Properties, Inc. - Hunts Is.

County:	Rockingham	USGS quad(s):	Hampton (4207087)
Town(s):	Seabrook	Lat, Long:	425327N, 0705031W
Size:	13.9 acres	Elevation:	5 feet

NHB10-2146 EOCODE: CT00000184*015*NH

Precision: Within (but not necessarily restricted to) the area indicated on the map.

Directions: Occurs at three forested uplands surrounded by salt marsh. For Seabrook Nuclear Power Plant area: From Rte. 1A in Seabrook, turn east on Rocks Road. Proceed to Seabrook Nuclear Power Plant site and continue east to the marsh. Several occurrences are found on Hunts Island in the estuary, and also one by a powerline on the east side of the power plant. For the Seabrook School Salt Marsh area: From Seabrook, take Rte. 1 south ca. 1.5 miles to Walton Road (in Smithtown). Turn left on Walton Road and go east ca. 1.25 miles. Park behind the Seabrook Elementary/Middle School off of Walton Road. For the Beckmans Island area: From Rte. 1A in Seabrook, go east on Depot Road. Drive to east end of Depot Road and park in lot. Site is to the north of the boat channel on Beckmans Island.

Dates documented

First reported:	1997-07-05	Last reported:	1997-09-17

Nichols, Bill. 1997. Field survey to Blackwater River Salt Marsh on July 5.

Nichols, William F. 2000. Ecological Assessment of Selected Towns in New Hamphire's Coastal Zone. Prepared by NH Natural Heritage Inventory. Concord, NH.

NHB10-2146 EOCODE: CE00000004*034*NH

New Hampshire Natural Heritage Bureau - Community Record

High salt marsh

Legal Status		Conservation Status	
Federal:	Not listed	Global:	Not ranked (need more information)
State:	Not listed	State:	Rare or uncommon

Description at this Location

Conservation Rank: Excellent quality, condition and lanscape context ('A' on a scale of A-D).

Comments on Rank: These ranks are for the entire estuary.

Detailed Description: 2006: Community observed and photographed.1997: In addition to *Spartina patens* (salt-meadow cord-grass) and *Juncus gerardii* (salt marsh rush), other common plants on the high marsh included smooth cord-grass (short form) and *Distichlis spicata* (spike-grass). *D. spicata* formed pure stands in wetter, more poorly drained areas, or mixed with *S. patens*, growing at similar elevations on the high marsh. *J. gerardii* dominated landward of salt meadow-grass in narrow vegetative zones with decreased tidal flooding and soil water salinity, beginning at about mean spring high water. This zone had the highest species richness within the high marsh and included *Solidago sempervirens* (seaside goldenrod), *Panicum virgatum* (switch-grass), *Hierochloe odorata* (sweet grass), *Carex hormathodes* (necklace sedge), *Festuca rubra* (red fescue), *Aster novi-belgii* (New York aster), *Elytrigia repens* (quack-grass), *Spartina pectinata* (fresh-water cord-grass), and *Potentilla anserina* (silverweed).

General Area: 1997: At Hampton Harbor, the mean tidal range is 8.3 feet with spring tides averaging 9.5 feet. Here, the high marsh rises from ca. 4 feet above mean sea level at its lower end to 5 feet above mean sea level at the landward limit of the salt marsh rush zone. The Blackwater - Hampton River Estuary contains the majority of the estimated 6200 acres of salt marsh in the state. The Blackwater River portion of the estuary continues south into Salisbury, MA. The estuarine system extends seaward to an imaginary line drawn across Hampton Harbor Inlet and upstream and landward to where ocean-derived salts are less than or equal to 0.5 parts per thousand during the period of average annual low freshwater flow (Cowardin et al. 1979). This estuary is surrounded by moderate levels of residential and commercial development. Several exemplary subtidal and intertidal communities occur in this estuary. Subtidal communities include the undifferentiated ***saline/brackish subtidal channel/bay bottom*** and ***tidal creek bottom***. Other intertidal communities are ***brackish marsh***, ***coastal shoreline strand/swale***, ***saline/brackish intertidal flat***, and ***low salt marsh***. Exemplary ***dry Appalachian oak-hickory forest*** occurs at the site as "salt marsh islands", forested uplands surrounded by salt marsh. Most of the estuary is unaffected by restricted tidal flow. Other areas are described as having an adequate tidal inlet by the USDA Soil Conservation Service (1994). The largest portions of the estuary determined to have inadequate tidal inlets include the Meadow Pond area, the Taylor River - Drakes River area west of the rail road track, and the Browns River west of the rail road track (USDA Soil Conservation Service 1994). In the last four years, several salt marsh restoration projects have begun in this estuary (Ammann, A.P. pers. comm., 1997).

General Comments:

Management Comments: 1997: Marsh ditched heavily; greenhead boxes present.

Location

Survey Site Name: Hampton Harbor

Managed By: ASNH to Properties, Inc. - Pelton

County:	Rockingham	USGS quad(s):	Hampton (4207087)
Town(s):	Hampton	Lat, Long:	425407N, 0704957W
Size:	3448.9 acres	Elevation:	4 feet

NHB10-2146 EOCODE: CE00000004*034*NH

Precision: Within (but not necessarily restricted to) the area indicated on the map.

Directions: Large area more or less framed by Rte. 1 to the west, Rte. 101 to the north, Rte. 1A to the east, and the Massachusetts state line to the south. Occurs behind barrier beaches, along inland bays, and other areas protected from high-energy wave action.

Dates documented

First reported:	1997-07-05	Last reported:	2006-08-17

Kimball, Ben and Pete Bowman. 2006. Field survey to The Sands on August 17.

Nichols, William F. 2000. Ecological Assessment of Selected Towns in New Hamphire's Coastal Zone. Prepared by NH Natural Heritage Inventory. Concord, NH.

NHB10-2146 EOCODE: CE00000011*036*NH

New Hampshire Natural Heritage Bureau - Community Record

intertidal flat

Legal Status		Conservation Status	
Federal:	Not listed	Global:	Not ranked (need more information)
State:	Not listed	State:	Rare or uncommon

Description at this Location

Conservation Rank: Excellent quality, condition and lanscape context ('A' on a scale of A-D).

Comments on Rank: Ranks are for an area at Seabrook School Salt Marsh.

Detailed Description: 1997: No details.

General Area: 1997: The Blackwater - Hampton River Estuary contains the majority of the estimated 6200 acres of salt marsh in the state. The Blackwater River portion of the estuary continues south into Salisbury, MA. The estuarine system extends seaward to an imaginary line drawn across Hampton Harbor Inlet and upstream and landward to where ocean-derived salts are less than or equal to 0.5 parts per thousand during the period of average annual low freshwater flow (Cowardin et al. 1979). This estuary is surrounded by moderate levels of residential and commercial development. Several exemplary subtidal and intertidal communities occur in this estuary. Subtidal communities include the undifferentiated ***saline/brackish subtidal channel/bay bottom*** and ***tidal creek bottom***. Other intertidal communities are ***brackish marsh***, ***coastal shoreline strand/swale***, and high and ***low salt marsh***. Exemplary dry Appalachian oak-hickory forest occurs at the site as "salt marsh islands", forested uplands surrounded by salt marsh. Most of the estuaryis unaffected by restricted tidal flow. Other areas are described as having an adequate tidal inlet by the USDA Soil Conservation Service (1994). The largest portions of the estuary determined to have inadequate tidal inlets include the Meadow Pond area, the Taylor River - Drakes River area west of the rail road track, and the Browns River west of the rail road track (USDA Soil Conservation Service 1994). In the last four years, several salt marsh restoration projects have begun in this estuary (Ammann, A.P. pers. comm., 1997).

General Comments: 1997: Extensive areas of this community type were found within the Blackwater - Hampton River Estuary. Intertidal sand and mud flats are gently sloping, sparsely vegetated, habitats. The substrate, exposed completely at extra low spring tide, ranges in composition from sands to muds and silts. Benthic diatoms and other microalgae occurring in this environment are important contributors to the primary productivity of the total estuarine system (Sickley 1989). Macroalgae is typically uncommon across the exposed substrate. Characteristic invertebrates found in New Hampshire's intertidal mudflats include polychaete worms (including Nereis virens, Nephtys caeca, Clymenella tortquata, and Scoloplos spp.) and mollusks (including soft-shelled clam [Mya arenaria], Baltic Macoma [Macoma balthica], gem shell [Gemma gemma], and swamp Hydrobia [Hydrobia minuta]) (NAI 1973). Arthropods are also well represented and include green crabs (Carcinus maenus), rock crabs (Cancer irroratus), flat-clawed hermit crabs (Pagurus pollicaris), and horseshoe crabs (Limulus polyphemis). During the diurnal (twice daily) tidal flooding several species of fish and other aquatic species feed on the benthos and epibenthic algae. This community also provides important foraging habitat for shorebirds and other animals when the intertidal flat is exposed. The diverse variety of primary foods (microalgae, phytoplankton, and detritus) available to consumers supports the high productivity found on intertidal flats. The substrate is composed of sand or silt and clay rich in organic matter. Vascular plants are sparse to more typically absent.

Management Comments:

Location

Survey Site Name: Hampton Harbor

Managed By: Hampton Beach State Park

NHB10-2146 EOCODE: CE00000011*036*NH

County:	Rockingham	USGS quad(s):	Hampton (4207087)
Town(s):	Hampton	Lat, Long:	425405N, 0704917W
Size:	1183.7 acres	Elevation:	

Precision: Within (but not necessarily restricted to) the area indicated on the map.

Directions: Large area more or less framed by Rte. 1 to the west, Rte. 101 to the north, Rte. 1A to the east, and the Massachusetts state line to the south. Occurs between estuarine marshes or other coastal communities landward and subtidal communities seaward and includes tidal creek channels exposed at low tide.

Dates documented

First reported:	1997-07-05	Last reported:	1997-10-08

Nichols, Bill. 1997. Field survey to Blackwater River Salt Marsh on July 5.

Nichols, William F. 2000. Ecological Assessment of Selected Towns in New Hamphire's Coastal Zone. Prepared by NH Natural Heritage Inventory. Concord, NH.

NHB10-2146 EOCODE: CE00000003*035*NH

New Hampshire Natural Heritage Bureau - Community Record

Low salt marsh

Legal Status		Conservation Status	
Federal:	Not listed	Global:	Not ranked (need more information)
State:	Not listed	State:	Rare or uncommon

Description at this Location

Conservation Rank: Excellent quality, condition and lanscape context ('A' on a scale of A-D).
Comments on Rank: These ranks are for the entire estuary.

Detailed Description: 1997: No details.
General Area: 1997: The Blackwater - Hampton River Estuary contains the majority of the estimated 6200 acres of salt marsh in the state. The Blackwater River portion of the estuary continues south into Salisbury, MA. The estuarine system extends seaward to an imaginary line drawn across Hampton Harbor Inlet and upstream and landward to where ocean-derived salts are less than or equal to 0.5 parts per thousand during the period of average annual low freshwater flow (Cowardin et al. 1979). This estuary is surrounded by moderate levels of residential and commercial development. Several exemplary subtidal and intertidal communities occur in this estuary. Subtidal communities include the undifferentiated ***saline/brackish subtidal channel/bay bottom*** and ***tidal creek bottom***. Other intertidal communities are ***brackish marsh***, ***coastal shoreline strand/swale***, ***saline/brackish intertidal flat***, and ***high salt marsh***. Exemplary dry Appalachian oak-hickory forest occurs at the site as "salt marsh islands", forested uplands surrounded by salt marsh. Most of the estuary is unaffected by restricted tidal flow. Other areas are described as having an adequate tidal inlet by the USDA Soil Conservation Service (1994). The largest portions of the estuary determined to have inadequate tidal inlets include the Meadow Pond area, the Taylor River - Drakes River area west of the rail road track, and the Browns River west of the rail road track (USDA Soil Conservation Service 1994). In the last four years, several salt marsh restoration projects have begun in this estuary (Ammann, A.P. pers. comm., 1997).
General Comments:
Management Comments:

Location

Survey Site Name: Hampton Harbor
Managed By: ASNH to Properties, Inc. - Pelton

County:	Rockingham	USGS quad(s):	Hampton (4207087)
Town(s):	Hampton	Lat, Long:	425407N, 0704957W
Size:	3448.9 acres	Elevation:	4 feet

Precision: Within (but not necessarily restricted to) the area indicated on the map.

Directions: Large area more or less framed by Rte. 1 to the west, Rte. 101 to the north, Rte. 1A to the east, and the Massachusetts state line to the south. Occurs behind barrier beaches, along inland bays, and other areas protected from high-energy wave action.

Dates documented

First reported: 1997-07-05 Last reported: 1997-10-08

Nichols, Bill. 1997. Field survey to Blackwater River Salt Marsh on July 5.

Nichols, William F. 2000. Ecological Assessment of Selected Towns in New Hamphire's Coastal Zone. Prepared by NH Natural Heritage Inventory. Concord, NH.

NHB10-2146 EOCODE: CE00000003*035*NH

NHB10-2146 EOCODE: PDCHE0J040*018*NH

New Hampshire Natural Heritage Bureau - Plant Record

Dwarf Glasswort (*Salicornia bigelovii*)

Legal Status		Conservation Status	
Federal:	Not listed	Global:	Demonstrably widespread, abundant, and secure
State:	Listed Endangered	State:	Critically imperiled due to rarity or vulnerability

Description at this Location

Conservation Rank: Not ranked

Comments on Rank: Sub-population of a large "A-" population.

Detailed Description: 1997: 101-1000 mature fruiting plants in a 100-1000 square meter area. A similar-sized population also occurs in pannes to the north.

General Area: 1997: Salt marsh. Associated plant species include *Spartina patens* (salt-meadow cord-grass), *Spartina alterniflora* (smooth cord-grass), *Distichlis spicata* (spike-grass), *Juncus gerardii* (salt marsh rush), and *Triglochin maritimum* (arrow-grass). *Salicornia europaea* (common glasswort) also occurs at the site.

General Comments:

Management Comments:

Location

Survey Site Name: Beckman's Island

Managed By:

County:	Rockingham	USGS quad(s):	Hampton (4207087)
Town(s):	Seabrook	Lat, Long:	425323N, 0705040W
Size:	2.8 acres	Elevation:	3 feet

Precision: Within (but not necessarily restricted to) the area indicated on the map.

Directions: From Seabrook head south ca. 0.5 mile to Depot Road. Travel east to boat ramp at the end of the road. Site is then ca. 100 m ENE.

Dates documented

First reported: 1997-09-17 Last reported: 1997-09-17

Nichols, Bill. 1997. Field survey to Farm Brook on September 19.

Nichols, William F. 2000. Ecological Assessment of Selected Towns in New Hamphire's Coastal Zone. Prepared by NH Natural Heritage Inventory. Concord, NH.

NHB10-2146 EOCODE: PDCHE0J040*002*NH

New Hampshire Natural Heritage Bureau - Plant Record

Dwarf Glasswort (*Salicornia bigelovii*)

Legal Status		Conservation Status	
Federal:	Not listed	Global:	Demonstrably widespread, abundant, and secure
State:	Listed Endangered	State:	Critically imperiled due to rarity or vulnerability

Description at this Location

Conservation Rank: Historical records only - current condition unknown.
Comments on Rank: Sub-population of a large "A-" population.

Detailed Description: 1982: 25 or more plants in 5x2 area directly east of *Salicornia virginica*. Plants just starting to flower.
General Area: Flat, full sun, damp but above main area of inundated marsh with *Salicornia virginica*.
General Comments:
Management Comments:

Location

Survey Site Name: RR Tracks
Managed By: Landing + Vicinity Marsh

County:	Rockingham	USGS quad(s):	Hampton (4207087)
Town(s):	Hampton Falls	Lat, Long:	425437N, 0705110W
Size:	2.8 acres	Elevation:	10 feet

Precision: Within (but not necessarily restricted to) the area indicated on the map.

Directions: Hampton Falls. RR tracks site.drive to east end of Depot Rd. Go south along RR tracks to Hampton Falls River. Site on west side of RR tracks just north of Hampton Falls River.

Dates documented

First reported: 1982 Last reported: 1982-08-17

Dunlop, Deb. New England College, Botany Department, Box 30, Henniker, NH 03242. 603/428-2233.

Nichols, William F. 2000. Ecological Assessment of Selected Towns in New Hamphire's Coastal Zone. Prepared by NH Natural Heritage Inventory. Concord, NH.

NHB10-2146 EOCODE: PDCHE0J040*004*NH

New Hampshire Natural Heritage Bureau - Plant Record

Dwarf Glasswort (*Salicornia bigelovii*)

Legal Status		Conservation Status	
Federal:	Not listed	Global:	Demonstrably widespread, abundant, and secure
State:	Listed Endangered	State:	Critically imperiled due to rarity or vulnerability

Description at this Location

Conservation Rank: Historical records only - current condition unknown.
Comments on Rank: Sub-population of a large "A-" population.

Detailed Description: 1982: Plants only 1 cm tall and indistinguishable from other species of *Salicornia* (6/10). Collections made from flowering material (8/17). 1972: Specimen collected.
General Area: Salt marsh with *Salicornia virginica*.
General Comments:
Management Comments:

Location

Survey Site Name: Brown River Salt Marsh
Managed By:

County:	Rockingham	USGS quad(s):	Hampton (4207087)
Town(s):	Seabrook	Lat, Long:	425402N, 0705051W
Size:	2.8 acres	Elevation:	10 feet

Precision: Within (but not necessarily restricted to) the area indicated on the map.

Directions: Brown River salt marsh. North of "The Rocks".

Dates documented

First reported: 1931 Last reported: 1982-08-17

Dunlop, Deb. New England College, Botany Department, Box 30, Henniker, NH 03242. 603/428-2233.

Nichols, William F. 2000. Ecological Assessment of Selected Towns in New Hamphire's Coastal Zone. Prepared by NH Natural Heritage Inventory. Concord, NH.

NHB10-2146 EOCODE: PDCHE0J040*005*NH

New Hampshire Natural Heritage Bureau - Plant Record

Dwarf Glasswort (*Salicornia bigelovii*)

Legal Status		Conservation Status	
Federal:	Not listed	Global:	Demonstrably widespread, abundant, and secure
State:	Listed Endangered	State:	Critically imperiled due to rarity or vulnerability

Description at this Location

Conservation Rank: Historical records only - current condition unknown.
Comments on Rank: Sub-population of a large "A-" population.

Detailed Description: 1982: 200 or more plants in 20 by 10 foot area, not yet in flower.
General Area: 1982: Wet panne in salt marsh with some scattered *Spartina patens* (salt-meadow cord-grass). Flat, full sun.
General Comments:
Management Comments:

Location

Survey Site Name: Hunts Island Creek West
Managed By: F&G to PSNH - Perkins

County:	Rockingham	USGS quad(s):	Hampton (4207087)
Town(s):	Seabrook	Lat, Long:	425343N, 0705058W
Size:	2.8 acres	Elevation:	10 feet

Precision: Within (but not necessarily restricted to) the area indicated on the map.

Directions: Hunt Island Creek. Marsh directly south of Seabrook nuclear reactor along north side of old stone wall. Marsh east of Seabrook "nature trail."

Dates documented

First reported: 1982 Last reported: 1982-08-17

Dunlop, Deb. New England College, Botany Department, Box 30, Henniker, NH 03242. 603/428-2233.

Nichols, William F. 2000. Ecological Assessment of Selected Towns in New Hamphire's Coastal Zone. Prepared by NH Natural Heritage Inventory. Concord, NH.

NHB10-2146 EOCODE: PDCHE0J040*009*NH

New Hampshire Natural Heritage Bureau - Plant Record

Dwarf Glasswort (*Salicornia bigelovii*)

Legal Status		Conservation Status	
Federal:	Not listed	Global:	Demonstrably widespread, abundant, and secure
State:	Listed Endangered	State:	Critically imperiled due to rarity or vulnerability

Description at this Location

Conservation Rank: Historical records only - current condition unknown.
Comments on Rank: Sub-population of a large "A-" population.

Detailed Description: 1916: Batchelder specimen #4428 at NHA.
General Area: 1916: Salt marsh.
General Comments:
Management Comments:

Location

Survey Site Name: Hampton Harbor
Managed By:

County:	Rockingham	USGS quad(s):	Hampton (4207087)
Town(s):	Hampton Falls	Lat, Long:	425425N, 0705008W
Size:	7.7 acres	Elevation:	10 feet

Precision: Within (but not necessarily restricted to) the area indicated on the map.

Directions: Hampton Falls. Salt marsh.

Dates documented

First reported: 1916 Last reported: 1916-09-08

Nichols, William F. 2000. Ecological Assessment of Selected Towns in New Hamphire's Coastal Zone. Prepared by NH Natural Heritage Inventory. Concord, NH.

NHB10-2146 EOCODE: PDCHE0J040*014*NH

New Hampshire Natural Heritage Bureau - Plant Record

Dwarf Glasswort (*Salicornia bigelovii*)

Legal Status		Conservation Status	
Federal:	Not listed	Global:	Demonstrably widespread, abundant, and secure
State:	Listed Endangered	State:	Critically imperiled due to rarity or vulnerability

Description at this Location

Conservation Rank: Historical records only - current condition unknown.
Comments on Rank: Sub-population of a large "A-" population.

Detailed Description: 1982: Very small population, only about 10 plants.
General Area: Full sun in saltmarsh with *Agalinis maritima*, *Spartina* spp., and *Plantago maritima*.
General Comments:
Management Comments:

Location

Survey Site Name: Causeway Road
Managed By:

County:	Rockingham	USGS quad(s):	Hampton (4207087)
Town(s):	Seabrook	Lat, Long:	425302N, 0705055W
Size:	2.8 acres	Elevation:	10 feet

Precision: Within (but not necessarily restricted to) the area indicated on the map.

Directions: Seabrook. East of the causeway road in wet panne near saltmarsh on north side of major channel.

Dates documented

First reported: 1982 Last reported: 1982-08-10

Dunlop, Deb. New England College, Botany Department, Box 30, Henniker, NH 03242. 603/428-2233.

Nichols, William F. 2000. Ecological Assessment of Selected Towns in New Hamphire's Coastal Zone. Prepared by NH Natural Heritage Inventory. Concord, NH.

NHB10-2146 EOCODE: PDPGN0L0Z0*001*NH

New Hampshire Natural Heritage Bureau - Plant Record

Erect Knotweed (*Polygonum erectum*)

Legal Status		**Conservation Status**	
Federal:	Not listed	Global:	Demonstrably widespread, abundant, and secure
State:	Listed Endangered	State:	Not ranked (need more information)

Description at this Location

Conservation Rank: Historical records only - current condition unknown.
Comments on Rank:

Detailed Description: 1972: Straus specimen at Clo Straus personal herbarium.
General Area:
General Comments:
Management
Comments:

Location

Survey Site Name: Brown River Salt Marsh
Managed By:

County:	Rockingham	USGS quad(s):	Hampton (4207087)
Town(s):	Seabrook	Lat, Long:	425402N, 0705051W
Size:	2.8 acres	Elevation:	10 feet

Precision: Within (but not necessarily restricted to) the area indicated on the map.

Directions: Seabrook. Brown River Salt Marsh. Edge of saltmarsh at end of "The Rocks" road.

Dates documented

First reported:	1972	Last reported:	1972-09-11

NHB10-2146 EOCODE: PMSPA01050*004*NH

New Hampshire Natural Heritage Bureau - Plant Record

Large Bur-reed (*Sparganium eurycarpum*)

Legal Status		Conservation Status	
Federal:	Not listed	Global:	Demonstrably widespread, abundant, and secure
State:	Listed Threatened	State:	Imperiled due to rarity or vulnerability

Description at this Location

Conservation Rank: Historical records only - current condition unknown.
Comments on Rank:

Detailed Description: 1984: Between 11-50 fruiting plants in 10-100 square yards of population area. Normal vigor.

General Area: 1984: Peat-muck. Inundated with water early in year. Saturated after that. Associated species include Echinochloa pungens [muricata] (cockspur grass), *Leersia oryzoides* (rice cut-grass), *Spartina pectinata* (fresh-water cord-grass, slough-grass), Scirpus americanus [pungens] x cyperinus ([hybrid] three-square rush), *Cyperus strigosus* (straw-colored umbrella-sedge), *Carex scoparia* (broom sedge), *Dulichium arundinaceum* (three-way sedge), *Sagittaria latifolia* (common arrowhead), *Pontederia cordata* (pickerel-weed), *Polygonum robustius* (robust knotweed), *Morus alba* (white mulberry), *Hypericum canadense* x H. [Triadenum] virginicum ([hybrid?] Canada and marsh St. John's-wort), *Lythrum salicaria* (purple loosestrife), *Cicuta bulbifera* (bulbiliferous water-hemlock), Lycopus sp. (water horehound), Scutellaria epilobiifolia [galericulata] (marsh skullcap), *Myosotis scorpioides* (true forget-me-not), *Sambucus canadensis* (common elderberry), Aster simplex [lanceolatus var. simplex] (tall white aster), and *Cephalanthus occidentalis* (buttonbush).

General Comments:

Management Comments: 1984: Notify Town of Hampton Falls and NH Wetlands Board that parking lot gravel is encroaching on marsh border of pond.

Location

Survey Site Name: Dodge Ponds
Managed By: John Fosss Field

County:	Rockingham	USGS quad(s):	Hampton (4207087)
Town(s):	Hampton Falls	Lat, Long:	425438N, 0705224W
Size:	39.7 acres	Elevation:	20 feet

Precision: Within (but not necessarily restricted to) the area indicated on the map.

Directions: Dodge Ponds, along marshy border of large and small ponds.

Dates documented

First reported: 1984-08-21 Last reported: 1984-08-21

Straus, C. 1984. Field survey to Dodge Ponds on August 21.

NHB10-2146 EOCODE: PDRAN04040*011*NH

New Hampshire Natural Heritage Bureau - Plant Record

Long-fruited Anemone (*Anemone cylindrica*)

Legal Status		Conservation Status	
Federal:	Not listed	Global:	Demonstrably widespread, abundant, and secure
State:	Listed Endangered	State:	Not ranked (need more information)

Description at this Location

Conservation Rank: Historical records only - current condition unknown.
Comments on Rank:

Detailed Description: 1997: Not observed (not a focused search). 1972: Documented as "occasional" on Hunts Island by Albion Hodgdon and Johonet Wicks.
General Area: 1997: A "salt marsh islands", forested upland surrounded by salt marsh.
General Comments:
Management Comments:

Location

Survey Site Name: Hunts Island
Managed By: ASNH to Properties, Inc. - Hunts Is.

County:	Rockingham	USGS quad(s):	Hampton (4207087)
Town(s):	Seabrook	Lat, Long:	425349N, 0705017W
Size:	2.8 acres	Elevation:	10 feet

Precision: Within (but not necessarily restricted to) the area indicated on the map.

Directions: From Rte 1A, turn east on Rocks Road. From Seabrook Nuclear Power Plant, proceed east to site on Hunts Island.

Dates documented

First reported: 1972-06 Last reported: 1972-06

Nichols, Bill. 1997. Field survey to Seabrook Nuclear Plant on September 17.

Hodgdon, Albion R. & Johonet C. Wicks. 1972. Appendix A. Botanical Survey of Seabrook Nuclear Project Site.

NHB10-2146 EOCODE: PDBRA06170*011*NH

New Hampshire Natural Heritage Bureau - Plant Record

Missouri Rock Cress (*Boechera missouriensis*)

Legal Status		**Conservation Status**	
Federal:	Not listed	Global:	Demonstrably widespread, abundant, and secure
State:	Listed Threatened	State:	Imperiled due to rarity or vulnerability

Description at this Location

Conservation Rank: Good quality, condition and lanscape context ('B' on a scale of A-D).
Comments on Rank: Rank does not consider the effects of the nuclear power plant.

Detailed Description: 1997: 160 basal rosettes; 40 fruiting stems.
General Area: 1997: A "salt marsh islands", forested upland surrounded by salt marsh. Dominant species are: *Quercus rubra* (red oak), *Quercus velutina* (black oak), *Quercus alba* (white oak), *Carya ovata* (shagbark hickory), and *Pinus strobus* (white pine). Also present are: *Smilacina stellata* var. *crassa* (coastal starry false Solomon's seal), *Tilia americana* (basswood), *Lonicera morrowii* (Morrow's honeysuckle), and *Juniperus virginiana* (eastern red cedar).
General Comments: 1997: East side of island younger and population likely receiving more shade now than it did in recent past.
Management Comments:

Location

Survey Site Name: Hunts Island
Managed By: ASNH to Properties, Inc. - Hunts Is.

County:	Rockingham	USGS quad(s):	Hampton (4207087)
Town(s):	Seabrook	Lat, Long:	425349N, 0705017W
Size:	2.8 acres	Elevation:	10 feet

Precision: Within (but not necessarily restricted to) the area indicated on the map.

Directions: From Rte 1A, turn east on Rocks Road. From Seabrook Nuclear Power Plant, proceed east. On rocky whalebacks at east end of Hunts Island.

Dates documented

First reported: 1997-09-17 Last reported: 1997-09-17

Nichols, Bill. 1997. Field survey to Seabrook Nuclear Plant on September 17.

NHB10-2146 EOCODE: PDCPR06020*001*NH

New Hampshire Natural Heritage Bureau - Plant Record

Orange Horse-gentian (*Triosteum aurantiacum*)

Legal Status		Conservation Status	
Federal:	Not listed	Global:	Demonstrably widespread, abundant, and secure
State:	Listed Endangered	State:	Critically imperiled due to rarity or vulnerability

Description at this Location

Conservation Rank: Fair quality, condition and/or lanscape context ('C' on a scale of A-D).
Comments on Rank: Rank does not consider the effects of the nuclear power plant.

Detailed Description: 1997: 6 clumps with 67 fruiting stems, scattered in small area of powerline in open and somewhat beneath shubs, all stems in fruit, some dropping when touched. 1982: ca. 60 plants in 1-2 acre area, robust and free of insect damage. 1972: Specimens at NHA, ARH and JW #19717.
General Area: 1997: Powerline corridor. 1982 (?): Sunny open area, mild slope, mesic. Ledges in sunny opening.
General Comments:
Management Comments:

Location

Survey Site Name: The Rocks
Managed By:

County:	Rockingham	USGS quad(s):	Hampton (4207087)
Town(s):	Seabrook	Lat, Long:	425358N, 0705045W
Size:	2.8 acres	Elevation:	15 feet

Precision: Within (but not necessarily restricted to) the area indicated on the map.

Directions: The Rocks. Along old utility powerline near southeast fence of Seabrook Power Station. Near end of point at southwestern side of "The Rocks" on ledges.

Dates documented

First reported: 1972 Last reported: 1997-09-17

Nichols, Bill. 1997. Field survey to Seabrook Nuclear Plant on September 17.

NHB10-2146 EOCODE: PDCPR06020*002*NH

New Hampshire Natural Heritage Bureau - Plant Record

Orange Horse-gentian (*Triosteum aurantiacum*)

Legal Status		Conservation Status	
Federal:	Not listed	Global:	Demonstrably widespread, abundant, and secure
State:	Listed Endangered	State:	Critically imperiled due to rarity or vulnerability

Description at this Location

Conservation Rank: Good quality, condition and lanscape context ('B' on a scale of A-D).
Comments on Rank: Rank does not consider the effects of the nuclear power plant.

Detailed Description: 1997: 211 stems. 1982: Over 100 mature plants, robust and abundant in scattered patches.
General Area: 1997: A "salt marsh islands", forested upland surrounded by salt marsh. Dominants: *Quercus rubra* (red oak), *Quercus velutina* (black oak), *Quercus alba* (white oak), *Pinus strobus* (white pine), and *Carya ovata* (shagbark hickory). 1982: Hickory-oak open woods. *Vitis novae-angliae* (New England grape) and *Celtis occidentalis* (hackberry) nearby. Flat, mesic.
General Comments:
Management Comments:

Location

Survey Site Name: Hunts Island
Managed By: ASNH to Properties, Inc. - Hunts Is.

County:	Rockingham	USGS quad(s):	Hampton (4207087)
Town(s):	Seabrook	Lat, Long:	425349N, 0705017W
Size:	2.8 acres	Elevation:	10 feet

Precision: Within (but not necessarily restricted to) the area indicated on the map.

Directions: Hunts Island. Southeast of Seabrook Power Plant, plants found near old cellar hole on southern half of the island.

Dates documented

First reported: 1972-06 Last reported: 1997-09-17

Nichols, Bill. 1997. Field survey to Seabrook Nuclear Plant on September 17.

Hodgdon, Albion R. & Johonet C. Wicks. 1972. Appendix A. Botanical Survey of Seabrook Nuclear Project Site.

NHB10-2146 EOCODE: PDCHE0M060*004*NH

New Hampshire Natural Heritage Bureau - Plant Record

Perennial Glasswort (*Salicornia ambigua*)

Legal Status		Conservation Status	
Federal:	Not listed	Global:	Not ranked (need more information)
State:	Listed Endangered	State:	Critically imperiled due to rarity or vulnerability

Description at this Location

Conservation Rank: Fair quality, condition and/or lanscape context ('C' on a scale of A-D).
Comments on Rank:

Detailed Description: 1997: At least two large mats in a 5-10 square-meter area. 1982: 50 or more stalks in 15x10 foot area, plants just starting to flower. Plants appear vigorous.
General Area: 1997: Gulf of Maine Salt Marsh. 1982: Flat, wet, full sun, with *Spartina patens* (salt-meadow cord-grass). Salt Marsh.
General Comments:
Management Comments:

Location

Survey Site Name: Hampton Falls River
Managed By: Landing + Vicinity Marsh

County:	Rockingham	USGS quad(s):	Hampton (4207087)
Town(s):	Hampton Falls	Lat, Long:	425437N, 0705110W
Size:	2.8 acres	Elevation:	10 feet

Precision: Within (but not necessarily restricted to) the area indicated on the map.

Directions: Hampton Falls. "Birmins" [Brimers?] Salt Marsh. Take Depot Ave to railroad tracks, go south on tracks 1/8 mile. Plants on west side of tracks at base of banking in salt marsh.

Dates documented

First reported: 1982-08-17 Last reported: 1997-09-19

Nichols, Bill. 1997. Field survey to Hampton Falls River Salt Marsh on September 19.

Nichols, William F. 2000. Ecological Assessment of Selected Towns in New Hamphire's Coastal Zone. Prepared by NH Natural Heritage Inventory. Concord, NH.

NHB10-2146 EOCODE: PDCHE0M060*003*NH

New Hampshire Natural Heritage Bureau - Plant Record

Perennial Glasswort (*Salicornia ambigua*)

Legal Status		Conservation Status	
Federal:	Not listed	Global:	Not ranked (need more information)
State:	Listed Endangered	State:	Critically imperiled due to rarity or vulnerability

Description at this Location

Conservation Rank: Historical records only - current condition unknown.
Comments on Rank:

Detailed Description: 1982: 10-15 stalks, one plant beginning to flower. Herbarium specimens of Dunlop and Straus at UNH.
General Area: 1982: Full sun, moist, flat but above main area of inundation, salt marsh.
General Comments:
Management Comments:

Location

Survey Site Name: Brown River Salt Marsh
Managed By:

County:	Rockingham	USGS quad(s):	Hampton (4207087)
Town(s):	Seabrook	Lat, Long:	425402N, 0705051W
Size:	2.8 acres	Elevation:	10 feet

Precision: Within (but not necessarily restricted to) the area indicated on the map.

Directions: Seabrook. Brown River salt marsh. High marsh on north side of the rock in the salt marsh.

Dates documented

First reported: 1922 Last reported: 1982-08-17

Dunlop, Deb. New England College, Botany Department, Box 30, Henniker, NH 03242. 603/428-2233.

NHB10-2146 EOCODE: PDPGN0L211*009*NH

New Hampshire Natural Heritage Bureau - Plant Record

Prolific Knotweed (*Polygonum ramosissimum ssp. prolificum*)

Legal Status		Conservation Status	
Federal:	Not listed	Global:	Apparently secure but with cause for concern
State:	Listed Endangered	State:	Critically imperiled due to rarity or vulnerability

Description at this Location

Conservation Rank: Historical records only - current condition unknown.
Comments on Rank:

Detailed Description: 1982: Number of plants located on higher edges of marsh.
General Area: 1982: Mill Creek bank; high marshy area on north bank.
General Comments: 1982: New record.
Management Comments:

Location

Survey Site Name: Mill Creek
Managed By:

County:	Rockingham	USGS quad(s):	Hampton (4207087)
Town(s):	Seabrook	Lat, Long:	425316N, 0705041W
Size:	2.8 acres	Elevation:	5 feet

Precision: Within (but not necessarily restricted to) the area indicated on the map.

Directions: Rte. 1N to Seabrook, Left on Depot Road at Seabrook Station. Just past Causeway Road along edge of Mill Creek.

Dates documented

First reported: 1982-08-26 Last reported: 1982-08-26

NHB10-2146 EOCODE: PDPGN0L220*005*NH

New Hampshire Natural Heritage Bureau - Plant Record

Robust Knotweed (*Persicaria robustior*)

Legal Status		Conservation Status	
Federal:	Not listed	Global:	Apparently secure but with cause for concern
State:	Listed Endangered	State:	Critically imperiled due to rarity or vulnerability

Description at this Location

Conservation Rank: Historical records only - current condition unknown.

Comments on Rank:

Detailed Description: 1984: 1 flowering plant. Gravel from parking lot destroyed part of site. 1983: ca. 101-1000 plants, with flowers and fruit. Fairly extensive colony on emersed pond shore, at time of low water.

General Area: 1984: Peat and muck. Associated species include *Sparganium eurycarpum* (giant bur-reed), *Cyperus strigosus* (straw-colored umbrella-sedge), *Leersia oryzoides* (rice cut-grass), and several species of Juncus (rushes). 1983: Mud and gravel on pond shore. Associated species: *Eleocharis acicularis* (least spike-rush) and a second Eleocharis species.

General Comments:

Management Comments:

Location

Survey Site Name: Dodge Ponds

Managed By:

County:	Rockingham	USGS quad(s):	Hampton (4207087)
Town(s):	Hampton Falls	Lat, Long:	425441N, 0705156W
Size:	2.5 acres	Elevation:	15 feet

Precision: Within (but not necessarily restricted to) the area indicated on the map.

Directions: Hampton Falls. Dodge Ponds. West side of Rte 1 on margin of Dodge Pond, just beyond parking area. Also on east of Lafayette Road on smaller Dodge Ponds.

Dates documented

First reported: 1983-09-21 Last reported: 1984-08-21

Straus, C. 1984. Field survey to Dodge Ponds on August 21.

NHB10-2146 EOCODE: PDSCR010H0*002*NH

New Hampshire Natural Heritage Bureau - Plant Record

Salt-marsh Gerardia (*Agalinis maritima*)

Legal Status		Conservation Status	
Federal:	Not listed	Global:	Demonstrably widespread, abundant, and secure
State:	Listed Endangered	State:	Critically imperiled due to rarity or vulnerability

Description at this Location

Conservation Rank: Not ranked
Comments on Rank: Sub-population of a large "A-" population.

Detailed Description: 1997: No details recorded. 1982: Specimen collected. 50+ plants almost all in flower. Those not flowering difficult to spot. Flowers very ephemeral.
General Area: 1997: Observed in cove of ***brackish marsh***. 1982: 0-10 foot elevation, flat, full sun, damp mud. In pannes in *Spartina patens* (salt-meadow cord-grass) salt marsh.
General Comments:
Management Comments:

Location

Survey Site Name: Beckmans Island
Managed By:

County:	Rockingham	USGS quad(s):	Hampton (4207087)
Town(s):	Seabrook	Lat, Long:	425325N, 0705033W
Size:	2.8 acres	Elevation:	10 feet

Precision: Within (but not necessarily restricted to) the area indicated on the map.

Directions: From Rte. 1A in Seabrook, go east on Depot Road. Drive to east end of Depot Road and park in lot. Site is north of the boat channel, on the northwest side of Beckmans Island.

Dates documented

First reported: 1982-08-26 Last reported: 1997-09-19

Nichols, Bill. 1997. Field survey to Farm Brook on September 19.

Nichols, William F. 2000. Ecological Assessment of Selected Towns in New Hamphire's Coastal Zone. Prepared by NH Natural Heritage Inventory. Concord, NH.

NHB10-2146 EOCODE: PDSCR010H0*004*NH

New Hampshire Natural Heritage Bureau - Plant Record

Salt-marsh Gerardia (*Agalinis maritima*)

Legal Status		Conservation Status	
Federal:	Not listed	Global:	Demonstrably widespread, abundant, and secure
State:	Listed Endangered	State:	Critically imperiled due to rarity or vulnerability

Description at this Location

Conservation Rank: Not ranked
Comments on Rank: Sub-population of a large "A-" population.

Detailed Description: 1997: More than 600 plants in a 0.1-hectare area, all in flower. 1982: Dunlop and Bertrand specimen at NHA. 50+ plants in wet panne almost all in flower; flowers very ephemeral.
General Area: 1997: Triglochin forb pannes on the ***high salt marsh***. Dominant species: *Triglochin maritimum* (arrow-grass), *Spartina patens* (salt-meadow cord-grass), *Distichlis spicata* (spike-grass), *Juncus gerardii* (salt marsh rush), and *Spartina alterniflora* (smooth cord-grass). 1982: 0-10 foot elevation, flat, full sun, damp mud.
General Comments:
Management Comments:

Location

Survey Site Name: Beckmans Island, SE
Managed By:

County:	Rockingham	USGS quad(s):	Hampton (4207087)
Town(s):	Seabrook	Lat, Long:	425324N, 0705028W
Size:	2.8 acres	Elevation:	10 feet

Precision: Within (but not necessarily restricted to) the area indicated on the map.

Directions: Southeast side of Beckmans Island.

Dates documented

First reported: 1982-08-26 Last reported: 1997-09-17

Nichols, Bill. 1997. Field survey to Beckman's Island on September 17.

Nichols, William F. 2000. Ecological Assessment of Selected Towns in New Hamphire's Coastal Zone. Prepared by NH Natural Heritage Inventory. Concord, NH.

NHB10-2146 EOCODE: PDSCR010H0*005*NH

New Hampshire Natural Heritage Bureau - Plant Record

Salt-marsh Gerardia (*Agalinis maritima*)

Legal Status		Conservation Status	
Federal:	Not listed	Global:	Demonstrably widespread, abundant, and secure
State:	Listed Endangered	State:	Critically imperiled due to rarity or vulnerability

Description at this Location

Conservation Rank: Not ranked
Comments on Rank: Sub-population of a large "A-" population.

Detailed Description: 1997: No details recorded. 1982: Specimen collected; 3 plants in salt marsh edge. All flowering but so ephemeral that flowers fell off at touch.
General Area: 1982: 0-10 ft. flat, in full sun, moist but not inundated.
General Comments: 1982: Perhaps more plants, very easily overlooked when not in flower; with Spartina patens (salt-meadow cord-grass).
Management Comments:

Location

Survey Site Name: Hunts Island
Managed By: ASNH to Properties, Inc. - Hunts Is.

County:	Rockingham	USGS quad(s):	Hampton (4207087)
Town(s):	Seabrook	Lat, Long:	425349N, 0705017W
Size:	2.8 acres	Elevation:	10 feet

Precision: Within (but not necessarily restricted to) the area indicated on the map.

Directions: Hunts Island. About 25 ft. from the wooded northeast side of the island.

Dates documented

First reported: 1982 Last reported: 1997-09-17

Dunlop, Deb. New England College, Botany Department, Box 30, Henniker, NH 03242. 603/428-2233.

Nichols, William F. 2000. Ecological Assessment of Selected Towns in New Hamphire's Coastal Zone. Prepared by NH Natural Heritage Inventory. Concord, NH.

NHB10-2146 EOCODE: PDSCR010H0*001*NH

New Hampshire Natural Heritage Bureau - Plant Record

Salt-marsh Gerardia (*Agalinis maritima*)

Legal Status		Conservation Status	
Federal:	Not listed	Global:	Demonstrably widespread, abundant, and secure
State:	Listed Endangered	State:	Critically imperiled due to rarity or vulnerability

Description at this Location

Conservation Rank: Historical records only - current condition unknown.
Comments on Rank: Sub-population of a large "A-" population.

Detailed Description: 1982: Dunlop and Bertrand specimen at NHA. 50+ plants in scattered patches. Almost all plants noticed in flower, plants not in flower easily overlooked.
General Area: 1982: Higher salt marsh, 0-10 foot elevation. Flat, full sun, damp mud. In pannes in *Spartina patens* (salt-meadow cord-grass), sometimes with *Plantago maritima* (salt marsh plantain).
General Comments: Flowers very ephemeral.
Management Comments:

Location

Survey Site Name: Mill Creek
Managed By:

County:	Rockingham	USGS quad(s):	Hampton (4207087)
Town(s):	Seabrook	Lat, Long:	425306N, 0705047W
Size:	2.8 acres	Elevation:	10 feet

Precision: Within (but not necessarily restricted to) the area indicated on the map.

Directions: Mill Creek site. East side of Causeway Road. The north side of Mill Creek salt marsh.

Dates documented

First reported: 1982-08-26 Last reported: 1982-08-26

Dunlop, Deb. New England College, Botany Department, Box 30, Henniker, NH 03242. 603/428-2233.

Nichols, William F. 2000. Ecological Assessment of Selected Towns in New Hamphire's Coastal Zone. Prepared by NH Natural Heritage Inventory. Concord, NH.

NHB10-2146 EOCODE: PDSCR010H0*003*NH

New Hampshire Natural Heritage Bureau - Plant Record

Salt-marsh Gerardia (*Agalinis maritima*)

Legal Status		Conservation Status	
Federal:	Not listed	Global:	Demonstrably widespread, abundant, and secure
State:	Listed Endangered	State:	Critically imperiled due to rarity or vulnerability

Description at this Location

Conservation Rank: Historical records only - current condition unknown.
Comments on Rank: Sub-population of a large "A-" population.

Detailed Description: 1982: Specimen collected. Scattered "clumps" of 25-100 plants each in seven small pans spread along north side of creek, both east and west of Causeway Road, north edge of marsh.
General Area: 1982: 6-10 feet, flat, full sun, moist.
General Comments:
Management Comments:

Location

Survey Site Name: Shepard Brook
Managed By:

County:	Rockingham	USGS quad(s):	Hampton (4207087)
Town(s):	Seabrook	Lat, Long:	425302N, 0705055W
Size:	2.8 acres	Elevation:	10 feet

Precision: Within (but not necessarily restricted to) the area indicated on the map.

Directions: From Rte. 1A in Seabrook, take Depot Road (Farm Lane) east ca. one mile. Turn right on Causeway Road and proceed ca. 0.25 miles to intersection with Mill Creek.

Dates documented

First reported: 1982-08-10 Last reported: 1982-08-10

Dunlop, Deb. New England College, Botany Department, Box 30, Henniker, NH 03242. 603/428-2233.

Nichols, William F. 2000. Ecological Assessment of Selected Towns in New Hamphire's Coastal Zone. Prepared by NH Natural Heritage Inventory. Concord, NH.

NHB10-2146 EOCODE: PDSCR010H0*008*NH

New Hampshire Natural Heritage Bureau - Plant Record

Salt-marsh Gerardia (*Agalinis maritima*)

Legal Status		Conservation Status	
Federal:	Not listed	Global:	Demonstrably widespread, abundant, and secure
State:	Listed Endangered	State:	Critically imperiled due to rarity or vulnerability

Description at this Location

Conservation Rank: Historical records only - current condition unknown.
Comments on Rank: Sub-population of a large "A-" population.

Detailed Description: 1982: More than 50 plants in 30 x 10 foot area. Most flowering, but plant is very difficult to spot when it is not flowering and very ephemeral when it is.
General Area: 1982: Flat, full sun. Damp but not innundated. With *Spartina patens* (salt-meadow cordgrass).
General Comments:
Management Comments:

Location

Survey Site Name: Hunts Island Creek Marsh
Managed By: F&G to PSNH - Perkins

County:	Rockingham	USGS quad(s):	Hampton (4207087)
Town(s):	Seabrook	Lat, Long:	425343N, 0705058W
Size:	2.8 acres	Elevation:	10 feet

Precision: Within (but not necessarily restricted to) the area indicated on the map.

Directions: Hunt Island creek marsh. Directly south of nuclear reactor site, east of their nature trail. Along stone wall, on north side.

Dates documented

First reported: 1982-08-17 Last reported: 1982-08-17

Dunlop, Deb. New England College, Botany Department, Box 30, Henniker, NH 03242. 603/428-2233.

Nichols, William F. 2000. Ecological Assessment of Selected Towns in New Hamphire's Coastal Zone. Prepared by NH Natural Heritage Inventory. Concord, NH.

NHB10-2146 EOCODE: PDAST0S0D7*007*NH

New Hampshire Natural Heritage Bureau - Plant Record

Tall Wormwood (*Artemisia campestris ssp. caudata*)

Legal Status		Conservation Status	
Federal:	Not listed	Global:	Demonstrably widespread, abundant, and secure
State:	Listed Endangered	State:	Critically imperiled due to rarity or vulnerability

Description at this Location

Conservation Rank: Not ranked
Comments on Rank:

Detailed Description: 1997: Common (11-50 plants) on railroad tracks leading down to salt marsh to east. 1982: Numerous plants scattered along railroad bed on both sides. Specimens at NHA, NEBC (1916, 1982).
General Area: 1997: Open habitat on railroad banks.
General Comments:
Management Comments:

Location

Survey Site Name: Hampton Falls River
Managed By: ASNH Hampton Falls Saltmarsh - Swain

County:	Rockingham	USGS quad(s):	Hampton (4207087)
Town(s):	Hampton Falls	Lat, Long:	425449N, 0705102W
Size:	2.8 acres	Elevation:	10 feet

Precision: Within (but not necessarily restricted to) the area indicated on the map.

Directions: Railroad tracks, north of Hampton Falls River in Hampton Harbor salt marsh.

Dates documented

First reported: 1916 Last reported: 1997-09-19

Nichols, Bill. 1997. Field survey to Hampton Falls River Salt Marsh on September 19.

Nichols, William F. 2000. Ecological Assessment of Selected Towns in New Hamphire's Coastal Zone. Prepared by NH Natural Heritage Inventory. Concord, NH.

NHB10-2146 EOCODE: PDAST2E1E0*002*NH

New Hampshire Natural Heritage Bureau - Plant Record

Yellow Thistle (*Cirsium horridulum*)

Legal Status		**Conservation Status**	
Federal:	Not listed	Global:	Demonstrably widespread, abundant, and secure
State:	Listed Endangered	State:	Critically imperiled due to rarity or vulnerability

Description at this Location

Conservation Rank: Historical records only - current condition unknown.
Comments on Rank:

Detailed Description: 1982: 5 vigorous plants. Specimen of Dunlop at NHA.
General Area: Salt marsh, open, wet.
General Comments:
Management Comments:

Location

Survey Site Name: The Rocks
Managed By:

County:	Rockingham	USGS quad(s):	Hampton (4207087)
Town(s):	Seabrook	Lat, Long:	425358N, 0705045W
Size:	2.8 acres	Elevation:	2 feet

Precision: Within (but not necessarily restricted to) the area indicated on the map.

Directions: Seabrook. The Rocks. Southeast of Seabrook Nuclear Site. Immediate edge of salt marsh outside of fence. A second group more to the west and outside fence in thicket above marsh.

Dates documented

First reported: 1982 Last reported: 1982-08-17

Dunlop, Deb. New England College, Botany Department, Box 30, Henniker, NH 03242. 603/428-2233.

NHB10-2146 EOCODE: ARAAD04010*089*NH

New Hampshire Natural Heritage Bureau - Animal Record

Blanding's Turtle (*Emydoidea blandingii*)

Legal Status		Conservation Status	
Federal:	Not listed	Global:	Apparently secure but with cause for concern
State:	Listed Endangered	State:	Critically imperiled due to rarity or vulnerability

Description at this Location

Conservation Rank: Fair quality, condition and/or lanscape context ('C' on a scale of A-D).
Comments on Rank:

Detailed Description: 1990: Area 2060: 1 turtle. Dead on road.
General Area:
General Comments: 1990: Area 2060: Some shell pieces kept.
Management Comments:

Location

Survey Site Name: New Zealand Hill, south of
Managed By:

County: Rockingham
Town(s): Seabrook
Size: 1.9 acres

USGS quad(s): Exeter (4207088)
Lat, Long:
Elevation:

Precision: Within (but not necessarily restricted to) the area indicated on the map.

Directions: 1990: Area 2060: Flooded, marsh area just before the exit ramp for Seabrook on I-95 north.

Dates documented

First reported: 1990-08-01 Last reported: 1990-08-01

The New Hampshire Fish & Game Department has jurisdiction over rare wildlife in New Hampshire. Please contact them at 11 Hazen Drive, Concord, NH 03301 or at (603) 271-2461.

NHB10-2146 EOCODE: ABNNM08070*006*NH

New Hampshire Natural Heritage Bureau - Animal Record

Common Tern (*Sterna hirundo*)

Legal Status		Conservation Status	
Federal:	Not listed	Global:	Demonstrably widespread, abundant, and secure
State:	Listed Threatened	State:	Not ranked (need more information)

Description at this Location

Conservation Rank: Not ranked

Comments on Rank:

Detailed Description: 1992: No attempted nesting 18 May thru mid-June. 1991: 27 nests; no chicks produced. Highest count of adult terns was 50, on June 3. High tides and flooding rains of June 13 destroyed all nests. 2 pairs re-nested but were flooded out by high tides on July 11. 1990: On July 16, 42 nests; at least 9 chicks reached fledgling stage. Highest count of adult terns was 81 on July 16. Many nests abandoned after heavy rain / high tides in late July and early August. No terns at colony site by August 31. 1989: Colony arrived at site very late in breeding season.

General Area: 1991: A 50 x 100 meter area within 4-5 meters of the shoreline. Tern activity bent the (Juncus) rush into soft mats. A few nests were on mats of loose thatch that had been brought up with the tides.

General Comments: 1990: The density of this colony, along with its relative isolation and proximity to Hampton Harbor, may allow for improved success in the future.

Management Comments:

Location

Survey Site Name: Seabrook

Managed By:

County:	Rockingham	USGS quad(s):	Hampton (4207087)
Town(s):	Hampton Falls	Lat, Long:	425325N, 0704945W
Size:	2.8 acres	Elevation:	

Precision: Within (but not necessarily restricted to) the area indicated on the map.

Directions: Located on the west side of the Blackwater River between Lower Gill Rocks and Mill Creek, at the junction with Hampton Harbor. Most of the nests in a roughly 50 x 100 meters area, 4 - 5 feet from shoreline, in areas of Juncus spp. A few additional nests were found within 100 meters on either side of the central colony.

Dates documented

First reported:	1989	Last reported:	1991

De Luca, Diane. 1992. 1992 Nongame Report: Common Terns. Report prepared by Audubon Society of New Hamphsire for the New Hampshire Fish & Game Department.

The New Hampshire Fish & Game Department has jurisdiction over rare wildlife in New Hampshire. Please contact them at 11 Hazen Drive, Concord, NH 03301 or at (603) 271-2461.

NHB10-2146 EOCODE: ABNNM08070*005*NH

New Hampshire Natural Heritage Bureau - Animal Record

Common Tern (*Sterna hirundo*)

Legal Status		Conservation Status	
Federal:	Not listed	Global:	Demonstrably widespread, abundant, and secure
State:	Listed Threatened	State:	Not ranked (need more information)

Description at this Location

Conservation Rank: Historical records only - current condition unknown.
Comments on Rank: 2007: No records from this site since 1978.

Detailed Description: 1978: At least 2 nests.1969: 10 adults, 1 chick observed.1966: Ca. 10 birds present, 1 nest with 2 eggs.1964: 10 birds nesting.
General Area:
General Comments:
Management Comments:

Location

Survey Site Name: Hampton Falls RR Station
Managed By: Former Dodge Marsh

County:	Rockingham	USGS quad(s):	Hampton (4207087)
Town(s):	Hampton Falls	Lat, Long:	425444N, 0705105W
Size:	2.8 acres	Elevation:	5 feet

Precision: Within (but not necessarily restricted to) the area indicated on the map.

Directions: Hampton Falls Railroad station, Route 1, then East on Depot Ave.

Dates documented

First reported: 1964 Last reported: 1978

The New Hampshire Fish & Game Department has jurisdiction over rare wildlife in New Hampshire. Please contact them at 11 Hazen Drive, Concord, NH 03301 or at (603) 271-2461.

NHB10-2146 EOCODE: ABPAT02010*002*NH

New Hampshire Natural Heritage Bureau - Animal Record

Horned Lark (*Eremophila alpestris*)

Legal Status		Conservation Status	
Federal:	Not listed	Global:	Demonstrably widespread, abundant, and secure
State:	SC	State:	Not ranked (need more information)

Description at this Location

Conservation Rank: Not ranked
Comments on Rank:

Detailed Description: 1995: 1 adult seen, sex unknown, 1 immature, sex unknown (Obs_id 1236).
General Area: 1995: Terrestrial - Seacoast shore (Obs_id 1236).
General Comments: 1995: Adult and recently-fledged juvenile (Obs_id 1236).
Management Comments:

Location

Survey Site Name: Hampton Harbor Inlet
Managed By: Hampton Beach State Park

County:	Rockingham	USGS quad(s):	Hampton (4207087)
Town(s):	Hampton	Lat, Long:	425353N, 0704849W
Size:	7.7 acres	Elevation:	

Precision: Within (but not necessarily restricted to) the area indicated on the map.

Directions: 1995: Hampton Beach State Park Parking lot [north of Hampton Harbor Bridge] (Obs_id 1236).

Dates documented

First reported:	1995-04-29	Last reported:	1995-04-29

The New Hampshire Fish & Game Department has jurisdiction over rare wildlife in New Hampshire. Please contact them at 11 Hazen Drive, Concord, NH 03301 or at (603) 271-2461.

NHB10-2146 EOCODE: ABNKC01010*161*NH

New Hampshire Natural Heritage Bureau - Animal Record

Osprey (*Pandion haliaetus*)

Legal Status		Conservation Status	
Federal:	Not listed	Global:	Demonstrably widespread, abundant, and secure
State:	SC	State:	Not ranked (need more information)

Description at this Location

Conservation Rank: Not ranked
Comments on Rank:

Detailed Description: 2008: Nest 1: 1 fledged.2007: Nest 1: 2 fledged.
General Area:
General Comments:
Management
Comments:

Location

Survey Site Name: Blackwater Duck Blind
Managed By:

County:	Rockingham	USGS quad(s):	Hampton (4207087)
Town(s):	Seabrook	Lat, Long:	425303N, 0705003W
Size:	.4 acres	Elevation:	

Precision: Within (but not necessarily restricted to) the area indicated on the map.

Directions:

Dates documented

First reported:	2007	Last reported:	2008

The New Hampshire Fish & Game Department has jurisdiction over rare wildlife in New Hampshire. Please contact them at 11 Hazen Drive, Concord, NH 03301 or at (603) 271-2461.

NHB10-2146 EOCODE: ABNKC01010*167*NH

New Hampshire Natural Heritage Bureau - Animal Record

Osprey (*Pandion haliaetus*)

Legal Status		Conservation Status	
Federal:	Not listed	Global:	Demonstrably widespread, abundant, and secure
State:	SC	State:	Not ranked (need more information)

Description at this Location

Conservation Rank: Not ranked
Comments on Rank:

Detailed Description: 2008: Nest 1: 1 fledged.
General Area:
General Comments:
Management
Comments:

Location

Survey Site Name: Hampton Landing
Managed By: F&G Hampton Saltmarsh - Smart

County:	Rockingham	USGS quad(s):	Hampton (4207087)
Town(s):	Hampton	Lat, Long:	425451N, 0705016W
Size:	.4 acres	Elevation:	

Precision: Within (but not necessarily restricted to) the area indicated on the map.

Directions:

Dates documented

First reported:	2008	Last reported:	2008

The New Hampshire Fish & Game Department has jurisdiction over rare wildlife in New Hampshire. Please contact them at 11 Hazen Drive, Concord, NH 03301 or at (603) 271-2461.

NHB10-2146 EOCODE: ABNNB03070*003*NH

New Hampshire Natural Heritage Bureau - Animal Record

Piping Plover (*Charadrius melodus*)

Legal Status		Conservation Status	
Federal:	Listed Threatened	Global:	Rare or uncommon
State:	Listed Endangered	State:	Not ranked (need more information)

Description at this Location

Conservation Rank: Fair quality, condition and/or lanscape context ('C' on a scale of A-D).

Comments on Rank: Highly impacted habitat (parking lots, residential, beach use) but 5-6 pairs fledging 2-15 young most years. Rank is for the combined sub-populations.

Detailed Description: 2008: 2 nesting pairs, 3 chicks fledged.2007: 0 fledged.2006: 1 nesting pair, 4 chicks hatched, 0 fledged.2005: 2 nesting pairs, 4 chicks hatched, 0 fledged.2004: 2 nesting pairs, 4 chicks hatched, 1 fledged.2003: 5 nesting pairs, 12 chicks hatched, 4 fledged.2002: 5 nesting pairs, 11 chicks hatched, 0 fledged.2001: 5 nesting pairs, 15 chicks hatched, 12 fledged.2000: 5 nesting pairs, 14 chicks hatched, 12 fledged.1999: 5 nesting pairs, 16 chicks hatched, 15 fledged.1998: 5 nesting pairs, 16 chicks hatched, 12 fledged.1997: 3 nesting pairs, 12 chicks hatched, 3 fledged.

General Area: 2002: Seacoast shore. 1997: Sand beach.

General Comments:

Management Comments: 2006: Four chicks lost, probably to predation.2003: One nest was lost to predation, one to bad weather, and two to unspecified causes. 2002: Several nests and chicks were lost to severe weather, and others (including one parent) were lost to suspected predation.2000: Two chick deaths may have been due to cat predation, or in one case vehicular traffic. Enforcement of the town ordinance related to dogs at the beach continues to be needed. 1998: Threats included a bad storm in June (6 inches of rain in one day), high tides (to within 10 feet of the nests), predators such as skunks, dogs, gulls, and especially young children. Cages, signs, fences, and pamphlets were all employed to increase protection.

Location

Survey Site Name: Seabrook Beach

Managed By: Seabrook Dunes and Beach

County:	Rockingham	USGS quad(s):	Hampton (4207087)
Town(s):	Seabrook	Lat, Long:	425251N, 0704857W
Size:	35.1 acres	Elevation:	10 feet

Precision: Within (but not necessarily restricted to) the area indicated on the map.

Directions: Seabrook Beach opposite The Sands area. Nest locations: 2006: North of Hookset Street. 2003: Ocean side of Tilton/Hooksett St. in open beach (Obs_id 327); ocean side of Andover St. in dune slope (Obs_id 326); ocean side of Haberhill St., south in toe of dune (Obs_id 329), north in toe of dune (Obs_id 330); ocean side of Lowell St., toe of dune (Obs_id 328); ocean side of New Hampshire St. in open beach (Obs_id 331). 2002: One nest just south of the beach entrance from Tyngsboro Street and one just south of the beach entrance from Chelmsford Street. The GPS coordinates are for the location of the second nest (Obs_id 216). Two nests near the beach entrance from Dracut Street (Obs_id 217). Three nests just north of the beach entrance from Haverhill Street (Obs_id 218). Two nests just south of the beach entrance from Haverhill Street. The GPS coordinates are for the second nest (Obs_id 219). One nest in the center of the path which leads from the New Hampshire street entrance to the beach. This is at the very south end of Seabrook beach and borders the Mass. state line (Obs_id 220). 2001: Near beach entrance from Groveland Street (Obs_id 227). Near beach entrance from Tyngsboro Street. GPS coordinates are for the second nest (Obs_id 223). Near Hooksett Street (Obs_id 224). Near beach entrance from Dracut Street (Obs_id 226). Near beach entrance from Lawrence Street (Obs_id 225).

The U.S. Fish & Wildlife Service has jurisdiction over Federally listed species. Please contact them at 70 Commercial Street, Suite 300, Concord NH 03301 or at (603) 223-2541.

NHB10-2146 EOCODE: ABNNB03070*003*NH

Dates documented

First reported: 1997 Last reported: 2008-08

Kanter, John. 1998. Personal communication (locations of piping plover and common tern nests) during meeting on December 4.

Murphy, Kristen. 2006 Nesting Summary. Piping Plover (Charadrius melodus). NH Fish and Game Dept., Nongame and Endangered Wildlife Program. Concord, NH.

The U.S. Fish & Wildlife Service has jurisdiction over Federally listed species. Please contact them at 70 Commercial Street, Suite 300, Concord NH 03301 or at (603) 223-2541.

NHB10-2146 EOCODE: ABNNB03070*001*NH

New Hampshire Natural Heritage Bureau - Animal Record

Piping Plover (*Charadrius melodus*)

Legal Status		Conservation Status	
Federal:	Listed Threatened	Global:	Rare or uncommon
State:	Listed Endangered	State:	Not ranked (need more information)

Description at this Location

Conservation Rank: Historical records only - current condition unknown.
Comments on Rank: This sub-population has not fledged chicks since 1971.

Detailed Description: 1984: Pair, distraction display, nest not found. 1971: Last year nesting known, 2 birds, 4 eggs. 1970: 2 young fledged. 1969: 4 eggs, 1 known fledged. 1968: 4 eggs, 2 known fledged. 1967: 4 fledged. 1966: Nest with 4 eggs.
General Area: 1984: Sand dunes with beach grass, beach peas.
General Comments: 1986: Off-road vehicle access eliminated as of June/July 1986. NH Endangered Species Program working with recovery team re: future management.
Management Comments:

Location

Survey Site Name: Hampton Harbor Inlet
Managed By: Former Barge Facility Land

County:	Rockingham	USGS quad(s):	Hampton (4207087)
Town(s):	Seabrook	Lat, Long:	425336N, 0704905W
Size:	9.3 acres	Elevation:	3 feet

Precision: Within (but not necessarily restricted to) the area indicated on the map.

Directions: East side of Hampton Harbor and south side of Hampton Harbor inlet, to the west of Rte 1A.

Dates documented

First reported: 1963 Last reported: 1984-05-12

Smith, Carol. 1986. Conversation with Dick Dyer, recovery team leader, regarding piping plovers at Hampton Harbor inlet on October 20.

The U.S. Fish & Wildlife Service has jurisdiction over Federally listed species. Please contact them at 70 Commercial Street, Suite 300, Concord NH 03301 or at (603) 223-2541.

NHB10-2146 EOCODE: ABNNF02010*001*NH

New Hampshire Natural Heritage Bureau - Animal Record

Willet (*Catoptrophorus semipalmatus*)

Legal Status		**Conservation Status**	
Federal:	Not listed	Global:	Demonstrably widespread, abundant, and secure
State:	SC	State:	Not ranked (need more information)

Description at this Location

Conservation Rank: Not ranked
Comments on Rank:

Detailed Description: 2004: Possible breeding, <15 observed. 1998: 2 observe. 1997: 150 adults. 1995: 8 observed.1991: 1 to 4 adults observed on three occasions. 1990: 2 observed on two occasions. 1986: 5 observed. 1985: 5-6 adults, 1 chick.
General Area:
General Comments:
Management Comments:

Location

Survey Site Name: Blackwater River
Managed By: F&G Seabrook Saltmarsh - Prop. Inc.

County:	Rockingham	USGS quad(s):	Hampton (4207087)
Town(s):	Seabrook	Lat, Long:	425341N, 0705008W
Size:	3.8 acres	Elevation:	

Precision: Within (but not necessarily restricted to) the area indicated on the map.

Directions:

Dates documented

First reported:	1985-07-18	Last reported:	2004

The New Hampshire Fish & Game Department has jurisdiction over rare wildlife in New Hampshire. Please contact them at 11 Hazen Drive, Concord, NH 03301 or at (603) 271-2461.

NHB10-2146 EOCODE: ABNNF02010*004*NH

New Hampshire Natural Heritage Bureau - Animal Record

Willet (*Catoptrophorus semipalmatus*)

Legal Status		**Conservation Status**	
Federal:	Not listed	Global:	Demonstrably widespread, abundant, and secure
State:	SC	State:	Not ranked (need more information)

Description at this Location

Conservation Rank: Not ranked
Comments on Rank:

Detailed Description: 2004: 1 nest, 16-30 adults. 2003: 8 adults. 1992: 6 adults.
General Area:
General Comments:
Management Comments:

Location

Survey Site Name: Hampton River
Managed By: Former John N. Chase Marsh

County:	Rockingham	USGS quad(s):	Hampton (4207087)
Town(s):	Hampton Falls	Lat, Long:	425437N, 0705048W
Size:	1.9 acres	Elevation:	

Precision: Within (but not necessarily restricted to) the area indicated on the map.

Directions:

Dates documented

First reported:	2004	Last reported:	2004

The New Hampshire Fish & Game Department has jurisdiction over rare wildlife in New Hampshire. Please contact them at 11 Hazen Drive, Concord, NH 03301 or at (603) 271-2461.

Memo

NH Natural Heritage Bureau

To: Jeremy Susco, U.S. NRC
11555 Rockville Pike
Mailstop: O-11F1
Rockville, MD 20852

From: Melissa Coppola, NH Natural Heritage Bureau
Date: 9/13/2010 (valid for one year from this date)
Re: Review by NH Natural Heritage Bureau
NHB File ID: NHB10-2248
Project type: Railroads, Transmission Lines, Pipelines: Transmission line, etc.
Town: Seabrook, NH
Location: Seabrook Station in Seabrook, NH
cc: Kim Tuttle

As requested, I have searched our database for records of rare species and exemplary natural communities, with the following results.

Comments: This site is within an area flagged for possible impacts on the state-listed *Ligumia nasuta* (eastern pondmussel) in the Great Pond.

Invertebrate Species	State[1]	Federal	Notes
Eastern Pond Mussel (*Ligumia nasuta*)	SC	--	Contact the NH Fish & Game Dept (see below).

Natural Community	State[1]	Federal	Notes
Atlantic white cedar - yellow birch - pepperbush swamp	--	--	Changes to the hydrology of the wetland are the greatest threat facing the cedar swamp. Damming which causes pooling for extended periods can flood and drown existing trees, and drainage that results in lower water levels can lead to invasion by other species that can out compete -- and eventually eliminate -- Atlantic white cedar trees. Increased nutrient input from stormwater runoff could also deleteriously impact this acidic, low-nutrient plant community.
Brackish marsh	--	--	Threats to these communities are primarily alterations to the hydrology of the wetland (such as ditching or tidal restrictions that might affect the sheet flow of tidal waters across the intertidal flat) and increased input of nutrients and pollutants in storm runoff.
Emergent marsh - shrub swamp system	--	--	
Herbaceous seepage marsh	--	--	As this wetland is strongly influenced by groundwater seepage, it could be affected by landscape alterations which modify groundwater movement or increase stormwater flow into it.
High salt marsh	--	--	Threats to these communities are primarily alterations to the hydrology of the wetland (such as ditching or tidal restrictions that might affect the sheet flow of tidal waters
intertidal flat	--	--	

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Low salt marsh	--	--	across the intertidal flat) and increased input of nutrients and pollutants in storm runoff.
Poor level fen/bog system	--	--	Level fens are stagnant, and as such are characterized by low nutrient levels, relatively high acidity levels, and accumulations of peat. The primary threats to this community are changes to its hydrology (especially that which causes pooling), increased nutrient input from stormwater runoff, and sedimentation from nearby disturbance.
Red maple - sensitive fern swamp	--	--	These swamps are influenced by groundwater seepage and springs which moderate water fluctuations and maintain conditions favorable for the accumulation of organic matter. The primary threats are changes to the hydrology of the wetland complex, particularly raising or lowering the water levels, and increased nutrient and pollutant input carried in by stormwater runoff.
Swamp white oak floodplain forest	--	--	Threats are primarily changes to the hydrology of the river, land conversion and fragmentation, introduction of invasive species, and increased input of nutrients and pollutants.
Temperate minor river floodplain system*	--	--	Threats are primarily changes to the hydrology of the river, land conversion and fragmentation, introduction of invasive species, and increased input of nutrients and pollutants.

Plant species	**State[1]**	**Federal**	**Notes**
Dwarf Glasswort (*Salicornia bigelovii*)*	E	--	Threats are primarily alterations to the hydrology of the wetland, such as ditching or tidal restrictions that might affect the sheet flow of tidal waters across the intertidal flat, activities that eliminate plants, and increased input of nutrients and pollutants in storm runoff.
Dwarf Huckleberry (*Gaylussacia bigeloviana*)	T	--	The primary threats are changes to this species' peatland habitat, including changes to local hydrology, increased nutrient input from stormwater runoff, and sedimentation from nearby disturbance.
Northern Blazing Star (*Liatris novae-angliae*)	E	--	Threats to this highly imperilled species are development activities that eliminate its habitat and invasion of its open, grassy habitat by trees and shrubs.
Perennial Glasswort (*Salicornia ambigua*)	E	--	Primarily vulnerable to changes to the hydrology of its habitat, especially alterations that change water levels. It may also be susceptible to increased pollutants and nutrients carried in stormwater runoff.
Robust Knotweed (*Persicaria robustior*)	E	--	Threats include changes to local hydrology that would affect its habitat. It grows on river or streambanks, pond or lake shores, and in forested swamps.
Tall Wormwood (*Artemisia campestris ssp.*	E	--	This species grows in dry dune systems and is sensitive to disturbances that eliminate

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Concord NH 03302-1856

Memo

NH Natural Heritage Bureau

caudata) | its habitat or disturb the natural dynamics of the dune area.

Vertebrate species	State[1]	Federal	Notes
Banded Sunfish (*Enneacanthus obesus*)	SC	--	Contact the NH Fish & Game Dept (see below).
Blanding's Turtle (*Emydoidea blandingii*)	E	--	Contact the NH Fish & Game Dept (see below).
Common Tern (*Sterna hirundo*)*	T	--	Contact the NH Fish & Game Dept (see below).
Golden-winged Warbler (*Vermivora chrysoptera*)*	SC	--	Contact the NH Fish & Game Dept (see below).
Spotted Turtle (*Clemmys guttata*)	T	--	Contact the NH Fish & Game Dept (see below).
Vesper Sparrow (*Pooecetes gramineus*)	SC	--	Contact the NH Fish & Game Dept (see below).

[1]Codes: "E" = Endangered, "T" = Threatened, "--" = an exemplary natural community, or a rare species tracked by NH Natural Heritage that has not yet been added to the official state list. An asterisk (*) indicates that the most recent report for that occurrence was more than 20 years ago.

Contact for all animal reviews: Kim Tuttle, NH F&G, (603) 271-6544.

A negative result (no record in our database) does not mean that a sensitive species is not present. Our data can only tell you of known occurrences, based on information gathered by qualified biologists and reported to our office. However, many areas have never been surveyed, or have only been surveyed for certain species. For some purposes, including legal requirements for state wetland permits, the fact that no species of concern are known to be present is sufficient. However, an on-site survey would provide better information on what species and communities are indeed present.

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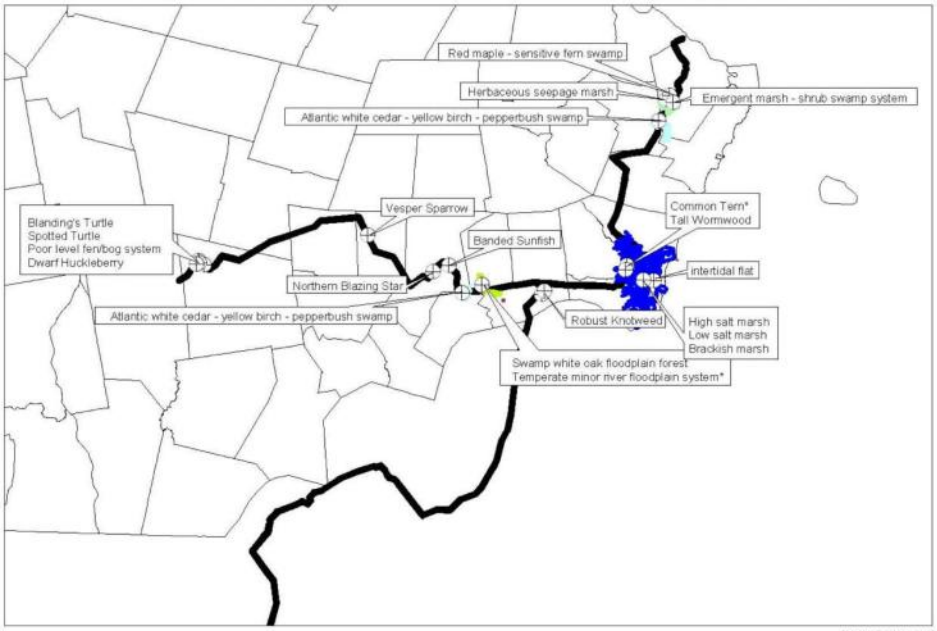
NHB10-2248

NH NATURAL HERITAGE BUREAU

Known locations of rare species and exemplary natural communities

Note: Mapped locations are not always exact. Occurrences that are not in the vicinity of the project are not shown.



*Historical record

0 [illegible] Miles

1:350000

Valid for one year from this date: 13 Sep 2010

NHB10-2248 EOCODE: CP00000166*001*NH

New Hampshire Natural Heritage Bureau - Community Record

Atlantic white cedar - yellow birch - pepperbush swamp

Legal Status		Conservation Status	
Federal:	Not listed	Global:	Not ranked (need more information)
State:	Not listed	State:	Imperiled due to rarity or vulnerability

Description at this Location

Conservation Rank: Good quality, condition and lanscape context ('B' on a scale of A-D).
Comments on Rank:

Detailed Description: 1996: No details. 1989: Has a healthy population of *Chamaecyparis thyoides* (Atlantic white cedar) plus *Picea mariana* (black spruce), *Tsuga canadensis* (hemlock), and *Larix* (larch). Excellent variety of bog plants.
General Area: 1972: Bordered by two roads, forest land, and a railroad bed.
General Comments: Swamp logged in the past, but has since regained a natural quality. NH Natural Area #3. 335 acres total wetlands at Packer Bog.
Management Comments:

Location

Survey Site Name: Packer Bog
Managed By: Packer Bog

County:	Rockingham	USGS quad(s):	Portsmouth (4307017)
Town(s):	Greenland	Lat, Long:	430149N, 0704851W
Size:	359.6 acres	Elevation:	30 feet

Precision: Within (but not necessarily restricted to) the area indicated on the map.

Directions: Greenland at Packer Bog.

Dates documented

First reported: 1972 Last reported: 1996-07-16

Nichols, Bill. 1996. Field survey to Packer Bog, Greenland on July 16.

Nichols, B. & D. Sperduto. 1996. Ecological inventories of 1996 project areas on the White Mountain National Forest in New Hampshire. New Hampshire Natural Heritage Program, Concord, NH. 83 pp.

NHB10-2248 EOCODE: CP00000166*021*NH

New Hampshire Natural Heritage Bureau - Community Record

Atlantic white cedar - yellow birch - pepperbush swamp

Legal Status		Conservation Status	
Federal:	Not listed	Global:	Not ranked (need more information)
State:	Not listed	State:	Imperiled due to rarity or vulnerability

Description at this Location

Conservation Rank: Good quality, condition and lanscape context ('B' on a scale of A-D).
Comments on Rank:

Detailed Description: 1993: *Chamaecyparis thyoides* (Atlantic white cedar) dominates 45-55 acres of the 62-acre wetland. One of largest, but not necessarily best, occurrences in the state; recent cutting has created a young age structure (average dbh = 18 inches). Other species include *Acer rubrum* (red maple), *Betula alleghaniensis* (yellow birch), *Vaccinium corymbosum* (highbush blueberry), *Toxicodendron vernix* (poison sumac), and Sphagnum moss.

General Area: 1993: Water is plentiful with near permanent saturation in most areas. East end of complex is drier, and litter and duff predominate over Sphagnum. Water ph is 4.2-4.8.

General Comments: 2007: Originally the surveysite name contained "(Newton Wetland #4)."

Management Comments: 1993: No immediate needs.

Location

Survey Site Name: Newton - Kingston Cedar Swamp
Managed By: Bowley Parcel

County:	Rockingham	USGS quad(s):	Kingston (4207181)
Town(s):	Kingston	Lat, Long:	425335N, 0710158W
Size:	111.4 acres	Elevation:	100 feet

Precision: Within (but not necessarily restricted to) the area indicated on the map.

Directions: North on New Boston Road (Route 108) in Newton. The cedar swamp can be reached from the back of Union Cemetery. Proceed downslope (north) for 450 feet. Or, enter from the small parking area on New Boston Road 0.6 miles north of New Boston Road. From Main Street, the east arm of the wetland is 0.5 miles north of New Boston Road. Proceed west for 300 feet.

Dates documented

First reported: 1993-07-06 Last reported: 1993-09-09

Ritter, N. 1993. Field survey to Wetland #4: Newton on September 9.

Sperduto, D. & N. Ritter. 1994. Altantic White Cedar Wetlands of New Hampshire. Environmental Protection Agency, Boston, MA.

NHB10-2248 EOCODE: CE00000005*012*NH

New Hampshire Natural Heritage Bureau - Community Record

Brackish marsh

Legal Status		Conservation Status	
Federal:	Not listed	Global:	Not ranked (need more information)
State:	Not listed	State:	Imperiled due to rarity or vulnerability

Description at this Location

Conservation Rank: Good quality, condition and lanscape context ('B' on a scale of A-D).

Comments on Rank: Rank is for largest area visited (Taylor River). Others were B- (three sites) or C (Seabrook Salt Marsh).

Detailed Description: 1997: A characteristic mix of graminoids includes *Agrostis stolonifera* var. *palustris* (marsh creeping bent-grass), *Spartina patens* (salt-meadow cord-grass), *Juncus gerardii* (salt marsh rush), *Solidago sempervirens* (seaside goldenrod), *Distichlis spicata* (spike-grass), *Juncus arcticus* var. *littoralis* (shore rush), *Elytrigia repens* (quack-grass), *Spartina pectinata* (fresh-water cord-grass, slough-grass), *Carex paleacea* (chaffy salt sedge), *Hierochloe odorata* (sweet grass), *Aster novi-belgii* (New York aster), *Scirpus pungens* (three-square rush), and several other less frequent species. At the Seabrook School area, ephemeral runoff channel/stream entering from west; area dominated by *Lythrum salicaria* (purple loosestrife). Small elevated knoll in middle with *Quercus bicolor* (swamp white oak), *Toxicodendron radicans* (climbing poison ivy), and *Rosa virginiana* (Virginia rose).

General Area: 1997: The Blackwater - Hampton River Estuary contains the majority of the estimated 6200 acres of salt marsh in the state. The Blackwater River portion of the estuary continues south into Salisbury, MA. The estuarine system extends seaward to an imaginary line drawn across Hampton Harbor Inlet and upstream and landward to where ocean-derived salts are less than or equal to 0.5 parts per thousand during the period of average annual low freshwater flow (Cowardin et al. 1979). This estuary is surrounded by moderate levels of residential and commercial development. Several exemplary subtidal and intertidal communities occur in this estuary. Exemplary subtidal communities are ***tidal creek bottom*** and undifferentiated ***saline/brackish subtidal channel/bay bottom***. Exemplary intertidal communities are ***brackish marsh***, ***coastal shoreline strand/swale***, ***saline/brackish intertidal flat***, and high and ***low salt marsh***. Exemplary dry Appalachian oak-hickory forest occurs at the site as "salt marsh islands", forested uplands surrounded by salt marsh. Most of the estuary is unaffected by restricted tidal flow. Other areas are described as having an adequate tidal inlet by the USDA Soil Conservation Service (1994). The largest portions of the estuary determined to have inadequate tidal inlets include the Meadow Pond area, the Taylor River - Drakes River area west of the rail road track, and the Browns River west of the rail road track (USDA Soil Conservation Service 1994). In the last four years, several salt marsh restoration projects have begun in this estuary (Ammann, A.P. pers. comm., 1997).

General Comments: 1997: Tidally flooded by salt water only during spring tides and storm surges. Supports a greater diversity of plants and generally flooded less frequently than the robust forb brackish marsh. Elevationally higher, received more freshwater input, and experienced less frequent tidal flooding than the high salt marsh. Occasionally occurs along the upper margins of the high salt marsh where sufficient fresh water runoff or groundwater discharge flows onto the marsh surface. This hydrologic regime supports brackish marsh species and other species most often found in fresh or salt marshes but tolerant of brackish conditions and able to successfully compete in this environment.

Management Comments:

Location

Survey Site Name: Hampton Harbor

Managed By: ASNH to Properties, Inc. - Pelton

County: Rockingham USGS quad(s): Hampton (4207087)

NHB10-2248 EOCODE: CE00000005*012*NH

Town(s):	Hampton	Lat, Long:	425407N, 0704957W
Size:	3448.9 acres	Elevation:	5 feet

Precision: Within (but not necessarily restricted to) the area indicated on the map.

Directions: Large area more or less framed by Rte. 1 to the west, Rte. 101 to the north, Rte. 1A to the east, and the Massachusetts state line to the south. 1997: Five areas visited. Wrights Island (park at Seabrook Sewage Treatment Plant), Farm Brook (drive to east end of Depot Road and park in lot), two areas at Seabrook School Salt Marsh (park behind the Seabrook Elementary/Middle School off of Walton Road), and Taylor River (along the northern portions of the Taylor River Estuary from Drakes Creek to Tide Mill Creek).

Dates documented

First reported:	1997-07-05	Last reported:	1997-10-06

Nichols, Bill. 1997. Field survey to Blackwater River Salt Marsh on July 5.

Nichols, William F. 2000. Ecological Assessment of Selected Towns in New Hamphire's Coastal Zone. Prepared by NH Natural Heritage Inventory. Concord, NH.

NHB10-2248 EOCODE: EP00000025*014*NH

New Hampshire Natural Heritage Bureau - System Record

Emergent marsh - shrub swamp system

Legal Status		Conservation Status	
Federal:	Not listed	Global:	Not ranked (need more information)
State:	Not listed	State:	Demonstrably widespread, abundant, and secure

Description at this Location

Conservation Rank: Good quality, condition and lanscape context ('B' on a scale of A-D).

Comments on Rank: Despite the compromised condition and context ranks, this is an exemplary system because it is a very large, diverse emergent marsh system with coastal plain affinities.

Detailed Description: 2009: Emergent marsh, seepage marsh, meadow marsh, and shrub thicket communities cover most of Great Bog, a broad, coastal plain basin with very poorly drained marine sediment soil and moderate to deep mucky peat soils (over marine sediments). Sedges and/or cattails dominate the marsh communities, which occupy most of the treeless or sparsely wooded areas of the larger wetland. Shrub thickets are also common but occupy a minority of the system. These various communities cover large areas individually, but also occur together in more complex, fine-scaled mosaics in places. Herbaceous seepage marsh and cattail marsh are apparently the most extensive communities. Herbaceous seepage marshes, described from earlier visits and dominated by *Carex lacustris* (lake sedge), occupy large areas in the western part of Great Bog on Maybid silt loam soil, and possibly occur elsewhere. *Typha latifolia* (common cattail) dominate the cattail marshes in most areas on deeper mucks, but some are dominated by *Typha angustifolia* (narrow-leaved cattail), including the south-central portion of the wetland (south of the upland island in the middle of the wetland). *Carex stricta* (tussock sedge) dominates areas of ***tall graminoid meadow marsh*** and ***mixed tall graminoid - scrub-shrub marsh***, along with various other sedges, grasses, forbs, and medium-height to tall shrubs. Shrub thickets include ***alder - dogwood - arrowwood alluvial thicket*** and ***highbush blueberry - winterberry shrub thicket***. *Ilex verticillata* (winterberry), *Vaccinium corymbosum* (highbush blueberry), *Clethra alnifolia* (sweet pepperbush), *Alnus incana* ssp. *rugosa* (speckled alder) are abundant. *Lyonia ligustrina* (male berry) and *Toxicodendron vernix* (poison sumac) are occasional. Small to large colonies of *Phragmites australis* (common reed) occupy portions of the wetland, including the eastern lobe adjacent to Banefield Rd., which was sprayed with herbicide in September 2009. The marsh and shrub communities extend to the upland margin around most of the periphery, but transition to various swamp communities along the northeast side and discontinuously elsewhere.

General Area: 2009: Great Bog is set in low-relief coastal terrain, surrounded by both dry and mesic Appalachian oak - hickory forests, as well as swamps along subtle drainages that feed into the wetland. A complex mosaic of parent materials in the surrounding landscape include shallow ablation till, outwash sediments, and silt and clay soils of marine origin. Upland forests and swamps occur on the largely undeveloped northeast side. Roads, parking lots, and other residential and industrial development are common close to the wetland in other border areas. Invasive exotic shrubs are common in the upland areas immediately adjacent to the wetland, including vast forest thickets of *Frangula alnus* (alder-buckthorn) on the upland island in the central part of the wetland, through which the powerline corridor runs. These are perhaps the most extensive, old, and impenetrable thickets of alder-buckthorn this surveyor has seen, covering dozens of acres. Eighty percent or more cover of alder-buckthorn was common, with very little or no other vegetation in the understory. Other portions of this upland island were more open old fields with remnant orchard trees. Numerous other invasives are present, including *Rosa multiflora* (multiflora rose), *Berberis thunbergii* (Japanese barberry), and *Celastrus orbiculatus* (Asian bittersweet).

General Comments:

Management Comments:

Location

NHB10-2248 EOCODE: EP00000025*014*NH

Survey Site Name: Great Bog
Managed By: Great Bog

County:	Rockingham	USGS quad(s):	Portsmouth (4307017)
Town(s):	Portsmouth	Lat, Long:	430243N, 0704754W
Size:	349.3 acres	Elevation:	

Precision: Within (but not necessarily restricted to) the area indicated on the map.

Directions: 2009: Accessed site from railroad tracks that cross Banefield Rd.

Dates documented

First reported:	2009-09-29	Last reported:	2009-09-29

NHB10-2248 EOCODE: CP00000103*001*NH

New Hampshire Natural Heritage Bureau - Community Record

Herbaceous seepage marsh

Legal Status		Conservation Status	
Federal:	Not listed	Global:	Not ranked (need more information)
State:	Not listed	State:	Rare or uncommon

Description at this Location

Conservation Rank: Good quality, condition and lanscape context ('B' on a scale of A-D).

Comments on Rank: A very large seepage marsh in a compromised landscape context.

Detailed Description: 2002: The northern portion of the seepage marsh is characterized by dense swards of *Carex lacustris* (lake sedge) (50%) accompanied by *Typha latifolia* (common cat-tail, 10%), *Toxicodendron radicans* (climbing poison ivy, 5-10%), *Thelypteris palustris* var. *pubescens* (marsh fern, 5-10%), *Onoclea sensibilis* (sensitive fern, 5%), and scattered sapling *Acer rubrum* (red maple, 1-5%). Numerous other herbs are present in low abundance. This area grades further south into sparse woodland areas with more red maple (20-40 ft. tall, including many dead snags), but still more marshy than swampy. A soil sample was very well decomposed muck over silty muck. 1989: The hybrid cattail *Typha* x *Glauca* dominates open areas with extremely abundant *Lysimachia thyrsiflora* (tufted loosestrife). State record *Carex trichocarpa* (hairy-fruited sedge) occurs at the marsh-swamp ecotone.

General Area: 2002: The seepage marsh is the dominant community in the central and western portions of Great Bog, and bounded to the west by the large seepage swamp, to the north by railroad tracks, to the NW by swamp white oak swamp, to the west by the highway and disturbed emergent marsh, and to the south by powerlines and upland areas. While surrounded by development, Great Bog is so large that it is actually one of the largest and least developed tracts of land in Portsmouth. 1989: Borders the red maple swamp forests that the Great Bog largely consists of.

General Comments: 1989: Further field work and a field form is needed.

Management Comments:

Location

Survey Site Name: Great Bog

Managed By: Hospital Corporation of America

County:	Rockingham	USGS quad(s):	Portsmouth (4307017)
Town(s):	Portsmouth	Lat, Long:	430251N, 0704822W
Size:	128.6 acres	Elevation:	40 feet

Precision: Within (but not necessarily restricted to) the area indicated on the map.

Directions: Great Bog. South and east of crook in powerline right-of-way. Best approach to portion of site visited in 2002 (without pulling over on I-95) is from north via the railroad tracks just south of crossing of Rte. 33 and I-95. Park in vicinity of Rte. 33 crossing of railroad tracks, at industrial complex on Griffen Rd to south of Rte. 33 (closest but dense shrub border along railroad track) or at railroad bridge by Greenland and Borthwick Streets just north of Rte. 33 (easiest). Proceed southwest on railroad tracks. The seepage swamp is located to the south just past the industrial complex (0.25 miles from Rte. 33); the seepage marsh is found further along past the seepage swamp (open area with few trees ca. 0.45 miles from Rte. 33); and the swamp white oak swamp is found where trees pick up again south of the RR tracks closer to the highway crossing (0.7 miles from Rte. 33).

Dates documented

First reported:	1989-05-30	Last reported:	2002-09-27

NHB10-2248 EOCODE: CP00000103*001*NH

Sperduto, Dan. 2002. Field survey to Great Bog on September 27.

Sperduto, Daniel, and Stephanie Neid. 2003. Exemplary Bogs and Fens in New Hampshire: Part II. Prepared for the Environmental Protection Agency by the NH Natural Heritage Bureau. Concord, NH.

NHB10-2248 EOCODE: CE00000004*034*NH

New Hampshire Natural Heritage Bureau - Community Record

High salt marsh

Legal Status		Conservation Status	
Federal:	Not listed	Global:	Not ranked (need more information)
State:	Not listed	State:	Rare or uncommon

Description at this Location

Conservation Rank: Excellent quality, condition and lanscape context ('A' on a scale of A-D).

Comments on Rank: These ranks are for the entire estuary.

Detailed Description: 2006: Community observed and photographed.1997: In addition to *Spartina patens* (salt-meadow cord-grass) and *Juncus gerardii* (salt marsh rush), other common plants on the high marsh included smooth cord-grass (short form) and *Distichlis spicata* (spike-grass). *D. spicata* formed pure stands in wetter, more poorly drained areas, or mixed with *S. patens*, growing at similar elevations on the high marsh. *J. gerardii* dominated landward of salt meadow-grass in narrow vegetative zones with decreased tidal flooding and soil water salinity, beginning at about mean spring high water. This zone had the highest species richness within the high marsh and included *Solidago sempervirens* (seaside goldenrod), *Panicum virgatum* (switch-grass), *Hierochloe odorata* (sweet grass), *Carex hormathodes* (necklace sedge), *Festuca rubra* (red fescue), *Aster novi-belgii* (New York aster), *Elytrigia repens* (quack-grass), *Spartina pectinata* (fresh-water cord-grass), and *Potentilla anserina* (silverweed).

General Area: 1997: At Hampton Harbor, the mean tidal range is 8.3 feet with spring tides averaging 9.5 feet. Here, the high marsh rises from ca. 4 feet above mean sea level at its lower end to 5 feet above mean sea level at the landward limit of the salt marsh rush zone. The Blackwater - Hampton River Estuary contains the majority of the estimated 6200 acres of salt marsh in the state. The Blackwater River portion of the estuary continues south into Salisbury, MA. The estuarine system extends seaward to an imaginary line drawn across Hampton Harbor Inlet and upstream and landward to where ocean-derived salts are less than or equal to 0.5 parts per thousand during the period of average annual low freshwater flow (Cowardin et al. 1979). This estuary is surrounded by moderate levels of residential and commercial development. Several exemplary subtidal and intertidal communities occur in this estuary. Subtidal communities include the undifferentiated ***saline/brackish subtidal channel/bay bottom*** and ***tidal creek bottom***. Other intertidal communities are ***brackish marsh***, ***coastal shoreline strand/swale***, ***saline/brackish intertidal flat***, and ***low salt marsh***. Exemplary ***dry Appalachian oak-hickory forest*** occurs at the site as "salt marsh islands", forested uplands surrounded by salt marsh. Most of the estuary is unaffected by restricted tidal flow. Other areas are described as having an adequate tidal inlet by the USDA Soil Conservation Service (1994). The largest portions of the estuary determined to have inadequate tidal inlets include the Meadow Pond area, the Taylor River - Drakes River area west of the rail road track, and the Browns River west of the rail road track (USDA Soil Conservation Service 1994). In the last four years, several salt marsh restoration projects have begun in this estuary (Ammann, A.P. pers. comm., 1997).

General Comments:

Management Comments: 1997: Marsh ditched heavily; greenhead boxes present.

Location

Survey Site Name: Hampton Harbor

Managed By: ASNH to Properties, Inc. - Pelton

County:	Rockingham	USGS quad(s):	Hampton (4207087)
Town(s):	Hampton	Lat, Long:	425407N, 0704957W
Size:	3448.9 acres	Elevation:	4 feet

NHB10-2248 EOCODE: CE00000004*034*NH

Precision: Within (but not necessarily restricted to) the area indicated on the map.

Directions: Large area more or less framed by Rte. 1 to the west, Rte. 101 to the north, Rte. 1A to the east, and the Massachusetts state line to the south. Occurs behind barrier beaches, along inland bays, and other areas protected from high-energy wave action.

Dates documented

First reported: 1997-07-05 Last reported: 2006-08-17

Kimball, Ben and Pete Bowman. 2006. Field survey to The Sands on August 17.

Nichols, William F. 2000. Ecological Assessment of Selected Towns in New Hamphire's Coastal Zone. Prepared by NH Natural Heritage Inventory. Concord, NH.

NHB10-2248 EOCODE: CE00000011*036*NH

New Hampshire Natural Heritage Bureau - Community Record

intertidal flat

Legal Status		Conservation Status	
Federal:	Not listed	Global:	Not ranked (need more information)
State:	Not listed	State:	Rare or uncommon

Description at this Location

Conservation Rank: Excellent quality, condition and lanscape context ('A' on a scale of A-D).

Comments on Rank: Ranks are for an area at Seabrook School Salt Marsh.

Detailed Description: 1997: No details.

General Area: 1997: The Blackwater - Hampton River Estuary contains the majority of the estimated 6200 acres of salt marsh in the state. The Blackwater River portion of the estuary continues south into Salisbury, MA. The estuarine system extends seaward to an imaginary line drawn across Hampton Harbor Inlet and upstream and landward to where ocean-derived salts are less than or equal to 0.5 parts per thousand during the period of average annual low freshwater flow (Cowardin et al. 1979). This estuary is surrounded by moderate levels of residential and commercial development. Several exemplary subtidal and intertidal communities occur in this estuary. Subtidal communities include the undifferentiated ***saline/brackish subtidal channel/bay bottom*** and ***tidal creek bottom***. Other intertidal communities are ***brackish marsh***, ***coastal shoreline strand/swale***, and high and ***low salt marsh***. Exemplary dry Appalachian oak-hickory forest occurs at the site as "salt marsh islands", forested uplands surrounded by salt marsh. Most of the estuaryis unaffected by restricted tidal flow. Other areas are described as having an adequate tidal inlet by the USDA Soil Conservation Service (1994). The largest portions of the estuary determined to have inadequate tidal inlets include the Meadow Pond area, the Taylor River - Drakes River area west of the rail road track, and the Browns River west of the rail road track (USDA Soil Conservation Service 1994). In the last four years, several salt marsh restoration projects have begun in this estuary (Ammann, A.P. pers. comm., 1997).

General Comments: 1997: Extensive areas of this community type were found within the Blackwater - Hampton River Estuary. Intertidal sand and mud flats are gently sloping, sparsely vegetated, habitats. The substrate, exposed completely at extra low spring tide, ranges in composition from sands to muds and silts. Benthic diatoms and other microalgae occurring in this environment are important contributors to the primary productivity of the total estuarine system (Sickley 1989). Macroalgae is typically uncommon across the exposed substrate. Characteristic invertebrates found in New Hampshire's intertidal mudflats include polychaete worms (including Nereis virens, Nephtys caeca, Clymenella tortquata, and Scoloplos spp.) and mollusks (including soft-shelled clam [Mya arenaria], Baltic Macoma [Macoma balthica], gem shell [Gemma gemma], and swamp Hydrobia [Hydrobia minuta]) (NAI 1973). Arthropods are also well represented and include green crabs (Carcinus maenus), rock crabs (Cancer irroratus), flat-clawed hermit crabs (Pagurus pollicaris), and horseshoe crabs (Limulus polyphemis). During the diurnal (twice daily) tidal flooding several species of fish and other aquatic species feed on the benthos and epibenthic algae. This community also provides important foraging habitat for shorebirds and other animals when the intertidal flat is exposed. The diverse variety of primary foods (microalgae, phytoplankton, and detritus) available to consumers supports the high productivity found on intertidal flats. The substrate is composed of sand or silt and clay rich in organic matter. Vascular plants are sparse to more typically absent.

Management Comments:

Location

Survey Site Name: Hampton Harbor

Managed By: Hampton Beach State Park

NHB10-2248 EOCODE: CE00000011*036*NH

County:	Rockingham	USGS quad(s):	Hampton (4207087)
Town(s):	Hampton	Lat, Long:	425405N, 0704917W
Size:	1183.7 acres	Elevation:	

Precision: Within (but not necessarily restricted to) the area indicated on the map.

Directions: Large area more or less framed by Rte. 1 to the west, Rte. 101 to the north, Rte. 1A to the east, and the Massachusetts state line to the south. Occurs between estuarine marshes or other coastal communities landward and subtidal communities seaward and includes tidal creek channels exposed at low tide.

Dates documented

First reported:	1997-07-05	Last reported:	1997-10-08

Nichols, Bill. 1997. Field survey to Blackwater River Salt Marsh on July 5.

Nichols, William F. 2000. Ecological Assessment of Selected Towns in New Hamphire's Coastal Zone. Prepared by NH Natural Heritage Inventory. Concord, NH.

NHB10-2248 EOCODE: CE00000003*035*NH

New Hampshire Natural Heritage Bureau - Community Record

Low salt marsh

Legal Status		Conservation Status	
Federal:	Not listed	Global:	Not ranked (need more information)
State:	Not listed	State:	Rare or uncommon

Description at this Location

Conservation Rank: Excellent quality, condition and lanscape context ('A' on a scale of A-D).
Comments on Rank: These ranks are for the entire estuary.

Detailed Description: 1997: No details.
General Area: 1997: The Blackwater - Hampton River Estuary contains the majority of the estimated 6200 acres of salt marsh in the state. The Blackwater River portion of the estuary continues south into Salisbury, MA. The estuarine system extends seaward to an imaginary line drawn across Hampton Harbor Inlet and upstream and landward to where ocean-derived salts are less than or equal to 0.5 parts per thousand during the period of average annual low freshwater flow (Cowardin et al. 1979). This estuary is surrounded by moderate levels of residential and commercial development. Several exemplary subtidal and intertidal communities occur in this estuary. Subtidal communities include the undifferentiated ***saline/brackish subtidal channel/bay bottom*** and ***tidal creek bottom***. Other intertidal communities are ***brackish marsh***, ***coastal shoreline strand/swale***, ***saline/brackish intertidal flat***, and ***high salt marsh***. Exemplary dry Appalachian oak-hickory forest occurs at the site as "salt marsh islands", forested uplands surrounded by salt marsh. Most of the estuary is unaffected by restricted tidal flow. Other areas are described as having an adequate tidal inlet by the USDA Soil Conservation Service (1994). The largest portions of the estuary determined to have inadequate tidal inlets include the Meadow Pond area, the Taylor River - Drakes River area west of the rail road track, and the Browns River west of the rail road track (USDA Soil Conservation Service 1994). In the last four years, several salt marsh restoration projects have begun in this estuary (Ammann, A.P. pers. comm., 1997).
General Comments:
Management Comments:

Location

Survey Site Name: Hampton Harbor
Managed By: ASNH to Properties, Inc. - Pelton

County:	Rockingham	USGS quad(s):	Hampton (4207087)
Town(s):	Hampton	Lat, Long:	425407N, 0704957W
Size:	3448.9 acres	Elevation:	4 feet

Precision: Within (but not necessarily restricted to) the area indicated on the map.

Directions: Large area more or less framed by Rte. 1 to the west, Rte. 101 to the north, Rte. 1A to the east, and the Massachusetts state line to the south. Occurs behind barrier beaches, along inland bays, and other areas protected from high-energy wave action.

Dates documented

First reported: 1997-07-05 Last reported: 1997-10-08

Nichols, Bill. 1997. Field survey to Blackwater River Salt Marsh on July 5.

Nichols, William F. 2000. Ecological Assessment of Selected Towns in New Hamphire's Coastal Zone. Prepared by NH Natural Heritage Inventory. Concord, NH.

NHB10-2248 EOCODE: EP00000002*028*NH

New Hampshire Natural Heritage Bureau - System Record

Poor level fen/bog system

Legal Status		Conservation Status	
Federal:	Not listed	Global:	Not ranked (need more information)
State:	Not listed	State:	Rare or uncommon

Description at this Location

Conservation Rank: Fair quality, condition and/or lanscape context ('C' on a scale of A-D).
Comments on Rank:

Detailed Description: 1992: Population of *Gaylussacia dumosa* var bigeloviana was found in the fen community.
General Area: he classic fen sequence of floating mat, open peat, low heath, tall heath, dwarf spruce and larch, and shrub swamp is found in this wetland complex. The lag varies from 20 to over 200 feet wide, although the low and high heath zones are not always well developed. The dominant plant in the low heath where the dwarf huckleberry was found was leatherleaf. Dwarf black spruce and larch are scattered throughout this zone. The shrub swamp further back from the pond is dominated by mountain holly, winterberry holly, and high bush blueberry.
General Comments:
Management Comments:

Location

Survey Site Name: Lower Shields Pond
Managed By:

County:	Rockingham	USGS quad(s):	Derry (4207183)
Town(s):	Derry	Lat, Long:	425503N, 0711927W
Size:	41.8 acres	Elevation:	380 feet

Precision: Within (but not necessarily restricted to) the area indicated on the map.

Directions: Take Rte 28BYP north from Derry Village traffic circle ca 2 miles to Shields Pond Road on the right. Go ca. 0.5 mile to culverted creek. There is a path beyond the powerlines that you hike to from the west side of the stream.

Dates documented

First reported: 1992-09-11 Last reported: 1992-09-11

Royte, Josh and John Lortie. 1992. Field survey to Lower Shields Pond on September 11.

NHB10-2248 EOCODE: CP00000094*015*NH

New Hampshire Natural Heritage Bureau - Community Record

Red maple - sensitive fern swamp

Legal Status		Conservation Status	
Federal:	Not listed	Global:	Not ranked (need more information)
State:	Not listed	State:	Imperiled due to rarity or vulnerability

Description at this Location

Conservation Rank: Good quality, condition and lanscape context ('B' on a scale of A-D).

Comments on Rank: This is a fairly mature and very large example in a compromised landscape context. This part of Great Bog is less influenced by hydrologic alterations than portions nearer the outlet to the west.

Detailed Description: 2002: Two seepage swamp associations were observed at the north end of the seepage swamp system. Area 1 occurs further east (ie along border of development to the east) and has a denser *Acer rubrum* (red maple) cover (60-70%) and a sparse shrub layer. It is dominated by *Carex stricta* (tussock sedge; 35%), *Calamagrostis canadensis* (blue-joint; 15-20%), and *Onoclea sensibilis* (sensitive fern), with lesser quantities of *Carex lacustris* (lake sedge) and *Toxicodendron radicans* (climbing poison ivy). Area 2 is a classic red maple/lake sedge seepage swamp, with all the species of Area 1 present in lower abundance, less dense red maple (40%), a dominant layer of *Carex lacustris* (lake sedge; 60%) and sensitive fern (5%), and a denser shrub layer consisting mostly of *Vaccinium corymbosum* (highbush blueberry; 30%) and *Ilex verticillata* (winterberry; 5%). *Ulmus americana* (American elm) is occasional in the subcanopy. 1989: Acer rubrum (red maple) dominates. Understory dominants include *Carex stricta* (tussock sedge), *Alnus serrulata* (smooth alder), *Onoclea sensibilis* (sensitive fern), *Symplocarpus foetidus* (skunk cabbage). *Lysimachia thyrsiflora* (tufted loosestrife) also occurs here.

General Area: 2002: The seepage swamp is the dominant community in eastern portion of Great Bog, and bounded to the west by the large seepage marsh, to the north by railroad tracks, to the south by powerlines and upland. While surrounded by development, Great Bog is so large that it is actually one of the largest and least developed tracts of land in Portsmouth.

General Comments: 1989: Further field work needed.

Management Comments:

Location

Survey Site Name: Great Bog

Managed By: City of Portsmouth Land

County:	Rockingham	USGS quad(s):	Portsmouth (4307017)
Town(s):	Portsmouth	Lat, Long:	430303N, 0704807W
Size:	100.0 acres	Elevation:	55 feet

Precision: Within (but not necessarily restricted to) the area indicated on the map.

Directions: Great Bog. North and west of powerline right-of-way. Best approach to portion of site visited in 2002 (without pulling over on I-95) is from north via the railroad tracks just south of crossing of Rte. 33 and I-95. Park in vicinity of Rte. 33 crossing of railroad tracks, at industrial complex on Griffen Rd to south of Rte. 33 (closest but dense shrub border along RR track) or at RR bridge by Greenland and Borthwick Streets just north of Rte. 33 (easiest). Proceed southwest on RR tracks. The seepage swamp is located to the south just past the industrial complex (0.25 miles from Rte. 33); the seepage marsh is found further along past the seepage swamp (open area with few trees ca. 0.45 miles from Rte. 33); and the swamp white oak swamp is found where trees pick up again south of the RR tracks closer to the highway crossing (0.7 miles from Rte. 33).

Dates documented

NHB10-2248 EOCODE: CP00000094*015*NH

First reported: 1989-05-30 Last reported: 2002-09-27

Sperduto, Dan. 2002. Field survey to Great Bog on September 27.

Sperduto, Daniel, and Stephanie Neid. 2003. Exemplary Bogs and Fens in New Hampshire: Part II. Prepared for the Environmental Protection Agency by the NH Natural Heritage Bureau. Concord, NH.

NHB10-2248 EOCODE: CT00000226*001*NH

New Hampshire Natural Heritage Bureau - Community Record

Swamp white oak floodplain forest

Legal Status		Conservation Status	
Federal:	Not listed	Global:	Not ranked (need more information)
State:	Not listed	State:	Critically imperiled due to rarity or vulnerability

Description at this Location

Conservation Rank: Excellent quality, condition and lanscape context ('A' on a scale of A-D).

Comments on Rank:

Detailed Description: 1998: The low terrace floodplain forest is dominated by *Quercus bicolor* (swamp white oak), *Acer rubrum* (red maple), and *Carya ovata* (shagbark hickory), with *Fraxinus americana* (white ash) and *Ulmus americana* (American elm) in the understory. *Onoclea sensibilis* (sensitive fern) and *Osmunda cinnamomea* (cinnamon fern) are dominant in the herb layer. The terrace sits distinctly lower than the surrounding landscape (by 2-4 meters) and buffers the meandering river course. Vines and shrub species (e.g. *Toxicodendron radicans* (climbing poison ivy), *Viburnum lentago* (nannyberry), and *Viburnum dentatum* var. *lucidum* (northern arrowwood)) fill in natural gaps and edges. Soils are not particularly enriched (pH=5.2), but they are dark, very fine sandy loams that may have some coastal influence (i.e. silt from marine sedimentation). A fair amount of dead wood was scattered throughout the floodplain, with a large recent blowdown oak adjacent to the observation plot. River is entrenched by 1-2 meters within a steep silty bank, yet flooding and depositional processes appear to be active, with some meanders cutting more deeply, and others about to be cut off. Microtopographic variation is slight on this mostly flat terrace.

General Area: 1998: Housing and other development appear to encroach from all sides, but not actually into the low terrace. The wetland complex seems to be fairly large and wide, but above the flooded zone, there appears to be considerable human disturbance and fragmentation. Just downstream of the surveyed area, the Richard Sargent Management area provides a buffer along and upslope of the floodplain.

General Comments: 1998: From aerial photographs, the low terrace floodplain forest appears to extend well beyond the surveyed property. This is an excellent example of swamp white oak floodplain, but landowner patterns and development may threaten its integrity over the long term.

Management Comments: 1998: Monitor landowner patterns and adjacent fragmentation

Location

Survey Site Name: Powwow River
Managed By: Welch Parcel

County:	Rockingham	USGS quad(s):	Kingston (4207181)
Town(s):	East Kingston	Lat, Long:	425357N, 0710038W
Size:	193.3 acres	Elevation:	80 feet

Precision: Within (but not necessarily restricted to) the area indicated on the map.

Directions: From Kingston, take Rte. 107A south to Rte. 108 south in East Kingston. Turn left into CWR Timber Management and Realty dirt driveway/timber yard. Park and hike east on logging roads to floodplain terrace. An alternate route is to access the natural community directly from Chase Rd. at Smith Corner.

Dates documented

First reported: 1998-09-02 Last reported: 1998-09-02

Bechtel, Doug. 1998. Field survey to Powwow River on September 2.

NHB10-2248 EOCODE: CT00000226*001*NH

Nichols, William F., Daniel D. Sperduto, Douglas A. Bechtel, and Katherine F. Crowley. 2000. Floodplain Forest Natural Communities along Minor Rivers and Large Streams in New Hampshire. Prepared by NH Natural Heritage. Concord, NH.

NHB10-2248 EOCODE: ER00000003*026*NH

New Hampshire Natural Heritage Bureau - System Record

Temperate minor river floodplain system

Legal Status		Conservation Status	
Federal:	Not listed	Global:	Not ranked (need more information)
State:	Not listed	State:	Rare or uncommon

Description at this Location

Conservation Rank:	Historical records only - current condition unknown.
Comments on Rank:	Unique coastal plain river with large exemplary wetland.
Detailed Description:	1986: Dominated by *Acer rubrum* and *Quercus bicolor* (dominant only on coastal plain in NH) w/some *Carya ovata* (shagbark hickory). Vines abound; *Toxicodendron radicans* (poison ivy), *Smilax rotundifolia* (bullbrier), *Vitis* spp. (grape). Dense vegetation, swamp extends to regularly inundated alluvial areas.
General Area:	1986: Narrow river that drains large area in flat coastal plain area; seems to result in frequent flooding of narrow, swampy floodplain.
General Comments:	1986: Historic station for *Lygodium palmatum* (climbing fern); swamp has very dense physiognomy, natural & undisturbed.
Management Comments:	

Location

Survey Site Name:	Pow Wow River		
Managed By:	Welch Parcel		
County:	Rockingham	USGS quad(s):	Exeter (4207088)
Town(s):	East Kingston	Lat, Long:	425357N, 0710038W
Size:	191.7 acres	Elevation:	95 feet

Precision: Within (but not necessarily restricted to) the area indicated on the map.

Directions: Pow Wow River. SW corner of Exeter quad. Along river west of Chase Road.

Dates documented

First reported:	1986	Last reported:	1986-06-23

Korpi, J. and F. Brackley. 1986. Field survey to Chase Hill on August 4.

NHB10-2248 EOCODE: PDCHE0J040*002*NH

New Hampshire Natural Heritage Bureau - Plant Record

Dwarf Glasswort (*Salicornia bigelovii*)

Legal Status		Conservation Status	
Federal:	Not listed	Global:	Demonstrably widespread, abundant, and secure
State:	Listed Endangered	State:	Critically imperiled due to rarity or vulnerability

Description at this Location

Conservation Rank: Historical records only - current condition unknown.
Comments on Rank: Sub-population of a large "A-" population.

Detailed Description: 1982: 25 or more plants in 5x2 area directly east of *Salicornia virginica*. Plants just starting to flower.
General Area: Flat, full sun, damp but above main area of inundated marsh with *Salicornia virginica*.
General Comments:
Management Comments:

Location

Survey Site Name: RR Tracks
Managed By: Landing + Vicinity Marsh

County:	Rockingham	USGS quad(s):	Hampton (4207087)
Town(s):	Hampton Falls	Lat, Long:	425437N, 0705110W
Size:	2.8 acres	Elevation:	10 feet

Precision: Within (but not necessarily restricted to) the area indicated on the map.

Directions: Hampton Falls. RR tracks site.drive to east end of Depot Rd. Go south along RR tracks to Hampton Falls River. Site on west side of RR tracks just north of Hampton Falls River.

Dates documented

First reported: 1982 Last reported: 1982-08-17

Dunlop, Deb. New England College, Botany Department, Box 30, Henniker, NH 03242. 603/428-2233.

Nichols, William F. 2000. Ecological Assessment of Selected Towns in New Hamphire's Coastal Zone. Prepared by NH Natural Heritage Inventory. Concord, NH.

NHB10-2248 EOCODE: PDERI0G031*009*NH

New Hampshire Natural Heritage Bureau - Plant Record

Dwarf Huckleberry (*Gaylussacia bigeloviana*)

Legal Status		Conservation Status	
Federal:	Not listed	Global:	Apparently secure but with cause for concern
State:	Listed Threatened	State:	Imperiled due to rarity or vulnerability

Description at this Location

Conservation Rank: Good quality, condition and lanscape context ('B' on a scale of A-D).
Comments on Rank:

Detailed Description: 1992: Ca. 200 plants seen, 60 percent with mature fruit and dispersing seed, 30 percent in leaf. Growing at the bottom of a slope in wet-mesic condition. May be more plants scattered through the leatherleaf.

General Area: 1992: The huckleberry was found on a low heath mat that rings a portion of the shallow water pond. The classic fen sequence of floating mat, open peat, low heath, tall heath, dwarf spruce and larch, and shrub swamp, is found in this wetland complex. The dominant plant in the low heath where the the dwarf huckleberry was found was *Chamaedaphne calyculata*. Dwarf *Picea mariana*, and *Larix larcina* are scattered throughout this zone. The shrub swamp further back from the pond is dominated by *Nemopanthus mucronata*, *Ilex verticillata*, and *Vaccininium corymbosum*.

General Comments:
Management Comments:

Location

Survey Site Name: Lower Shields Pond
Managed By:

County:	Rockingham	USGS quad(s):	Derry (4207183)
Town(s):	Derry	Lat, Long:	425503N, 0711927W
Size:	41.8 acres	Elevation:	370 feet

Precision: Within (but not necessarily restricted to) the area indicated on the map.

Directions: Take Rte 28BYP north from Derry Village traffic circle ca. 2 miles to Shields Pond Road on the right. Go ca. 0.5 mile to culverted creek. There is a path beyond the powerlines that you hike to from the west side of the stream.

Dates documented

First reported: 1992-09-11 Last reported: 1992-09-11

Royte, Josh and John Lortie. 1992. Field survey to Lower Shields Pond on September 11.

NHB10-2248 EOCODE: PDAST5X0Q2*015*NH

New Hampshire Natural Heritage Bureau - Plant Record

Northern Blazing Star (*Liatris novae-angliae*)

Legal Status		Conservation Status	
Federal:	Not listed	Global:	Rare or uncommon
State:	Listed Endangered	State:	Critically imperiled due to rarity or vulnerability

Description at this Location

Conservation Rank: Excellent quality, condition and lanscape context ('A' on a scale of A-D).
Comments on Rank: A large population for NH.

Detailed Description: 2004: 41 plants counted. Flowering rate is high (40% in flower, 10% in immature fruit). Population appears to be thriving. Plants on north side of highway are more vigorous than those on the south. 2003: Ca. 20 scattered plants observed, ca. 6 flowering.

General Area: 2004: Powerline corridor and highway margin. Dominant associated species include *Lotus corniculatus* (birdsfoot-trefoil), *Ionactis* [*Aster*] *linariifolius* (stiff-leaved aster), *Schizachyrium scoparium* (little bluestem), and *Carex pensylvanica* / *lucorum* (Pennsylvanian / distant sedge). 2003: Mowed area under powerline. Dry sandy/gravel on a SE-facing slope. Growing with *Quercus velutina* (black oak), *Pinus strobus* (white pine), *Comptonia peregrina* (sweet fern), *Vaccinium angustifolium* (lowbush blueberry), *Rumex acetosella* (red sorrel), and *Rubus pensilvanicus* (Pennsylvania dewberry).

General Comments: 2004: All suitable habitat in the immediate area was searched.

Management Comments: 2004: Area kept clear by maintenance crews. Some ATV use. Recommend keeping competing vegetation cut low (controlled burn?).

Location

Survey Site Name: Powwow River, west of
Managed By:

County:	Rockingham	USGS quad(s):	Kingston (4207181)
Town(s):	Kingston	Lat, Long:	425436N, 0710353W
Size:	1.7 acres	Elevation:	140 feet

Precision: Within (but not necessarily restricted to) the area indicated on the map.

Directions: Under powerlines on both sides of Rte. 125, ca. 200 feet SW of the intersection with Rte. 111 (a relatively recent intersection, not yet on topo map). Three distinct areas of population concentration.

Dates documented

First reported: 2003-08-30 Last reported: 2004-09-10

Kane, Chris. 2004. Field survey to Powwow River on September 10.

NHB10-2248 EOCODE: PDCHE0M060*004*NH

New Hampshire Natural Heritage Bureau - Plant Record

Perennial Glasswort (*Salicornia ambigua*)

Legal Status		Conservation Status	
Federal:	Not listed	Global:	Not ranked (need more information)
State:	Listed Endangered	State:	Critically imperiled due to rarity or vulnerability

Description at this Location

Conservation Rank: Fair quality, condition and/or lanscape context ('C' on a scale of A-D).
Comments on Rank:

Detailed Description: 1997: At least two large mats in a 5-10 square-meter area. 1982: 50 or more stalks in 15x10 foot area, plants just starting to flower. Plants appear vigorous.
General Area: 1997: Gulf of Maine Salt Marsh. 1982: Flat, wet, full sun, with *Spartina patens* (salt-meadow cord-grass). Salt Marsh.
General Comments:
Management Comments:

Location

Survey Site Name: Hampton Falls River
Managed By: Landing + Vicinity Marsh

County:	Rockingham	USGS quad(s):	Hampton (4207087)
Town(s):	Hampton Falls	Lat, Long:	425437N, 0705110W
Size:	2.8 acres	Elevation:	10 feet

Precision: Within (but not necessarily restricted to) the area indicated on the map.

Directions: Hampton Falls. "Birmins" [Brimers?] Salt Marsh. Take Depot Ave to railroad tracks, go south on tracks 1/8 mile. Plants on west side of tracks at base of banking in salt marsh.

Dates documented

First reported: 1982-08-17 Last reported: 1997-09-19

Nichols, Bill. 1997. Field survey to Hampton Falls River Salt Marsh on September 19.

Nichols, William F. 2000. Ecological Assessment of Selected Towns in New Hamphire's Coastal Zone. Prepared by NH Natural Heritage Inventory. Concord, NH.

NHB10-2248 EOCODE: PDPGN0L220*001*NH

New Hampshire Natural Heritage Bureau - Plant Record

Robust Knotweed (*Persicaria robustior*)

Legal Status		Conservation Status	
Federal:	Not listed	Global:	Apparently secure but with cause for concern
State:	Listed Endangered	State:	Critically imperiled due to rarity or vulnerability

Description at this Location

Conservation Rank: Not ranked
Comments on Rank:

Detailed Description: 1997: Noticed a few flowering stems. Incomplete survery. 1970: Hodgdon "several plants". 1967: Hodgdon specimen at NH.
General Area: 1997: Banks of Back River. 1970 (?): Plants beside brook, with *Lobelia cardinalis* (cardinal-flower).
General Comments:
Management Comments:

Location

Survey Site Name: Brookside Sanctuary
Managed By: Brookside Wildlife Sanctuary

County:	Rockingham	USGS quad(s):	Exeter (4207088)
Town(s):	South Hampton	Lat, Long:	425337N, 0705631W
Size:	2.8 acres	Elevation:	90 feet

Precision: Within (but not necessarily restricted to) the area indicated on the map.

Directions: In Brookside Audubon Sanctuary where Back River passes under Woodman Road.

Dates documented

First reported: 1967 Last reported: 1997-10-08

Nichols, Bill. 1997. Field survey to Back River on October 8.

NHB10-2248 EOCODE: PDAST0S0D7*007*NH

New Hampshire Natural Heritage Bureau - Plant Record

Tall Wormwood (*Artemisia campestris ssp. caudata*)

Legal Status		Conservation Status	
Federal:	Not listed	Global:	Demonstrably widespread, abundant, and secure
State:	Listed Endangered	State:	Critically imperiled due to rarity or vulnerability

Description at this Location

Conservation Rank: Not ranked
Comments on Rank:

Detailed Description: 1997: Common (11-50 plants) on railroad tracks leading down to salt marsh to east. 1982: Numerous plants scattered along railroad bed on both sides. Specimens at NHA, NEBC (1916, 1982).
General Area: 1997: Open habitat on railroad banks.
General Comments:
Management Comments:

Location

Survey Site Name: Hampton Falls River
Managed By: ASNH Hampton Falls Saltmarsh - Swain

County:	Rockingham	USGS quad(s):	Hampton (4207087)
Town(s):	Hampton Falls	Lat, Long:	425449N, 0705102W
Size:	2.8 acres	Elevation:	10 feet

Precision: Within (but not necessarily restricted to) the area indicated on the map.

Directions: Railroad tracks, north of Hampton Falls River in Hampton Harbor salt marsh.

Dates documented

First reported: 1916 Last reported: 1997-09-19

Nichols, Bill. 1997. Field survey to Hampton Falls River Salt Marsh on September 19.

Nichols, William F. 2000. Ecological Assessment of Selected Towns in New Hamphire's Coastal Zone. Prepared by NH Natural Heritage Inventory. Concord, NH.

NHB10-2248 EOCODE: AFCQB10030*006*NH

New Hampshire Natural Heritage Bureau - Animal Record

Banded Sunfish (*Enneacanthus obesus*)

Legal Status		Conservation Status	
Federal:	Not listed	Global:	Demonstrably widespread, abundant, and secure
State:	SC	State:	Rare or uncommon

Description at this Location

Conservation Rank: Not ranked
Comments on Rank:

Detailed Description: 2005: Area 8997: 2 observed. 1938: Powwow River: Specimen collected.
General Area: 2005: Area 8997: Freshwater - Pond.1938: Powwow River: Vegetation abundant; *Potamogeton* sp., *Ceratophyllum* sp., pickerel weed. Deep sluggish still water stream.
General Comments:
Management Comments:

Location

Survey Site Name: Powwow River
Managed By: Powwow Pond Access

County:	Rockingham	USGS quad(s):	Exeter (4207088)
Town(s):	Kingston	Lat, Long:	425455N, 0710248W
Size:	2.4 acres	Elevation:	95 feet

Precision: Within (but not necessarily restricted to) the area indicated on the map.

Directions: 2005: Area 8997: Powwow Pond at New Boston Rd. 1938: Powwow River: 0.25 miles above T2, Merrimack watershed. 1.5 miles west of South Hampton.

Dates documented

First reported:	1938	Last reported:	2005

Bailey, R. M. 1938. New Hampshire Fish and Game. Field Notes, Coll. Blanks Corr. to STA. M-107, M1 to STA. M11-10, M160. Field data files.

The New Hampshire Fish & Game Department has jurisdiction over rare wildlife in New Hampshire. Please contact them at 11 Hazen Drive, Concord, NH 03301 or at (603) 271-2461.

NHB10-2248 EOCODE: ARAAD04010*320*NH

New Hampshire Natural Heritage Bureau - Animal Record

Blanding's Turtle (*Emydoidea blandingii*)

Legal Status		Conservation Status	
Federal:	Not listed	Global:	Apparently secure but with cause for concern
State:	Listed Endangered	State:	Critically imperiled due to rarity or vulnerability

Description at this Location

Conservation Rank: Not ranked
Comments on Rank:

Detailed Description: 2005: Area 11511: 1 adult turtle observed 30 yards from a medium to large vernal pool.
General Area: 2005: Area 11511: Near medium to large vernal pool. Meadows and little woods.
General Comments:
Management Comments:

Location

Survey Site Name:
Managed By:

County: Rockingham
Town(s): Derry
Size: 7.7 acres

USGS quad(s): Derry (4207183)
Lat, Long:
Elevation:

Precision: Within (but not necessarily restricted to) the area indicated on the map.

Directions: 2005: Area 11511: About 200 yards from powerline off Paul Avenue.

Dates documented

First reported: 2005-04-18 Last reported: 2005-04-18

The New Hampshire Fish & Game Department has jurisdiction over rare wildlife in New Hampshire. Please contact them at 11 Hazen Drive, Concord, NH 03301 or at (603) 271-2461.

NHB10-2248 EOCODE: ARAAD04010*321*NH

New Hampshire Natural Heritage Bureau - Animal Record

Blanding's Turtle (*Emydoidea blandingii*)

Legal Status		Conservation Status	
Federal:	Not listed	Global:	Apparently secure but with cause for concern
State:	Listed Endangered	State:	Critically imperiled due to rarity or vulnerability

Description at this Location

Conservation Rank: Not ranked
Comments on Rank:

Detailed Description: 2008: Area 11543M: 2 adults seen.
General Area: 2008: Area 11543M: Beaver pond. On a log in the water.
General Comments:
Management Comments:

Location

Survey Site Name:
Managed By:

County: Rockingham
Town(s): Derry
Size: 30.8 acres

USGS quad(s): Derry (4207183)
Lat, Long:
Elevation:

Precision: Within (but not necessarily restricted to) the area indicated on the map.

Directions: 2008: Area 11543M: Intersection of powerlines off Scenic Drive and Paul Avenue.

Dates documented

First reported: 2008-05-14 Last reported: 2008-05-14

The New Hampshire Fish & Game Department has jurisdiction over rare wildlife in New Hampshire. Please contact them at 11 Hazen Drive, Concord, NH 03301 or at (603) 271-2461.

NHB10-2248 EOCODE: ARAAD04010*322*NH

New Hampshire Natural Heritage Bureau - Animal Record

Blanding's Turtle (*Emydoidea blandingii*)

Legal Status		Conservation Status	
Federal:	Not listed	Global:	Apparently secure but with cause for concern
State:	Listed Endangered	State:	Critically imperiled due to rarity or vulnerability

Description at this Location

Conservation Rank: Not ranked
Comments on Rank:

Detailed Description: 2006: Area 11689M: 1 young individual female seen on 2006-05-18. 1 adult seen on 2006-05-20.
General Area: 2006: Area 11689M: Near vernal pool.
General Comments:
Management Comments:

Location

Survey Site Name:
Managed By:

County:	Rockingham	USGS quad(s):	Derry (4207183)
Town(s):	Derry	Lat, Long:	
Size:	30.8 acres	Elevation:	

Precision: Within (but not necessarily restricted to) the area indicated on the map.

Directions: 2006: Area 11689M: Vernal pool near beaver pond at powerline between Paul Avenue & Scenic Drive.

Dates documented

First reported: 2006-05-18 Last reported: 2006-05-20

The New Hampshire Fish & Game Department has jurisdiction over rare wildlife in New Hampshire. Please contact them at 11 Hazen Drive, Concord, NH 03301 or at (603) 271-2461.

NHB10-2248 EOCODE: ABNNM08070*005*NH

New Hampshire Natural Heritage Bureau - Animal Record

Common Tern (*Sterna hirundo*)

Legal Status		Conservation Status	
Federal:	Not listed	Global:	Demonstrably widespread, abundant, and secure
State:	Listed Threatened	State:	Not ranked (need more information)

Description at this Location

Conservation Rank: Historical records only - current condition unknown.
Comments on Rank: 2007: No records from this site since 1978.

Detailed Description: 1978: At least 2 nests.1969: 10 adults, 1 chick observed.1966: Ca. 10 birds present, 1 nest with 2 eggs.1964: 10 birds nesting.
General Area:
General Comments:
Management Comments:

Location

Survey Site Name: Hampton Falls RR Station
Managed By: Former Dodge Marsh

County:	Rockingham	USGS quad(s):	Hampton (4207087)
Town(s):	Hampton Falls	Lat, Long:	425444N, 0705105W
Size:	2.8 acres	Elevation:	5 feet

Precision: Within (but not necessarily restricted to) the area indicated on the map.

Directions: Hampton Falls Railroad station, Route 1, then East on Depot Ave.

Dates documented

First reported:	1964	Last reported:	1978

The New Hampshire Fish & Game Department has jurisdiction over rare wildlife in New Hampshire. Please contact them at 11 Hazen Drive, Concord, NH 03301 or at (603) 271-2461.

NHB10-2248 EOCODE: ABPBX01030*001*NH

New Hampshire Natural Heritage Bureau - Animal Record

Golden-winged Warbler (*Vermivora chrysoptera*)

Legal Status		Conservation Status	
Federal:	Not listed	Global:	Apparently secure but with cause for concern
State:	SC	State:	Not ranked (need more information)

Description at this Location

Conservation Rank: Historical records only - current condition unknown.
Comments on Rank:

Detailed Description: 1986: 1 adult female seen (Obs_id 1634).
General Area: 1986: Terrestrial - Scrub / shrubland (Obs_id 1634).
General Comments: 1986: Female observed carrying food to undisclosed nest location in old clear cut (Obs_id 1634).
Management Comments:

Location

Survey Site Name: Chair Hill
Managed By: Brookside Wildlife Sanctuary

County:	Rockingham	USGS quad(s):	Exeter (4207088)
Town(s):	South Hampton	Lat, Long:	425329N, 0705641W
Size:	30.8 acres	Elevation:	

Precision: Within (but not necessarily restricted to) the area indicated on the map.

Directions: 1986: South of Peak Road at south side of Brookside Wildlife Sanctuary (ASNH). [Off of Woodman Rd., north of Chair Hill.] (Obs_id 1634).

Dates documented

First reported:	1986-06-04	Last reported:	1986-06-04

The New Hampshire Fish & Game Department has jurisdiction over rare wildlife in New Hampshire. Please contact them at 11 Hazen Drive, Concord, NH 03301 or at (603) 271-2461.

NHB10-2248 EOCODE: ARAAD02010*034*NH

New Hampshire Natural Heritage Bureau - Animal Record

Spotted Turtle (*Clemmys guttata*)

Legal Status		Conservation Status	
Federal:	Not listed	Global:	Demonstrably widespread, abundant, and secure
State:	Listed Threatened	State:	Imperiled due to rarity or vulnerability

Description at this Location

Conservation Rank: Good quality, condition and lanscape context ('B' on a scale of A-D).
Comments on Rank:

Detailed Description: 2006: Area 11884: 1 gravid (2 eggs) female killed on road. Area 11687M: 1 young individual seen on 2006-04-28. 1 4" long young individual seen on 2006-04-30. 1 adult seen on 2006-05-19. 1997: 1 adult observed.
General Area: 2006: Area 11687M: Powerline near beaver pond.1997: Small brook, outflow of Rainbow Pond.
General Comments: 1997: Observed by Joel and Ron Miller.
Management Comments:

Location

Survey Site Name: Rainbow Pond
Managed By:

County:	Rockingham	USGS quad(s):	Derry (4207183)
Town(s):	Derry	Lat, Long:	
Size:	11.0 acres	Elevation:	395 feet

Precision: Within (but not necessarily restricted to) the area indicated on the map.

Directions: 2006: Area 11884: Cul-de-sac on Paul Avenue. Area 11687M: Off Paul Avenue & Scenic Drive powerline intersection. 1996:[From Derry Village rotary, take Rte. 28 Bypass north about 2 miles. Turn right onto Shields Pond Road. Access outlet stream by taking the 5th left.]

Dates documented

First reported: 1997-06-21 Last reported: 2006-07-13

The New Hampshire Fish & Game Department has jurisdiction over rare wildlife in New Hampshire. Please contact them at 11 Hazen Drive, Concord, NH 03301 or at (603) 271-2461.

NHB10-2248 EOCODE: ABPBX95010*007*NH

New Hampshire Natural Heritage Bureau - Animal Record

Vesper Sparrow (*Pooecetes gramineus*)

Legal Status		**Conservation Status**	
Federal:	Not listed	Global:	Demonstrably widespread, abundant, and secure
State:	SC	State:	Not ranked (need more information)

Description at this Location

Conservation Rank: Not ranked
Comments on Rank:

Detailed Description: 2001: 10 seen, age and sex unknowns (Obs_id 1190).
General Area: 2001: Habitat not clear - birds in powerline corridor so probably a mix of open areas and shrubs (Obs_id 1190).
General Comments: 2001: Total of 10 birds includes some presumed to be juveniles, but exact breakdown of adults and young was not made by the observer (Obs_id 1190).
Management Comments:

Location

Survey Site Name: Coburn Hill, Powerlines West of
Managed By: Danville Town Forest

County:	Rockingham	USGS quad(s):	Sandown (4207182)
Town(s):	Danville	Lat, Long:	425624N, 0710810W
Size:	84.1 acres	Elevation:	

Precision: Within (but not necessarily restricted to) the area indicated on the map.

Directions: 2001: Powerlines near Ticker Town Road (class 6). [From intersection of Sandown Rd. travel the powerlines southwest to junction of 2 more powerlines. Go southwest, past wetland area about 1.1 miles.] (Obs_id 1190).

Dates documented

First reported:	2001-07-24	Last reported:	2001-07-24

The New Hampshire Fish & Game Department has jurisdiction over rare wildlife in New Hampshire. Please contact them at 11 Hazen Drive, Concord, NH 03301 or at (603) 271-2461.

APPENDIX D-1
ESSENTIAL FISH HABITAT ASSESSMENT

Essential Fish Habitat Assessment Seabrook Station, Unit 1 License Renewal

May 2011

Docket Number 50-443

U.S. Nuclear Regulatory Commission

Rockville, Maryland

TABLE OF CONTENTS

D-1.1 Introduction D-1-1

D-1.2 Description of the Proposed Action D-1-1
D-1.2.1 Site Location and Description D-1-2
D-1.2.1.1 Cooling and Auxiliary Water Systems D-1-2

D-1.3 Essential Fish Habitat Species Near the Site and Potential Adverse Effects D-8
D-1.3.1 Essential Fish Habitat Species Identified for Analysis D-1-8
D-1.3.2 Potential Adverse Effects to Essential Fish Habitat D-1-10
D-1.3.2.1 Information Related to Potential Adverse Impact on All Essential Fish Habitat Species D-1-13
D-1.3.2.2 Combined Impacts (Monitoring Data) D-1-24
D-1.3.3 Adverse Effects on Essential Fish Habitat by Species D-1-32
D-1.3.3.1 American Plaice (Hippoglossoides platessoides) (Juvenile and Adult) D-1-32
D-1.3.3.2 Atlantic butterfish (Peprilus triacanthus) (All Life Stages) D-1-34
D-1.3.3.3 Atlantic cod (Gadus morhua) (All Life Stages) D-1-36
D-1.3.3.4 tlantic herring (Clupea harengus) (Juvenile and Adult) D-1-39
D-1.3.3.5 Atlantic mackerel (Scomber scombrus) (All Life Stages) D-1-41
D-1.3.3.6 tlantic sea scallop (Placopecten magellanicus) (All Life Stages) D-1-44
D-1.3.3.7 Atlantic Surfclam (Spisula solidissima) (Juveniles and Adults) D-1-46
D-1.3.3.8 Haddock (Melanogrammus aeglefinus) (Juvenile) D-1-47
D-1.3.3.9 Monkfish/Goosefish (Lophius americanus) (All Life Stages) D-1-49
D-1.3.3.10 Ocean pout (Macrozoarces americanus) (All Life Stages) D-1-51
D-1.3.3.11 Pollock (Pollachius virens) (Juvenile) D-1-53
D-1.3.3.12 Red hake (Urophycis chuss) (All Life Stages) D-1-55
D-1.3.3.13 Scup (Stenotomus chrysops) (Juvenile and Adult) D-1-57
D-1.3.3.14 Summer flounder (Paralicthys dentatus) (Adult) D-1-59
D-1.3.3.15 Whiting/Silver hake (Merluccius bilinearis) (All life stages) D-1-60
D-1.3.3.16 Windowpane flounder (Scopthalmus aquosus) (Juveniles and Adults) D-1-63
D-1.3.3.17 Winter flounder (Pleuronectes americanus) (All Life Stages) D-1-65
D-1.3.3.18 Yellowtail flounder (Pleuronectes ferruginea) (Juveniles and Adults) D-1-67
D-1.3.3.19 Essential Fish Habitat Species Not Likely to Regularly Occur Near Seabrook D-1-69

D-1.4 Cumulative Effects to Essential Fish Habitat D-1-70

D-1.5 Essential Fish Habitat Conservation Measures D-1-73

D-1.6 Conclusion D-1-73

D-1.7 References D-1-75

Figures

Figure D-1-1. Location of Seabrook Station, 6-mi (10-km) region D-1-3
Figure D-1-2. Location of Seabrook Station, 50-mi (80-km) region D-1-4
Figure D-1-3. Seabrook Station site boundary and facility layout D-1-5
Figure D-1-4. Intake shafts and caps at Seabrook Station D-1-6
Figure D-1-5. Profile of intake tunnel and shafts at Seabrook Station D-1-7
Figure D-1-6. Circulating water pumphouse at Seabrook Station..... D-1-8
Figure D-1-7. Sampling Stations for Seabrook Station aquatic monitoring..... D-1-25

Tables

Table D-1-1. Species of fish with designated EFH in the vicinity of Seabrook D-1-9
Table D-1-2. Relative commonness of EFH species in Seabrook monitoring, entrainment, and impingement studies..... D-1-11
Table D-1-3. Aquatic resource issues identified in the GEIS D-1-13
Table D-1-4. Number of fish eggs entrained (in millions) for most common egg taxa entrained and for EFH species D-1-15
Table D-1-5. Number of fish larvae entrained (in millions) for the most common larval taxa entrained and for EFH species D-1-17
Table D-1-6. Number of impinged fish for the most common taxa impinged and for EFH species D-1-19
Table D-1-7. Number of bivalve larvae entrained (x 10^9)..... D-1-21
Table D-1-8. 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 D-1-26
Table D-1-9. Geometric mean catch per unit effort (CPUE) (No. per 10-minute tow) and upper and lower 95% CL during preoperational and operational monitoring years for the most abundant species..... D-1-27
Table D-1-10. Geometric mean CPUE (No. per 24-hr surface and bottom gill net set) and coefficient of variation (CV) during preoperational (1976–1989) and operational monitoring years (1990–1996)..... D-1-28
Table D-1-11. Geometric mean CPUE (No. per seine haul) and upper and lower 95% CL during preoperational and operational monitoring years D-1-30
Table D-1-12. Kelp density (No. per 100 m^2) and upper and lower 95% CL during preoperational and operational monitoring years D-1-31
Table D-1-13. Summary of NRC conclusions Regarding the Effect on Habitat by Species and Life Stages..... D-1-73

ABBREVIATIONS, ACRONYMS, AND SYMBOLS

ac	acre
ADAMS	Agencywide Documents Access and Management System
BACI	before-after control-impact
CFR	*U.S. Code of Federal Regulations*
cfs	cubic feet per second
CL	confidence limit
cm	centimeter
CO_2	carbon dioxide
CPUE	catch per unit effort
CV	coefficient of variation
CWA	Clean Water Act
DFO	Fisheries and Oceans Canada
EEP	Estuary Enhancement Program
EFH	Essential Fish Habitat
EPA	U.S. Environmental Protection Agency
ER	environmental report
FPLE	Flordia Power Light Energy Seabrook
fps	feet per second
FR	Federal Register
ft	foot
FMP	fishery management plan
GEIS	Generic Environmental Impact Statement
gpm	gallons per minute
ha	hectare
in.	inch
kg	kilogram
km	kilometer
lb	pound
m	meter
m/s	meters per second
m^3	cubic meters
m^3/day	cubic meters per day
m^3/s	cubic meters per second
m^3/yr	cubic meters per year
MAFMC	Mid-Atlantic Fishery Management Council
MARMAC	Marine Resources Monitoring, Assessment, and Prediction
MDS	multi-dimensional scaling
mgd	million gallons per day
mi	mile

mm	millimeter
MSA	Magnuson-Stevens Fishery and Conservation Management Act
MSL	mean sea level
MT	metric tons
NAI	Normandeau Associates, Inc.
NEFMC	New England Fishery Management Council
NEFSC	Northeast Fishery Science Center
NEPA	U.S. National Environmental Policy Act of 1969
NextEra	NextEra Energy Seabrook, LLC
NPDES	National Pollutant Discharge Elimination System
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NRC	U.S. Nuclear Regulatory Commission
PIC	proposal for information collection
ppt	parts per thousand
Seabrook	Seabrook Station, Unit 1
SEIS	Supplemental Environmental Impact Statement
USGCRP	U.S. Global Change Research Program

D-1 ESSENTIAL FISH HABITAT ASSESSMENT FOR THE PROPOSED LICENSE RENEWAL OF SEABROOK STATION

D-1.1 Introduction

In compliance with Section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA), as amended by the Sustainable Fisheries Act of 1996 (Public Law 104-267), the U.S. Nuclear Regulatory Commission (NRC) prepared this Essential Fish Habitat (EFH) Assessment for the proposed Federal action: NRC's decision whether or not to renew the operating license for Seabrook Station (Seabrook), Unit 1. Seabrook is located in Rockingham County, NH, on the shore of the Hampton-Seabrook Estuary and the Gulf of Maine.

Pursuant to the MSA, NRC staff requested, via letter dated July 16, 2010 (NRC, 2010), that the National Marine Fisheries Service (NMFS) provide information on EFH near the Seabrook site. In their response to NRC, NMFS (2010) indicated that marine waters off Seabrook and the Hampton-Seabrook Estuary have been designated as EFH for 23 Federally-managed species and directed the NRC to prepare an EFH Assessment as part of the EFH consultation process.

Accordingly, this EFH Assessment does the following:

- describes the proposed action
- identifies relevant commercial, Federally managed species within the vicinity of the proposed site
- assesses if the proposed action may adversely affect any designated EFH
- describes potential measures to avoid, minimize, or offset potential adverse impacts to EFH as a result of the proposed action

D-1.2 Description of the Proposed Action

The proposed Federal action is NRC's decision of whether or not to renew the operating license for Seabrook for an additional 20 years beyond the original 40-year term of operation.

NextEra Energy Seabrook, LLC (NextEra) initiated the proposed Federal action by submitting an application for license renewal of Seabrook, for which the existing license, NPF-86, expires on March 15, 2030. If NRC issues a renewed license for Seabrook, NextEra could continue to operate until the 20-year terms of the renewed license expire in 2050. If the operating license is not renewed, then the facility must shut down on or before the expiration date of the current operating license (March 15, 2030).

Pursuant to the NRC's environmental protection regulations in Title 10 of the *U.S. Code of Federal Regulations* (CFR) Part 51, which implement the U.S. National Environmental Policy Act of 1969 (NEPA), the NRC is publishing a draft supplemental environmental impact statement (SEIS) for Seabrook concurrent with this EFH Assessment. The SEIS is a site-specific supplement to the "Generic Environmental Impact Statement [GEIS] for License Renewal of Nuclear Plants," NUREG-1437 (NRC, 1996).

NextEra (2010) has proposed no major construction, refurbishment, or replacement activities associated with the proposed Federal action. During the proposed license renewal term,

NextEra would continue to perform site maintenance activities as well as vegetation management on the transmission line right-of-ways that connect Seabrook to the electric grid.

D-1.2.1 Site Location and Description

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. Two metropolitan areas lie 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 D-1-1 and Figure D-1-2 present the 6-mi (10-km) and 50-mi (80-km) area surrounding Seabrook, respectively.

The Seabrook site spans 889 acres (ac) (360 hectare (ha)) on a peninsula of land bordered by Browns River on the north, Hunts Island Creek on the south, and estuarine marshlands on the east. Two lots divide the site. The joint owners of Seabrook own Lot 1, which encompasses approximately 109 ac (44 ha). The majority of the operating facility is located on this mostly-developed lot. Site structures include the Unit 1 containment building, primary auxiliary building, 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, 2010). NextEra originally planned to construct two identical units at the Seabrook site but halted construction on Unit 2 prior to completion and uses the remaining Unit 2 buildings primarily for storage.

NextEra owns Lot 2, which is approximately 780 ac (316 ha). Lot 2 is mainly an open tidal marsh area with fabricated linear drainage ditches and tidal creeks, and it is available habitat for wildlife resources (NextEra, 2010). The site boundary is also the exclusion area. Figure D-1-3 provides a general layout of the Seabrook site.

The Seabrook cooling water comes from an intake structure located 60 feet (ft) (18.3 meters (m)) below mean lower low water in the Gulf of Maine (see Section D-1.2.1.1). The seafloor in this area is relatively flat, with bedrock covered by sand, algae, or sessile invertebrates (NAI, 2010). The immediate vicinity surrounding the Seabrook plant 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.

The Gulf of Maine and Hampton-Seabrook Estuary are complex waterbodies with many individual species performing different roles in the system, and, often, species perform several ecological roles throughout their lifecycles. Major assemblages of organisms within the marine and estuarine communities include plankton, fish, benthic invertebrates, and algae. Section 2.2.6 in the SEIS describes these assemblages and typical habitat types in the nearshore of the Gulf of Maine and within Hampton-Seabrook Estuary.

D-1.2.1.1 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 National Pollution Discharge Elimination System (NPDES) Permit (EPA, 2002a) and the applicant's environmental report (ER) (NextEra, 2010).

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

Source: (NextEra, 2010)

Figure D-1-2. Location of Seabrook, 50-mi (80-km) region

Source: (NextEra, 2010)

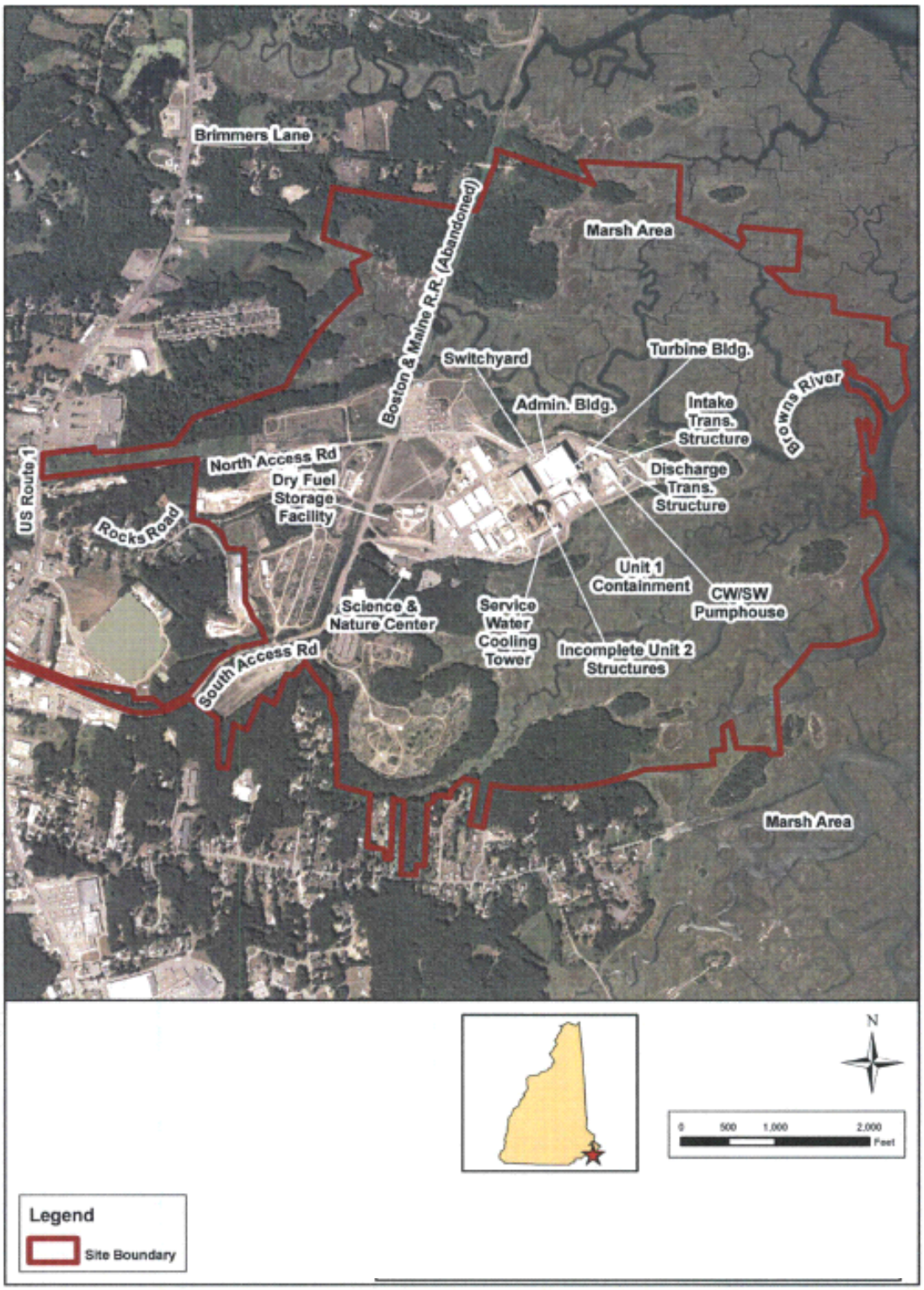


Figure D-1-3. Seabrook site boundary and facility layout

Source: (NextEra, 2010)

Water is drawn from the Gulf of Maine through three concrete intake structures that are located at the end of an intake tunnel in approximately 60 ft (18.3 m) of water depth. Each intake shaft extends up from the intake tunnel to above the bedrock, and a velocity cap sits on top (Figure D-1-4). NextEra implemented this structural design to reduce the intake velocity, thereby minimizing fish entrapment. In 1999, NextEra modified the intakes with additional vertical bars to help prevent seals from getting trapped (NMFS, 2002). The NPDES permit limits the intake velocity to 1.0 feet per second (fps) (0.3 meters per second (m/s)) (EPA, 2002a).

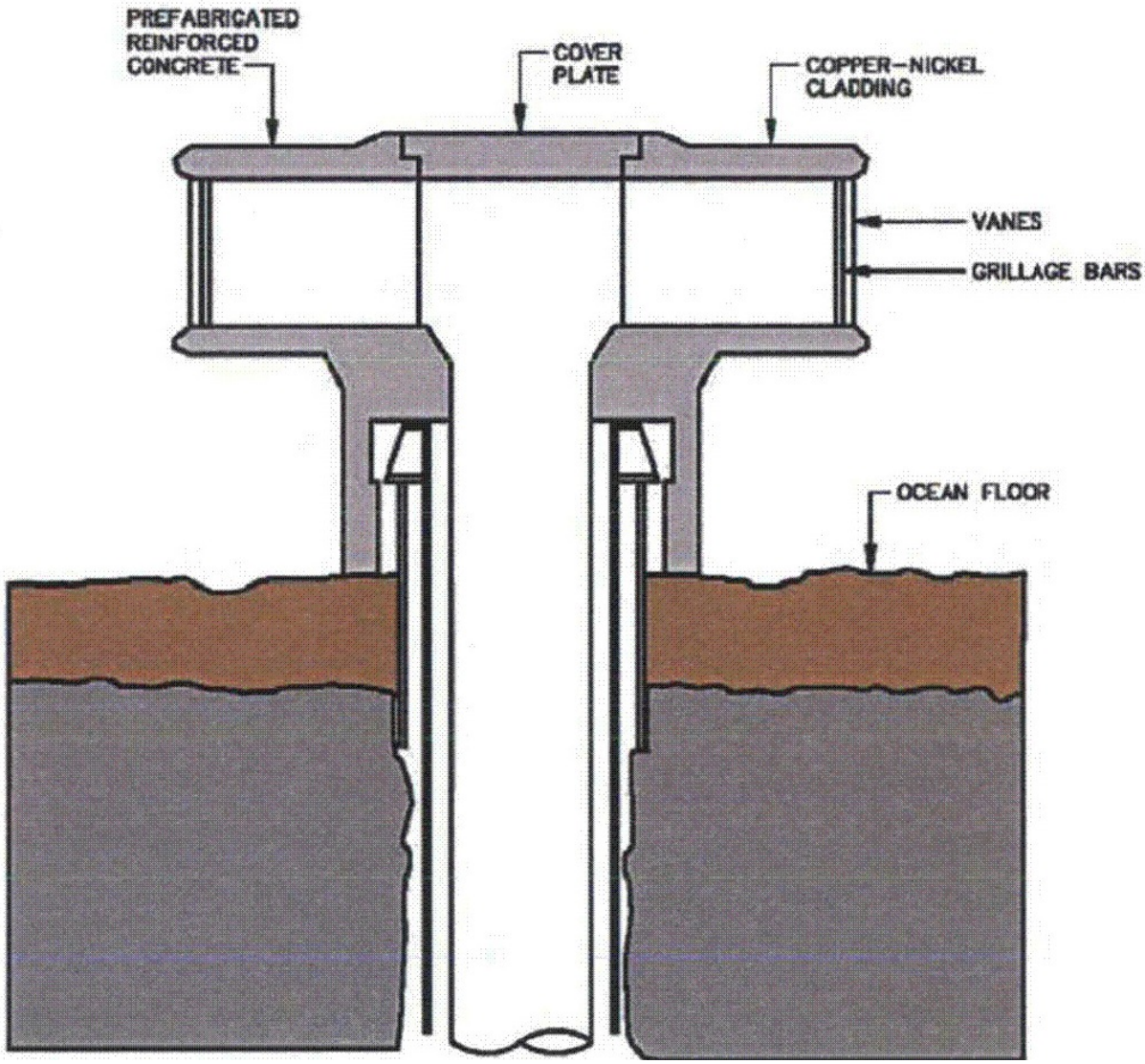


Figure D-1-4. Intake shafts and caps at Seabrook

Source: (ARCADIS et al., 2008)

Water flows from the intake structures 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 D-1-5). Concrete lines the 19-ft (5.8-m) diameter tunnel.

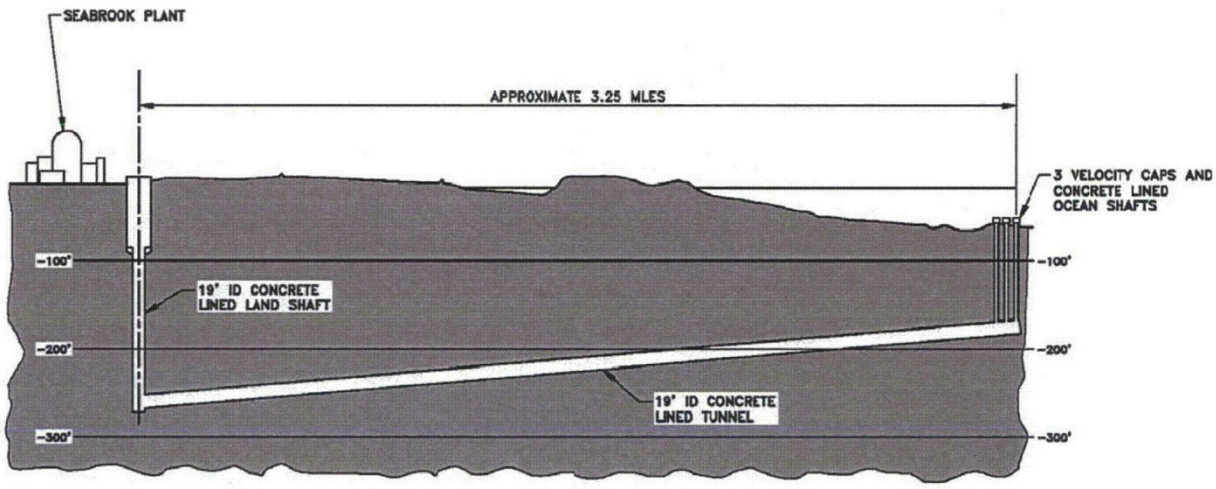


Figure D-1-5. Profile of intake tunnel and shafts at Seabrook

Source: (ARCADIS et al., 2008)

An intake transition structure, which includes three circulating water pumps that transport the water, is located beneath Seabrook (Figure D-1-6). Butterfly valves, 11-ft (3.4-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, 2010a). 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. Eleven 70-ft (21-m) deep concrete shafts about 100 ft (30 m) apart discharge the effluent. Each 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 6.5–10 ft (2–3 m) above the seafloor in depths of approximately 49–59 ft (15–18 m) of water (NAI, 2001). To increase the discharge velocity and more quickly diffuse the heated effluent, a double-nozzle fixture tops 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 (2.6 degrees Celsius) at the surface of the receiving water (EPA, 2002a).

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, 2010a). 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 up until 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 (Seabrook, 2008). NextEra injects chlorine and other water treatment chemicals in accordance with NPDES permit limits (EPA, 2002a).

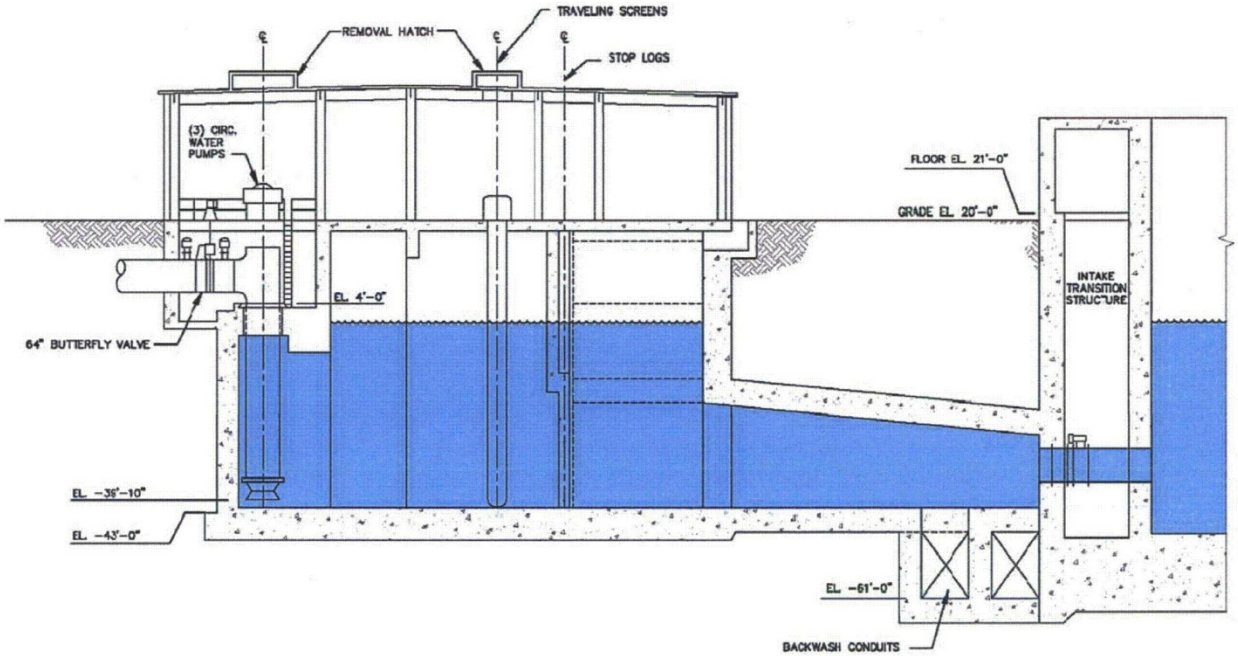


Figure D-1-6. Circulating water pumphouse at Seabrook

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 water reservoir. This makeup water reservoir is from the Gulf of Maine and stored in the service water tower. If this makeup reservoir 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).

Sections 2.1.1–2.1.5 of the SEIS provide additional information regarding the reactor and containment systems, other systems at Seabrook, and plant operations. Sections 2.1.7 and 2.2.5 provide additional information on Seabrook's surface water use and a description of the NDPES permit.

D-1.3 Essential Fish Habitat Species Near the Site and Potential Adverse Effects

D-1.3.1 Essential Fish Habitat Species Identified for Analysis

The waters and substrate necessary for spawning, breeding, feeding, or growth to maturity are considered EFH (16 U.S.C. 1802(10)). The portion of the Gulf of Maine and Hampton-Seabrook

Estuary adjacent to Seabrook, and its intake and discharge structures, contains designated EFH for several fish species and life stages.

In its *Guide to Essential Fish Habitat Designations in the Northeastern United States*, NMFS (2011a) 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 near 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 D-1-1.

Table D-1-1. Species of fish with designated EFH in 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	
Longfin inshore squid (*Loligo pealei*)			x	x
Monkfish/Goosefish (*Lophius americanus*)	x	x	x	x
Northern shortfin squid (*Illex illecebrosus*)			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
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

Source: (NMFS, 2011b)

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. Table D-1-2 presents a summary of the occurrence of EFH species within Seabrook's monitoring, entrainment, and impingement studies.

The NRC staff compared monitoring, entrainment, and impingement data with each of the EFH species listed in Table D-1-2. Seabrook regularly observed most EFH species within monitoring, entrainment, or impingement studies. However, Atlantic halibut, redfish, bluefin tuna, northern shortfin squid, and longfin inshore squid were rarely or occasionally identified during monitoring studies and were not entrained or impinged from 1990–2009. These fives species are analyzed in Section D-1.3.3.19 of this assessment. All other EFH species are analyzed in detail in Sections D-1.3.3.1–D-1.3.3.18 of this assessment.

D-1.3.2 Potential Adverse Effects to Essential Fish Habitat

The provisions of the regulations implementing the MSA define an "adverse effect" to EFH as the following (50 CFR 600.810):

> *Adverse effect* means any impact that reduces quality and/or quantity of EFH. Adverse effects may include direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to, benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality and/or quantity of EFH. Adverse effects to EFH may result from actions occurring within EFH or outside of EFH and may include site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions.

For purposes of conducting NEPA reviews, the NRC staff published the GEIS (NRC, 1996), which identifies 13 impacts to aquatic resources as either "Category 1" or "Category 2." Category 1 issues are generic in that they are similar at all nuclear plants and have one impact level (SMALL, MODERATE, or LARGE) for all nuclear plants. Mitigation measures for Category 1 issues are not likely to be sufficiently beneficial to warrant implementation. Category 2 issues vary from site to site and must be evaluated on a site-specific basis. Table D-1-3 lists the aquatic resource issues as identified in the GEIS.

The GEIS classifies all impact levels for aquatic resources as "SMALL" except impingement, entrainment, and heat shock. NRC defines "SMALL" as "having environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource" (10 CFR 51, App. B, Table B-1). The NRC staff believes that stressors with "SMALL" levels of impact for the purposes of implementing NEPA would likely not adversely affect EFH. Therefore, this EFH Assessment will focus on the potential adverse effects of impingement, entrainment, and heat shock on EFH. **Impingement** occurs when aquatic organisms are pinned against intake screens or other parts of the cooling water system intake structure. **Entrainment** occurs when aquatic organisms (usually eggs, larvae, and other small organisms) are drawn into the cooling water system and are subjected the thermal, physical, and chemical stress. **Heat shock** is acute thermal stress caused by exposure to a sudden elevation of water temperature that adversely affects the metabolism and behavior of fish and other aquatic organisms. In addition to heat shock, increased water temperatures at the discharge can also reduce the available habitat for fish species if the discharged water is higher than the environmental preferences of a particular species. This issue will be discussed together with heat shock.

Table D-1-2. Relative commonness of EFH species in Seabrook monitoring, entrainment, and impingement studies

Species	Eggs		Larvae		Juveniles and Adults			
	Plankton monitoring	Entrainment studies	Plankton monitoring	Entrainment studies	Trawl monitoring	Gill net monitoring	Seine monitoring	Impingement studies
American plaice	Common[a]	Occasional	Common	Occasional[b]	Occasional			Rare[c]
Atlantic butterfish	Occasional	Rare	Occasional	Rare	Rare	Occasional	Rare	Rare
Atlantic cod [e]	Common	Common	Common	Rare	Common	Occasional	Rare	Rare
Atlantic halibut					Rare			
Atlantic herring			Common	Occasional	Occasional	Abundant	Occasional	Common
Atlantic mackerel	Abundant[d]	Abundant	Abundant	Rare	Rare	Common	Rare	Rare
Atlantic sea scallop				Rare				
Atlantic surf clam				Rare				
Bluefin tuna								
Haddock [e]	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 [e]			Occasional					
Red hake [e]	Common	Common	Common	Occasional	Abundant	Occasional	Common	Common
Scup			Rare		Occasional	Rare		Rare
Summer flounder			Rare	Rare	Rare			Rare
Whiting/Silver hake	Common	Common	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 and Adults			
	Plankton monitoring	Entrainment studies	Plankton monitoring	Entrainment studies	Trawl monitoring	Gill net monitoring	Seine monitoring	Impingement studies
Yellowtail flounder [e]	Abundant	Occasional	Common	Rare	Abundant	Rare	Rare	Common

[a] Common: Occurring in >10% of samples but <10% of total catch; 5–10% of entrainment samples averaged over all years

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

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

[d] Abundant: >10% of total catch or entrainment over all years

[e] 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 appears in the table above. Groups of species include Atlantic cod/ haddock/witch flounder, cunner/yellowtail founder, red hake/white hake/spotted hake, and golden redfish/deepwater redfish/and Acadian redfish. For egg entrainment estimates of these groups of species, NextEra (2010b) estimated single species entrainment rates by applying the ratio of larval species to the egg species groups

Blank cells indicate the NAI (2010) did not identify the species within monitoring or entrainment studies.

Sources: (NAI, 2010; NextEra, 2010a)

Table D-1-3. Aquatic resource issues identified in the GEIS

Issues	Category	Impact level
For all plants		
Accumulation of contaminants in sediments or biota	1	SMALL
Entrainment of phytoplankton & zooplankton	1	SMALL
Cold shock	1	SMALL
Thermal plume barrier to migrating fish	1	SMALL
Distribution of aquatic organisms	1	SMALL
Premature emergence of aquatic insects	1	SMALL
Gas supersaturation (gas bubble disease)	1	SMALL
Low dissolved oxygen in the discharge	1	SMALL
Losses from parasitism, predation, & disease among organisms exposed to sublethal stresses	1	SMALL
Stimulation of nuisance organisms	1	SMALL
For plants with once-through heat dissipation systems		
Impingement of fish & shellfish	2	SMALL, MODERATE, or LARGE
Entrainment of fish & shellfish in early life stages	2	SMALL, MODERATE, or LARGE
Heat shock	2	SMALL, MODERATE, or LARGE

Source: (NRC, 1996)

In addition to impingement, entrainment, and heat shock (or thermal impacts), the NRC staff will assess the impacts to EFH species' food (forage species) and loss of habitat-forming species (such as sessile invertebrates and algae). Information on these areas that is relevant to all EFH species is in Section D-1.3.2.1. In addition, Section D-1.3.2.2 presents NextEra monitoring data of selected groups prior to and during operations at sampling sites near the intake and discharge structures (nearfield sampling sites) and at sampling sites 3–4 mi (5–8 km) away (farfield sampling sites). Monitoring data may indicate whether the combined impacts (or cumulative impacts) from Seabrook operation has resulted in the decline of forage species, habitat-forming species, or EFH species due to a decline in habitat quantity or quality. The NRC staff's conclusions and information specific to each EFH species is in Sections D-1.3.3.1–D-1.3.3.19. Section D-1.4 provides an analysis of cumulative impacts to EFH species or their habitat resulting from the past, present, and reasonably foreseeable future projects in the vicinity of Seabrook.

D-1.3.2.1 Information Related to Potential Adverse Impact on All Essential Fish Habitat Species

The section below provides information regarding potential adverse impacts to EFH that is relevant for the assessment of all 23 EFH species that may occur within the vicinity of Seabrook.

Entrainment and Impingement. Entrainment and impingement study results illustrate one type of operational impact on each species' habitat. Because the intake water is EFH, the ratio of

specimens from a species impinged or entrained at Seabrook to the total number of impinged or entrained organisms provides some indication of how great the impact from the cooling system will be on the corresponding EFH. The NRC staff obtained data on fish entrainment and impingement from Seabrook's Annual Biological Monitoring Reports, which summarize entrainment data from 1990–2009 and impingement data from 1994–2009 (NAI, 2010).

NextEra conducted entrainment studies four times per month (NAI, 2010). 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, 2008; NAI, 2010). Entrainment rates for commonly entrained species, EFH species, and common forage species are presented in Table D-1-4 for egg entrainment and Table D-1-5 for larvae entrainment.

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 2 standardized 24-hour samples per week and multiplied by 7 to estimate weekly impingement. Table D-1-6 shows impingement rates for commonly impinged species, EFH species, and common forage species.

NAI (2010) reported impingement estimates from 1994–2009. 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, 2010a).

NextEra also conducted entrainment studies for bivalve larvae (NAI, 2010). In these studies, NextEra collected three replicates per sampling date using a 0.003-in. (0.076-mm) mesh. Table D-1-7 describes entrainment rates for bivalve larvae.

<u>Thermal Impacts</u>. Heat shock can injure or kill fish. In addition, aquatic species, including EFH species or prey of EFH species, may largely avoid effluents due to high velocities, elevated temperatures, and turbulence. Seabrook's discharge to the Gulf of Maine is permitted under its NPDES permit (EPA, 2002a), 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 Clean Water Act (CWA) formal enforcement actions or violations related to discharge temperature in the last 5 years (EPA, 2010). EPA's Regional Administrator 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, 2002a).

Table D-1-4. Number of fish eggs entrained (in millions) for most common egg taxa entrained and for EFH species

Taxon[a]	1990[b]	1991[c]	1992[d]	1993[d]	1994[e]	1995[f]	1996	1997	1998	1999	2000	2001
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
Butterfish	0	0	0	0	0	0	0.1	0	0	<0.1	0	0
Cunner	489.3	147.2	0	58.4	0	18.2	93.9	221.5	63.6	220.3	1,206.7	239.6
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
Haddock	0.0	0.0	7.4	0.0	<0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hake	50.1	2.6	0	1.6	0.6	29.3	213.2	71.8	7.5	6.2	295.2	4.4
Monkfish/Goosefish	0	0	0	0	0	0	0	0	0.9	0	0.9	0
Pollock	0	1.0	0.4	0.2	0.1	0.4	0.4	0.2	2.9	0.2	<0.1	0.3
Whiting/Silver hake	11.4	0.0	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
Winter flounder	0	0	0	0	0	0	0	0	0	0	0.3	0
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 Species)	1,247.7	1,551.3	822.6	315.6	4.8	255.9	926.4	692.7	286.7	593.9	2,104.4	775.1

[a] 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 (2010a) estimated entrainment rates for each species by applying the ratio of larval species to the egg species groups.

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

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

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

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

[f] NextEra sampled 12 months per year.

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

Table D-1-4. Number of fish eggs entrained (in millions) for most common egg taxa entrained and for EFH species (cont.)

Taxon	2002	2003	2004	2005	2006	2007	2008	2009	Average	Percentage
American plaice	22.4	37.8	33.4	11.7	5.3	35.8	48.0	36.7	25.9	2.9%
Atlantic cod	77.8	15.5	9.3	16.0	15.7	15.1	48.0	15.4	32.6	3.6%
Atlantic mackerel	56.7	26.4	70.1	37.7	475.6	153.6	82.4	83.5	191.5	21.3%
Butterfish	0	0	0	0.4	0	0	0	0	<0.1	<0.1%
Cunner	1,395.7	143.9	518.1	251.2	489.4	295.0	444.5	1,451.2	387.4	43.0%
Fourbeard rockling	61.4	44.1	38.2	68.8	36.6	78.2	61.7	123.8	51.5	5.7%
Haddock	0	0	0	0.7	0	0	0	0	0.4	<0.1%
Hake	79.7	5.2	5.7	2.8	8.1	15.6	21.7	92.1	45.7	5.1%
Monkfish/Goosefish	0	0	0.1	0.1	0.1	0	0	0	0.1	<0.1%
Pollock	0.6	1.0	0.9	1.0	4.1	8.5	5.0	0.2	1.4	0.2%
Whiting/Silver hake	341.4	235.6	19.8	30.7	9.4	60.8	50.9	196.2	81.1	9.0%
Windowpane	39.1	15.5	18.2	26.2	24.7	34.7	25.9	61.8	31.7	3.5%
Winter flounder	0	0.3	0	0	0	0.2	1.1	<0.1	<0.1	<0.1%
Yellowtail flounder	3.9	0	0.1	5.0	1.1	7.8	0	4.1	42.8	4.8%
Total (All Species)	2,086.8	529.4	723.7	454.4	1,075.4	714.7	790.6	2,072.5	901.2	100%

[(a)] 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 (2010a) estimated entrainment rates for each species by applying the ratio of larval species to the egg species groups.

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

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

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

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

[(f)] In 1995-2009, NextEra sampled 12 months per year.

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

Table D-1-5. Number of fish larvae entrained (in millions) for the most common larval taxa entrained and for EFH species

Taxon	1990[a]	1991[b]	1992[c]	1993[d]	1994[e]	1995	1996	1997	1998	1999	2000	2001
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 butterfish	0	0	0	0	0	0	0	0.1	0	0	0	0
Atlantic cod	0.7	1.5	0.4	0.1	0	2.3	0.3	0.7	2.2	1.0	0.4	2.5
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 mackerel	0.2	4.7	0	0	0	0	0.1	0.4	0	0.1	0.3	0.1
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
Haddock	0	0	0.1	0	0	0	0	0	0	0	0	0
Hake	4.8	0	0	0.1	0	0.7	12.3	1.7	<0.1	0.1	29.8	0
Monkfish/Goosefish	0.1	0	0	0	0	0	0	0	0	0	2	0
Ocean pout	0	0	0	0	0	0	0	0	0	0	0	0
Pollock	0.2	0	0.1	0	0	0	0	0	<0.1	0	0	0
Summer flounder	0	0	0	0	0	0	0	0	<0.1	0	0	0
Whiting/Silver hake	7.7	0	0	0.1	0	0.9	16.9	69.0	0.2	0.4	33.2	0.6
Windowpane	3.8	<0.1	0.1	0.1	<0.1	2.0	2.0	5.6	1.4	3.7	2.3	1.3
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
Yellowtail flounder	0.1	0.3	0.1	0	0	0.1	1.6	0.5	0.3	0.8	0.3	0.5
Total (All Species)	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 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] Unless otherwise denoted, NextEra sampled the third week in April through the fourth week in October.

[e] NextEra did not conduct bivalve larvae entrainment studies.

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

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

Source: (NAI, 2010)

Table D-1-5. Number of fish larvae entrained (in millions) for the most common larval taxa entrained and for EFH species (cont.)

Taxon	2002	2003	2004	2005[f]	2006[g]	2007	2008	2009	Average	Percentage
American plaice	11.3	9.1	2.6	1.4	0.6	2.6	3.5	11.5	4.3	1.6%
American sand lance	10.5	27.1	107.1	28.3	14.1	36.6	71.2	128.6	27.9	10.3%
Atlantic butterfish	0	0	0	0	0	0	0	0	<0.1	<0.1%
Atlantic cod	34.6	2.5	0.5	1.6	0.3	1.6	1.4	1.4	3.0	1.0%
Atlantic herring	11.7	15.3	8.8	9.7	12.8	11.5	28.2	27.7	9.6	3.6%
Atlantic mackerel	0.4	0	20.2	0.1	0.5	0	<0.1	25.7	2.6	1.0%
Cunner	391.1	22.5	451.2	2.5	8.8	97.7	86.2	105.7	78.4	29.1%
Fourbeard rockling	176.4	19.3	61.4	2.0	4.9	16.4	11.9	20.3	22.7	8.4%
Grubby	6.6	27.5	51.8	7.8	9.3	15.4	8.3	31.6	15.3	5.7%
Haddock	0	0	0	0.1	0	0	0	0	<0.1	<0.1%
Hake	0.3	0.1	1.0	0	0.2	0	0.2	4.0	2.8	1.0%
Monkfish/Goosefish	0	0	0.1	0	0	0	0	<0.1	0.1	<0.1%
Ocean pout	0	<0.1	0	0	0	0	0	0	<0.1	<0.1%
Pollock	<0.1	0.6	0.1	0.1	0.8	0.8	0.3	0.3	0.2	0.1%
Summer flounder	0	<0.1	0	0	0	<0.1	0	0	<0.1	<0.1%
Whiting/Silver hake	5.9	0.5	0.2	0	0.1	0	17.9	8.2	8.1	3.0%
Windowpane	6.5	0.5	0.4	0.5	0.5	2.6	11.4	1.9	2.3	0.9%
Winter flounder	4.5	20.0	34.8	4.9	7.2	15.8	0.1	15.2	9.2	3.4%
Yellowtail flounder	0.9	0	0.1	<0.1	<0.1	2.7	0	0.3	0.4	0.2%
Total (All Species)	724.4	268.5	958.5	167.0	123.2	297.2	333.7	523.2	269.4	100%

[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] Unless otherwise denoted, NextEra sampled the third week in April through the fourth week in October.

[e] NextEra did not conduct bivalve larvae entrainment studies.

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

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

Source: (NAI, 2010)

Table D-1-6. Number of impinged fish for the most common taxa impinged and for EFH species

Species	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Alewife	0	8	1,753	2,797	14	16	4	35	1	9	212	87
American plaice	0	0	0	0	0	2	0	0	0	0	0	3
American sand lance	1,215	1,324	823	182	708	234	423	114	245	3,396	665	1,029
Atlantic butterfish	3	14	3	223	9	5	1	28	1,170	4	35	54
Atlantic herring	0	0	485	350	582	20	5	11	159	198	118	93
Atlantic mackerel	0	0	1	0	0	0	0	1	0	0	4	4
Atlantic menhaden	0	7	97	0	1	957	142	19	1,022	7	361	7,226
Atlantic silverside	5,348	1,621	1,119	210	834	1,335	31	282	1,410	20,507	877	2,717
Atlantic cod	58	119	94	69	38	66	29	30	199	3,091	467	454
Cunner	32	342	1,121	233	309	255	324	341	291	554	625	893
Grubby	2,678	2,415	1,457	430	3,269	3,953	1,174	549	1,089	2,523	676	531
Haddock	0	1	397	0	1	3	2	1	0	0	0	7
Hakes	2,822	2,188	156	122	4	68	113	523	1,813	166	35	11
Monkfish/Goosefish	3	13	0	0	7	17	15	59	18	10	0	8
Northern pipefish	188	579	1,200	243	268	748	370	714	936	2,716	1,413	1,724
Ocean pout	0	6	1	0	7	3	2	21	1	13	3	3
Pollock	1,681	899	1,835	379	536	11,392	534	405	719	499	80	218
Rainbow smelt	545	213	4,489	365	535	100	8	65	323	3,531	2,085	3,314
Red hake	1	16	1,478	371	903	1,120	112	155	52	271	892	821
Rock gunnel	494	1,298	1,122	459	2,929	2,308	1,514	2,251	2,066	6,274	4,137	1,752
Sea raven	78	125	1,015	223	137	132	206	271	166	217	129	221
Scup	0	14	9	0	3	1	0	3	11	11	0	21
Shorthorn sculpin	14	156	282	123	190	296	923	621	642	7,450	876	2,214
Snailfishes	180	165	1,013	351	856	2,356	690	334	616	451	185	442
Summer flounder	3	0	0	0	0	0	0	0	0	0	0	0
Threespine stickleback	67	155	320	174	773	506	10	280	34	1,549	130	307
Whiting/Silver hake	0	49	58	108	13	100	41	5	1,177	22	212	306
Windowpane	980	943	1,164	1,688	772	692	251	161	2,242	4,749	936	2,034
Winter flounder	1,435	1,171	3,231	468	1,143	3,642	102	777	897	10,491	783	1,875
Yellowtail flounder	0	1,149	4	23	11	97	0	8	5	0	0	0
Total (All taxa)	19,212	15,940	26,825	10,648	15,198	31,241	7,281	8,577	18,413	71,946	16,696	29,368

Source: (NAI, 2010)

Table D-1-6. Number of impinged fish for the most common taxa impinged and for EFH species (cont.)

Species	2006	2007	2008	2009	Total	Percent of Total	Annual Average
Alewife	255	244	41	0	5,476	1.6%	342
American plaice	0	0	7	0	12	0.0%	0.75
American sand lance	213	2,073	758	796	14,198	4.3%	887
Atlantic Butterfish	44	199	7	29	1,828	0.5%	114
Atlantic herring	189	260	27	490	2,987	0.9%	187
Atlantic mackerel	0	0	0	0	10	0.003%	1
Atlantic menhaden	94	160	67	39	10,199	3.1%	637
Atlantic silverside	788	639	247	525	38,490	11.5%	2,406
Atlantic cod	113	178	73	147	5,225	1.6%	327
Cunner	687	922	731	837	8,497	2.5%	531
Grubby	235	869	3,919	521	26,288	7.9%	1,643
Haddock	3	25	0	15	455	0.1%	28
Hakes	6	1,184	3,216	1,427	13,854	4.1%	866
Monkfish/Goosefish	0	11	0	0	161	0.0%	10
Northern pipefish	1,288	2,374	1,082	698	16,541	5.0%	1,034
Ocean pout	6	3	0	0	69	0.0%	4
Pollock	73	340	123	657	20,370	6.1%	1,273
Rainbow smelt	878	572	421	43	17,487	5.2%	1,093
Red hake	546	1,389	14	0	8,141	2.4%	509
Rock gunnel	3,782	3,174	937	701	35,198	10.5%	2,200
Sea raven	138	164	138	79	3,439	1.0%	215
Scup	4	8	13	15	113	0.0%	7
Shorthorn sculpin	1,258	465	1,515	266	17,291	5.2%	1,081
Snailfishes	330	76	233	85	8,363	2.5%	523
Summer flounder	4	0	0	0	7	0.0%	0
Threespine stickleback	139	193	80	118	4,835	1.4%	302
Whiting/Silver hake	31	21	204	325	2,672	0.8%	167
Windowpane	572	1,502	1,640	427	20,753	6.2%	1,297
Winter flounder	767	3,949	1,920	655	33,306	10.0%	2,082
Yellowtail flounder	10	11	3	0	1,321	0.4%	83
Total (All taxa)	12,955	22,472	17,935	9,304	334,011	100.0%	20,876

Source: (NAI, 2010)

Table D-1-7. Number of bivalve larvae entrained (x 10^9)

Taxon	1990[a]	1991[b]	1992[c]	1993[d]	1995	1996	1997	1998	1999	2000	2001	2002	2003
Prickly jingle	1,691	250.8	6.9	3,923	8,906	23,522	2,883	3,827	36,495	7542	4,129	8,204	3,218.1
Bivalvia mussles	181.7	38.1	14.5	334.5	797.1	671.4	71.1	64.5	651.3	228.6	483	194.2	73.7
Rock borer	876.6	421.3	189.8	2,406	2,598	4,670	923.7	609.7	4,417	1,921	1,575	567.3	1,203.9
Northern horsemussel	909.7	160.2	0.3	1,284	546.4	5,145	614.7	241.7	2,376	2,521	251.6	776.4	240.8
Soft shell clam	8.1	0.6	0.2	22.5	4.3	33.2	53.7	11.4	45.7	23.9	26.4	60.2	5.1
Truncate softshell clam	249.2	6.5	1.1	2.1	27.6	123	0.8	8.3	66	34.9	26.3	1.9	13.8
Blue mussels	3,991	1,688	121.9	10,051	13,231	17,932	1745	1,493	22,374	10,255	9621	3,318	2,199
Atlantic Sea scallop	0.7	0.7	0.1	16.9	6.2	31	0.8	0.8	11.5	9.9	8.5	0.8	0
Solenidae clams	61.1	0	75.7	102.5	1092	241.9	49.5	20.9	773.2	150.4	922.9	150.8	85.5
Atlantic Surf clam	69	4.4	0	48.5	112.5	171.1	22.5	14.8	175.5	33.6	50.8	44.2	3.1
Shipworm	0.01	15.9	0	0	4.8	7.4	1.7	0.8	29.9	1.5	0.3	2.3	0.1
Total (All taxon)	8,039	2,586	410	18,190	27,327	52,547	6,366	6,293	67,415	22,721	17,095	13,320	7,043

[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] In 1994, NextEra did not conduct bivalve larvae entrainment studies. Unless otherwise denoted for all other years,, NextEra sampled the third week in April through the fourth week in October.

[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 D-1-7. Number of bivalve larvae entrained (x 10^9) (cont.)

Taxon	2004	2005[e]	2006[f]	2007	2008	2009	Average
Prickly jingle	2,595	1,217	3,966	3,950	18,452	27,733	8,553.2
Bivalvia mussles	89.6	40.4	73.9	46.2	411.8	74.3	238.94
Rock borer	1,024	352.9	604.6	650.7	3,137	2,548	1,615.5
Northern horsemussel	843.2	292.9	715.1	172.5	2,270	1421	1,093.8
Soft shell clam	15.1	9.2	11.1	4.7	45.8	31.8	21.737
Truncate softshell clam	5.2	2.3	0.6	3	6.4	4.8	30.726
Blue mussels	1,526	921.5	1,351	834.4	2,700	3,974	5,754
Atlantic Sea scallop	0.7	0.1	0	0.1	0.3	1.2	4.7526
Solenidae clams	113.4	57.9	65.2	156.1	85.1	162.4	229.83
Atlantic Surf clam	10	14.5	20	2.8	100.7	31.5	48.921
Shipworm	0.6	0.3	0.8	0	1.8	2.3	3.7111
Total (All taxon)	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] In 1994, NextEra did not conduct bivalve larvae entrainment studies. In all other years, NextEra sampled the third week in April through the fourth week in October.

[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)

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 in a 32-ac (12.9-ha) area surrounding 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 exceed 5 degrees Fahrenheit (2.8 degrees Celsius) since operations began, which is the limit identified in the NPDES permit (EPA, 2002a; NAI, 2001; NAI, 2010). For the majority of months between August 1990 and December 2009, the monthly mean increase in the surface water temperature was less than 3.6 degrees Fahrenheit (2.0 degrees Celsius).

Based on Seabrook's water quality monitoring and Padmanabhan and Hecker's (1991) study, the habitat most likely affected by the thermal plume would be the upper water column (10–16 ft (3 to 5 m) of the ocean surface) in the immediate vicinity of the discharge (less than 328 ft (100 m)). Fish may avoid this area, but the thermal plume would not likely block fish movement because fish could swim around the thermal plume. Pelagic fish species that may avoid this area are discussed, as appropriate, in the species analysis below (Sections D-1.3.3.1–D-1.3.3.19). Benthic species, or species that primarily reside at the seafloor, may also avoid the immediate area surrounding the discharge structures due to higher temperature, velocities, and turbulence. This area should be considerably smaller than the area of increased temperature at the surface.

To examine the potential thermal impacts from plant operations on sessile species (and as an indicator of thermal impacts to other biological groups), NAI (2010) compared the abundance of cold water and warm water macroalgae species prior to and during operations at sites near the discharge structure (the nearfield site) and at sites approximately 3–4 nautical mi (5–8 km) from the intake and discharge structures (the farfield site). Benthic perennial algae are sensitive to changes in water temperature because they are immobile and live more than 2 years. Prior to operations, NAI (2010) collected six uncommon species 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) 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.

The NRC staff concluded in the SEIS that thermal impacts from Seabrook operations were SMALL, and operations have not noticeably altered aquatic communities near Seabrook. This conclusion was based on the findings that the thermal plume would not block fish passage and is within the limits of Seabrook's NPDES permit and that there were no clear patterns of emergent warm-water species or changes in the abundance of cold-water species.

Loss of Forage Species. Prey for the 23 EFH species includes phytoplankton, zooplankton (including fish and invertebrate eggs and larvae), juvenile and adult fish, and juvenile and adult invertebrates. Seabrook operations can adversely affect plankton prey if they are entrained in the cooling system or the thermal discharge significantly decreases the quality of the pelagic water habitat. Juvenile and adult fish prey could be affected by Seabrook operations if they are impinged in the cooling water system, if they avoid the area near the discharge because of the heated thermal effluent, or if bottom habitat (e.g., mussel beds or kelp forests) are adversely affected by Seabrook operations. Invertebrate prey could be affected by Seabrook operations if any of the following occurs:

- They are entrained in the Seabrook cooling system.
- They are mobile and impinged in the Seabrook cooling system.
- They are mobile and avoid the area near the discharge structures due to the discharge of heated thermal effluent.
- They are sessile, and growth is limited near the discharge structures due to the heated thermal effluent.

Loss of Habitat-Forming Species. In the Gulf of Maine, and the area in the vicinity of Seabrook's intake and discharge structures, rocky subtidal habitats are among the most productive habitats (Mann, 1973; Ojeda and Dearborn, 1989). Algae, mussels, oysters, and other sessile invertebrates 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 (Thompson, 2010; Witman and Dayton, 2001). Spawning fish, such as herring, shield eggs from currents and predators within rock crevices or sessile organisms attached to the bedrock (Thompson, 2010). In soft sediment habitats, shellfish beds form the main biogenic habitats.

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—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). Seabrook's heated effluent may affect growth of algae and sessile invertebrates. These groups may be particularly sensitive to changes in water quality because they are sessile and cannot move to avoid the area, sufficient light must reach the algae for the plant to photosynthesize, and particulars in the water can clog the feeding structures of sessile invertebrates that filter seawater for food.

D-1.3.2.2 Combined Impacts (Monitoring Data)

This section presents NextEra monitoring data of selected groups prior to and during operations at sampling sites near the intake and discharge structures (nearfield sampling sites) and at

sampling sites 3–4 mi (5–8 km) away (farfield sampling sites) (Figure D-1-7). Monitoring data may indicate if the combined impacts (or cumulative impacts) from Seabrook operation have resulted in the decline of a species or biological group due to a decline in habitat quantity or quality.

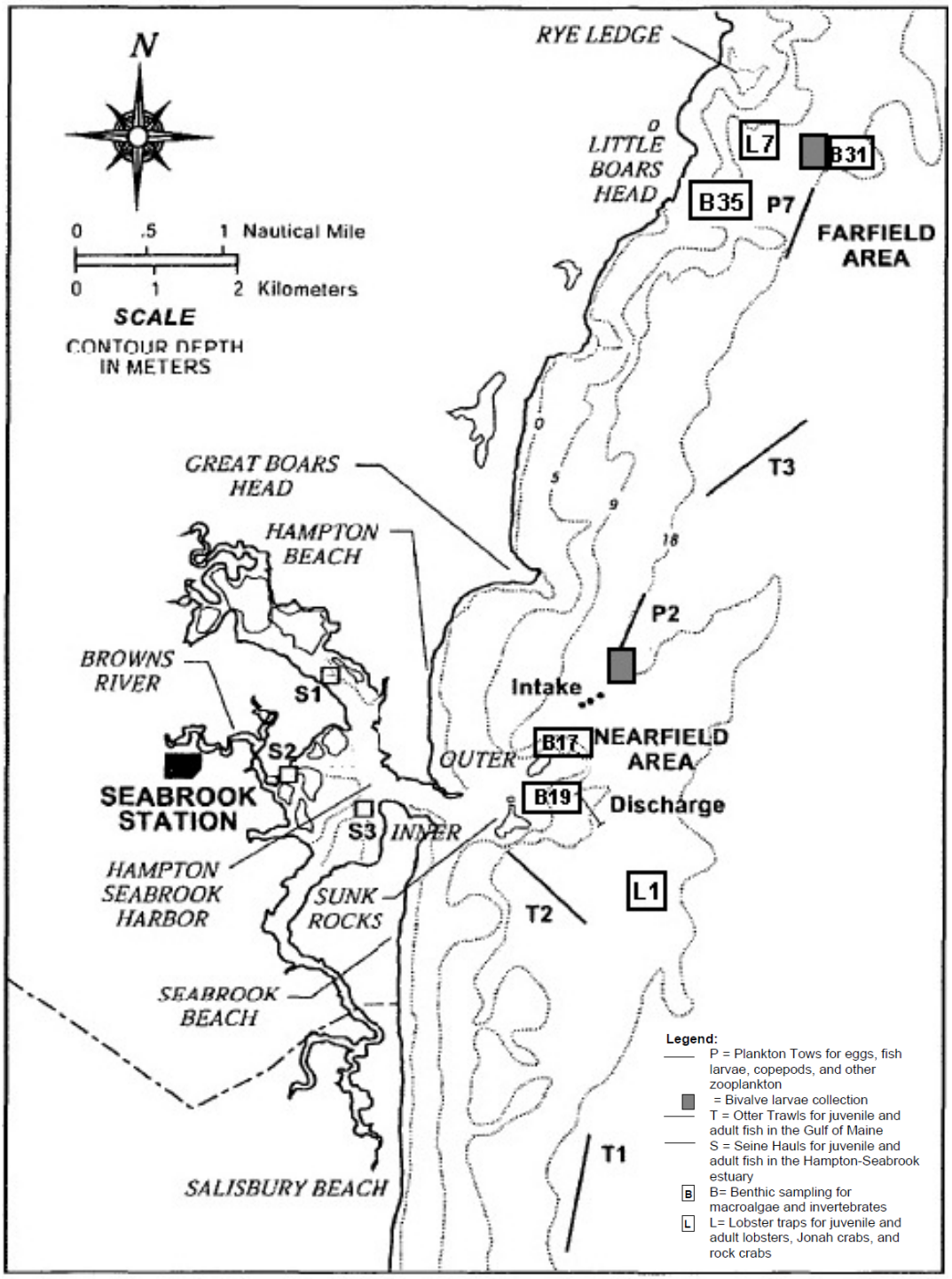


Figure D-1-7. Sampling Stations for Seabrook Station aquatic monitoring

NAI (2010) used a before-after control-impact (BACI) design to test for potential impacts from operation of Seabrook. This monitoring design was used to test for the statistical significance of differences in community structure, species abundance, or species diversity between the pre-operational and operational period at the nearfield and farfield sites. Statistically significant differences could result from entrainment, impingement, thermal impacts, loss of forage species, loss of habitat-forming species, or any combination of these effects of Seabrook operations.

Working with NAI and Public Service of New Hampshire staff, NextEra selected farfield sampling sites that would likely be outside the influence of Seabrook operations (NextEra, 2010a). 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 because the primary currents run north to south. NextEra selected specific farfield sampling sites based on similarities with the nearfield sampling sites regarding depth, substrate type, algal composition, wave energy, and other relevant factors (NextEra, 2010a).

Sections 2.2.6.3 and 4.5.5 of the SEIS describe the sampling methods, statistical methods, and monitoring results. Below is a brief summary of the monitoring results for phytoplankton, zooplankton, fish, invertebrates, and macroalgae.

Phytoplankton. NAI (1998) found no significant differences in phytoplankton abundance or chlorophyll *a* concentrations between the nearfield and farfield sites or between before and during plant operation. NAI (1998) observed minimal changes in species composition prior to and during operations. These results suggest that Seabrook operations have not adversely affected phytoplankton abundance near Seabrook.

Zooplankton. 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. 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).

When examining total bivalve larvae density, NAI (2010) did not find a significant difference between sampling sites prior to and during operations. For fish eggs and larvae, NAI (2010) observed no significant difference between sampling sites, but the study reported a significant difference prior to and during operations in the density of fish eggs and larval species (Table D-1-8).

Table D-1-8. 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

Taxon	Group 1[a]			Group 2 [a]		
	Lower 95% CL	Mean	Upper 95% CL	Lower 95% CL	Mean	Upper 95% CL
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 multi-dimensional scaling (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)

Because changes in community structure occurred at nearfield and farfield sampling sites, these results suggest that Seabrook operations have not adversely affected zooplankton near Seabrook.

Juvenile and Adult Fish. NextEra monitored the abundance of juvenile and adult fish prior to and during operations at nearfield and farfield sites using benthic trawls (Table D-1-9), gill nets (Table D-1-10), and seine pulls in the Hampton-Seabrook Estuary (Table D-1-10). For the majority of fish species, the abundance was higher prior to operations than during operations at both the nearfield and farfield sites. The abundance of a few fish species increased during operations at both nearfield and farfield sites.

Table D-1-9. Geometric mean catch per unit effort (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% CL	Mean	Upper 95% CL	Lower 95% CL	Mean	Upper 95% CL
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

Species	Sample site	Preoperational monitoring			Operational monitoring		
		Lower 95% CL	Mean	Upper 95% CL	Lower 95% CL	Mean	Upper 95% CL
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
	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)

Table D-1-10. Geometric mean CPUE (No. per 24-hr surface and bottom gill 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
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)

NAI (2010) reported different trends at farfield and nearfield sites for winter flounder, silver hake, and rainbow smelt during trawling surveys (Table D-1-9). 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 report if these trends were statistically significant. Rainbow smelt abundance decreased at all sampling sites, but the decrease was significantly greater at the nearfield site compared to the farfield sites (NAI, 2010).

NAI (2010) reported different trends at farfield and nearfield sites for American sand lance abundances during seine pulls in the Hampton-Seabrook Estuary (Table D-1-11). 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 report if these trends were statistically significant.

Table D-1-11. 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% CL	Mean	Upper 95% CL	Lower 95% CL	Mean	Upper 95% CL
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
	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)

NextEra monitoring results suggest that Seabrook operations have not likely affected most fish species 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 Seabrook, they have been adversely affected through operation of Seabrook's cooling water system.

Invertebrates. NAI (2010) reported similar trends of total invertebrate density and species diversity at the nearfield and farfield sampling sites before and during operations. Likewise, NAI (2010) reported similar trends at the nearfield and farfield sampling sites prior to and during operations for mytilid (mussel) spat, rock crabs, Jonah crabs, northern horse mussels, sea stars, green sea urchin, lobsters, and soft shell clams.

Macroaglae. NAI (2010) observed significant changes in kelp density prior to and during operations (Table D-1-12). 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 D-1-12. 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% CL	Mean	Upper 95% CL	Lower 95% CL	Mean	Upper 95% CL
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.

The decrease in *L. digitata* density was significantly greater at the nearfield sites, and 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 adversely affected through operation of Seabrook's cooling water system.

D-1.3.3 Adverse Effects on Essential Fish Habitat by Species

*D-1.3.3.1 American Plaice (*Hippoglossoides platessoides*) (Juvenile and Adult)*

Designated EFH in the Vicinity of Seabrook. The NMFS has designated American plaice juvenile and adult EFH in the vicinity of Seabrook (NMFS, 2011b). NAI (2010) observed American plaice juveniles and adults or both in 1−10 percent of trawling samples from the 1970s–2009 (Table D-1-2).

Species Description. American plaice are arctic-boreal pleuronectid flatfish (Johnson, 1995). American plaice inhabit both sides of the Atlantic Ocean. In the western Atlantic, American plaice are common from Newfoundland, Canada to Montauk Point, NY (Bigelow and Schroeder, 1953; Johnson, 2005). EFH for American plaice juveniles and adults includes bottom habitats with fine-grained, sandy, or gravel substrates in the Gulf of Maine (NMFS, 2011c). American plaice are relatively sedentary, and tagging studies have indicated that few migrate long distances. Fisheries and Oceans Canada (DFO) (1989 in Johnson 2005) recaptured the majority of tagged fish within 30 mi (48 km) of the tagging site after 7–8 years.

American plaice consume a wide-variety of prey and are opportunistic feeders, in that they will consume what is most available (Johnson, 2005). Prior to settling on the ocean floor, juveniles feed on small crustaceans—such as cumaceans—and polychaetes (Bigelow and Schroeder, 1953). Adults are primarily benthic but, at night, may migrate up into pelagic waters to prey on non-benthic species (DFO, 1989 in Johnson, 2005). During monitoring surveys, NAI (2010) did not observe American plaice in pelagic waters. Prey for adults include mostly echinoderms (e.g., sand dollars, sea urchins, and brittle stars) and crustaceans, cnidarians, and polychaetes (Johnson, 2005). Redfish eat American plaice larvae, and goosefish, halibut, cod, and other bottom feeders prey on the adults (Johnson, 2005).

Status of the Fishery. NMFS, the New England Fishery Management Council (NEFMC), and the Mid-Atlantic Fishery Management Council (MAFMC) currently manage the northeast multispecies fisheries management plan (FMP). The U.S. fishery for American plaice started to develop around 1975 in the Gulf of Maine, when other commercially desirable flatfish (e.g., yellowtail flounder, winter flounder, and summer flounder) began to decrease in abundance (Sullivan, 1981 in Johnson, 2005). American plaice populations in the western North Atlantic have declined dramatically since the early 1980s (Johnson, 2005). Contributing factors to the decline are likely overfishing, changes in water temperature, and water pollution (Johnson, 2005). American plaice is also bycatch for other fisheries. In New England, the mortality of American plaice bycatch was positively correlated with ondeck sorting time (Johnson, 2005). In 2009, NEFMC considered American plaice overfished (NMFS, 2010b).

Entrainment and Impingement at Seabrook. Although NMFS has not designated EFH for American plaice eggs and larvae, entrainment and impingement can adversely affect recruitment of juveniles and adults. Entrainment of American plaice eggs varied from 0.4 million

in 1994 to 52.3 million in 1992 (NAI, 2010). Annual average entrainment of American plaice eggs was 25.9 million per year (Table D-1-4). American plaice eggs comprised approximately 3 percent of the total fish eggs entrained at Seabrook.

Entrainment of American plaice larvae varied from 0 in 1994 to 11.5 million in 2009 (NAI, 2010). Annual average entrainment of American plaice larvae was 4.3 million per year (Table D-1-5). American plaice larvae comprised approximately 1.5 percent of the total fish larvae entrained at Seabrook.

Impingement of American plaice varied from zero in several years to seven in 2008 (NAI, 2010). Annual average impingement was less than one fish per year (Table D-1-6). American plaice comprised less than 1 percent of all impinged fish at Seabrook.

Because entrainment and impingement were relatively low for American plaice compared to other species at Seabrook, the NRC staff concludes that entrainment and impingement are not likely to adversely affect EFH for juvenile and adult American plaice during the remainder of the facility's operating license or during the proposed license renewal term.

Thermal Effects. The NRC staff does not expect Seabrook's thermal discharges to reduce available habitat to juvenile or adult American plaice. American plaice are primarily benthic (Johnson, 2005). A relatively small area near the discharge structure in deep water experiences increased temperatures (NAI, 2001; Padmanabhan and Hecker, 1991). Because the buoyant thermal plume at the discharge points quickly rises toward the surface, the NRC staff concludes that the heated effluent from Seabrook is not likely to adversely affect EFH for juvenile and adult American plaice during the remainder of the facility's operating license or during the proposed license renewal term.

Loss of Forage Species. Juvenile and adult American plaice are opportunistic feeds that primarily consume invertebrates, including green sea urchins (*Strongylocentrotus droebachiensis*) (Johnson, 2005). NextEra monitoring data show relatively similar trends of benthic invertebrate abundance, density, and species diversity—including the abundance of green sea urchins—prior to and during operations at sampling sites near the intake and discharge structures and 3–4 mi (5–8 km) away (NAI, 2010). Therefore, the NRC staff concludes that the potential loss of forage species at Seabrook is not likely to adversely affect EFH for juvenile and adult American plaice during the remainder of the facility's operating license or during the proposed license renewal term.

Loss of Habitat-Forming Species. American plaice inhabit soft bottom areas, including soft bottom areas that border bedrock (Johnson, 2005). Keats (1991) hypothesized that American plaice inhabited areas boarded by bedrock because bedrock is the preferred habitat for green sea urchins, an important prey species for American plaice. Because preferred habitat for American plaice are soft bottom substrates, such as fine sand or gravel, the NRC concludes that the potential loss of habitat-forming species is not likely to adversely affect EFH for juvenile and adult American plaice during the remainder of the facility's operating license or during the proposed license renewal term.

Combined Impacts (Monitoring Data). Seabrook monitoring data do not provide data specific to the abundance of juvenile and adult American plaice prior to and during operations (NAI, 2010).

Conclusion. Based on the above analysis, the NRC staff concludes that Seabrook operations are not likely to adversely affect EFH for American plaice juveniles or adults for the following reasons:

- Impingement and entrainment are relatively low.
- The thermal plume rises quickly to the surface.
- Invertebrate forage species are not likely adversely affected by Seabrook operations.
- Preferred habitat does not include shellfish or kelp beds.

*D-1.3.3.2 Atlantic butterfish (*Peprilus triacanthus*) (All Life Stages)*

Designated EFH in the Vicinity of Seabrook. The NMFS has designated eggs, larvae, juvenile, and adult Atlantic butterfish EFH in the vicinity of Seabrook (NMFS, 2011b). NAI (2010) observed Atlantic butterfish eggs and larvae in 1−10 percent of ichthyoplankton tows, juveniles and adults in 1–10 percent of gill net samples, juveniles and adults in less than 1 percent of trawling samples, and juveniles and adults in less than 1 percent of seine pull samples (Table D-1-2).

Species Description. Adult Atlantic butterfish are pelagic schooling fish that are ecologically important as a forage fish for many larger fishes, marine mammals, and birds. Atlantic butterfish inhabit the Atlantic coast from Newfoundland to Florida, but it is most abundant from the Gulf of Maine to Cape Hatteras (Cross et al., 1999; Overholtz, 2006). Adult butterfish migrate seasonally. In the summer, they migrate inshore into bays, estuaries, and coastal waters of southern New England and the Gulf of Maine. In winter, they migrate to the edge of the continental shelf in the Mid-Atlantic Bight (Cross et al., 1999). Adults generally stay within 200 mi (322 km) of the shore.

Butterfish reach sexual maturity between ages 1–2 years and rarely live more than 3 years (Overholtz, 2006). Adults are 5.9–9.1 in. (15–23 cm) long on average and can reach a weight of up to 1.1 pounds (lb) (0.5 kilograms (kg)). Females are broadcast spawners and spawn in large bays and estuaries from June–August. Females generally release eggs at night in the upper part of the water column in water of 59 degrees Fahrenheit (15 degrees Celsius) or more. Eggs are pelagic and buoyant (Cross et al., 1999). Butterfish eggs and larvae are found in water with depths ranging from the shore to 6,000 ft (1,828 m) and at temperatures between 53.6–73.4 degrees Fahrenheit (12–23 degrees Celsius) for eggs and between 39.2–82.4 degrees Fahrenheit (4–28 degrees Celsius) for larvae (Cross et al., 1999). Juvenile and adult butterfish are found in waters from 33–1,200 ft (10–366 m) deep and at temperatures ranging from 37–82 degrees Fahrenheit (3–28 degrees Celsius) (Cross et al., 1999). In summer, juvenile and adult butterfish can be found over the entire continental shelf, including sheltered bays and estuaries, to a depth of 656 ft (200 m) over substrates of sand, rock, or mud (Cross et al., 1999).

Butterfish prey mainly on urochordates and mollusks, with minor food sources including squid; crustaceans, such as amphipods and shrimp; annelid worms; and small fishes (Bigelow and Schroeder, 2002; Cross et al., 1999). In turn, many species—including haddock, silver hake, goosefish, bluefish, swordfish (*Xiphias gladuis*), sharks, and longfin inshore squid—eat adult butterfish (Cross et al., 1999).

Status of the Fishery. The Atlantic butterfish has been commercially fished since the late 1800s (Cross et al., 1999). By the mid-1900s, fishing fleets from Japan, Poland, the USSR, and other countries began to target the butterfish and caused a drastic increase in landings (Cross et al., 1999; Overholtz, 2006). Landings peaked in 1973 at 75.6 million lb (34,300 metric tons (MT)) (Overholtz, 2006). U.S. commercial landings averaged 7.1 million lb (3,200 MT) from 1965−2002 but have steadily decreased since 1985 (Overholtz, 2006). In 2009, NOAA reported a cumulative landing of 0.95 million lb (430 MT), and, as of November 27, 2010, the reported landings for 2010 were 1.2 million lb (550 MT) (NOAA, 2009; NOAA, 2010). Butterfish are also

caught as bycatch in other fisheries. Bycatch landings averaged 9.3 million lb (4,200 MT) per year from 1996–2002 (Overholtz, 2006).

The MAFMC manages the Atlantic butterfish under an FMP that includes the Atlantic mackerel, squid, and butterfish. The Atlantic butterfish fishery is capped by an annual coast-wide quota. A directed fishery for butterfish is open from January–August; however, most butterfish are harvested as bycatch in squid fisheries (NOAA, 2010a). In 2009, NEFMC reported butterfish to be overfished (NMFS, 2010b).

Entrainment and Impingement. Entrainment of Atlantic butterfish eggs varied from 0 in several years to 400,000 in 2005 (NAI, 2010). Annual average entrainment of Atlantic butterfish eggs was 25,500 per year from 1990–2009 (Table D-1-4). Entrainment of Atlantic butterfish larvae varied from 0 in several years to 1.19 million in 2007 (NAI, 2010). Annual average entrainment of Atlantic butterfish larvae was 90,000 per year from 1990–2009 (Table D-1-5). Atlantic butterfish eggs and larvae comprised less than 0.05 percent of the total fish eggs and larvae entrained at Seabrook from 1990–2009.

Impingement of Atlantic butterfish varied from 1 in 2000 to 1,170 in 2002 (NAI, 2010). Annual average impingement was 114 fish per year from 1994–2009 (Table D-1-6). Atlantic butterfish comprised less than 1 percent of all impinged fish at Seabrook from 1994–2009.

Because entrainment and impingement were relatively low for Atlantic butterfish compared to other species at Seabrook, the NRC staff concludes that entrainment and impingement are not likely to adversely affect EFH for all life stages of Atlantic butterfish during the remainder of the facility's operating license or during the proposed license renewal term.

Thermal Impacts. The NRC staff does not expect Seabrook's thermal discharges to reduce available habitat to butterfish eggs, larvae, juveniles, or adults. As described above, the habitat most likely affected by the thermal plume would be the upper water column (within 10–16 ft (3–5 m)) of the ocean surface) in the immediate vicinity of the discharge. At the surface, Padmanabhan and Hecker (1991) observed a temperature rise of 3 degrees Fahrenheit (1.7 degrees Celsius) or more in a 32-ac (12.9-ha) area surrounding the discharge. Seabrook's NPDES permit limits the rise in monthly mean temperature to 5 degrees Fahrenheit (2.8 degrees Celsius) in the "near field jet mixing region," or within waters less than 3.3 ft (1 m) from the surface. Butterfish are most common near Seabrook from August–November, when the surface temperature near Seabrook ranges from 46.4–65.8 degrees Fahrenheit (8–18.8 degrees Celsius) (NAI, 2001). Butterfish eggs and larvae are found in water at temperatures between 53.6–73.4 degrees Fahrenheit (12–23 degrees Celsius) for eggs and between 39.2–82.4 degrees Fahrenheit (4–28 degrees Celsius) for larvae (Cross et al., 1999). Juvenile and adult butterfish are found in waters at temperatures ranging from 37–82 degrees Fahrenheit (3–28 degrees Celsius) (Cross et al., 1999). With a temperature rise of 3–5 degrees Fahrenheit (1.7−2.8 degrees Celsius) at the surface near Seabrook, the thermal plume near the surface from August–November would be within the range of temperature that butterfish eggs, larvae, juveniles, and adults typically inhabit. Therefore, the NRC staff concludes that the increased temperatures of Seabrook's effluent are not likely to adversely affect EFH for all stages of Atlantic butterfish during the remainder of the facility's operating license or during the proposed license renewal term.

Loss of Forage Species. Atlantic butterfish primarily prey on invertebrates (Bigelow and Schroeder, 2002; Cross et al., 1999). NextEra monitoring data show relatively similar trends of benthic invertebrate density and species diversity prior to and during operations at sampling sites near the intake and discharge structures and 3–4 mi (5–8 km) away (NAI, 2010).

Therefore, the NRC staff concludes that the potential loss of forage species at Seabrook is not likely to adversely affect EFH for Atlantic butterfish during the remainder of the facility's operating license or during the proposed license renewal term.

Loss of Habitat-forming Species. All life stages of Atlantic butterfish are primarily pelagic (Cross et al., 1999), suggesting that they rarely use benthic habitats such as shellfish and kelp beds. Therefore, the NRC staff concludes that the potential loss of habitat-forming species is not likely to adversely affect EFH for all life stages of Atlantic butterfish during the remainder of the facility's operating license or during the proposed license renewal term.

Combined Impacts (Monitoring Data). Seabrook monitoring data do not provide data specific to the abundance of Atlantic butterfish eggs, larvae, juveniles, or adults prior to and during operations (NAI, 2010).

Conclusion

Based on the above analysis, the NRC staff concludes that Seabrook operations are not likely to adversely affect EFH for all life stages of Atlantic butterfish for the following reasons:

- Impingement and entrainment are relatively low for Atlantic butterfish.
- The increased temperature within the thermal plume at the surface would be with the range of temperatures that Atlantic butterfish inhabit.
- Invertebrate forage species are not likely to be adversely affected by Seabrook operations.
- Their preferred habitat does not include shellfish or kelp beds.

*D-1.3.3.3 Atlantic cod (*Gadus morhua*) (All Life Stages)*

Designated EFH in the Vicinity of Seabrook. The NMFS has designated eggs, larvae, juvenile, and adult Atlantic cod EFH in the vicinity of Seabrook (NMFS, 2011b). NAI (2010) observed Atlantic cod eggs and larvae in greater than 10 percent of ichthyoplankton tows, juveniles and adults in greater than 10 percent of trawling samples, juveniles and adults in 1–10 percent of gill net samples, and juveniles and adults in less than 1 percent of seine pull samples (Table D-1-2).

Species Description. Atlantic cod are demersal and highly-targeted commercially. Atlantic cod inhabit the northwestern Atlantic Ocean, from Greenland to Cape Hatteras, NC. In the U.S., the highest densities of Atlantic cod are on Georges Bank and the western Gulf of Maine, in waters between 33–492 ft (10–150 m) with rough bottoms and at temperatures between 32−50 degrees Fahrenheit (0–10 degrees Celsius) (Lough, 2004). Offshore New England, juvenile and adult Atlantic cod move seasonally in response to temperature changes, whereby Atlantic cod typically move into coastal waters during the fall and deeper waters during spring. At the extremes of their range, including Labrador and south of the Chesapeake, Atlantic cod migrate annually (Lough, 2004).

In Gulf of Maine, Atlantic cod reach sexual maturity at 2.1–2.9 years at lengths between 13–17 in. (32–44 cm) (Lough, 2004). Females spawn during winter and early spring in bottom waters generally between 41–44.6 degrees Fahrenheit (5–7 degrees Celsius). A large female may produce as many as 3–9 million eggs (Lough, 2004). Eggs and larvae for the first 3 months are pelagic (Lough, 2004). Once larvae reach 1.6–2.4 in. (4–6 cm), they begin to descend towards

the seafloor. As Atlantic cod develop into juveniles and adults, they are able to withstand deeper, colder, and more saline water, and they become more widely distributed (Lough, 2004). Complex substrate and vegetation provides refuge from predators for juvenile cod (Lough, 2004).

Forage species tend to vary by life stage and location (Lough, 2004). Juveniles and younger adults tend to consume pelagic and benthic invertebrates, while adult cod feed on both crustaceans and other fish, including cancer crabs, brittle stars, American sand lance, Atlantic herring, and American plaice (Johnson, 2005; Lough, 2004; Witman and Sebens, 1992). Atlantic herring and Atlantic mackerel can be important predators of Atlantic cod larvae (Lough, 2004). Silver hake, sclupin, larger cod, and other fish consume juvenile Atlantic cod (Edwards and Bowman, 1979 in Lough, 2004). Winter skate, silver hake, sea raven, longfin inshore squid, Atlantic halibut, fourspot flounder, and large adult cod consume smaller adult cod (Lough, 2004).

Status of the Fishery. Atlantic cod has been a highly targeted species since the 1700s. As a likely result of harvesting older and larger fish or due to intense exploitation in stock biomass, the size and age at maturity for Atlantic cod has declined in recent decades (Lough, 2004). Currently, Atlantic cod is managed as two stocks within U.S. waters: (1) the Gulf of Maine and (2) Georges Bank and southward (Mayo, 1995). In 2009, NEFMC reported Atlantic cod to be subject to overfishing (NMFS, 2010b).

Entrainment and Impingement. Entrainment of Atlantic cod eggs varied from 0.2 million in 1994 to 77.8 million in 2002 (NextEra, 2010a). Annual average entrainment of Atlantic cod eggs was 32.6 million per year from 1990–2009 (Table D-1-4). Atlantic cod eggs comprised 3.6 percent of the total fish eggs entrained at Seabrook from 1990–2009. Entrainment of Atlantic cod larvae varied from 0 in 1994 to 34.6 million in 2002 (NAI, 2010). Annual average entrainment of Atlantic cod larvae was 2.8 million per year from 1990–2009 (Table D-1-5). Atlantic cod larvae comprised approximately 1 percent of the total fish larvae entrained at Seabrook from 1990−2009.

Impingement of Atlantic cod varied from 29 in 2000 to 3,091 in 2003 (NAI, 2010). Annual average impingement was 327 fish per year from 1994–2009 (Table D-1-6). Atlantic cod comprised less than 2 percent of all impinged fish at Seabrook from 1994–2009.

Because entrainment and impingement were relatively low for Atlantic cod compared to other species at Seabrook, the NRC staff concludes that entrainment and impingement are not likely to adversely affect EFH for Atlantic cod during the remainder of the facility's operating license or during the proposed license renewal term.

Thermal Effects. The NRC staff does not expect Seabrook's thermal discharges to reduce available habitat to Atlantic cod eggs, juveniles, or adults. Seabrook's thermal discharge may reduce available habitat to Atlantic cod larvae.

Atlantic cod eggs and larvae are pelagic (Lough, 2004). NEFSC MARMAP ichthyoplankton surveys collected most eggs at temperatures ranging from 39–57 degrees Fahrenheit (4–14 degrees Celsius), but collected eggs as high as 72 degrees Fahrenheit (22 degrees Celsius) (Lough, 2004). NEFSC MARMAP ichthyoplankton surveys collected most larvae from 39–52 degrees Fahrenheit (4–11 degrees Celsius), but collected larvae as high as 66 degrees Fahrenheit (19 degrees Celsius) (Lough, 2004). Surface waters near the thermal plume typically range as high as 65.8 degrees Fahrenheit (18.8 degrees Celsius) (NAI, 2001). With a temperature rise of 3–5 degrees Fahrenheit (1.7–2.8 degrees Celsius), the thermal plume near

the surface could exceed the typical range of temperatures that Atlantic cod larvae inhabit. The habitat affected at the surface would likely be 32 ac (12.9 ha) or less (Padmanabhan and Hecker, 1991). Juvenile and adult Atlantic cod are primarily benthic (Lough, 2004), meaning that they spend most of the time residing near the seafloor. A relatively small area near the discharge structure in deep water experiences increased temperatures (NAI, 2001; Padmanabhan and Hecker, 1991). Because the buoyant thermal plume at the discharge points quickly rises toward the surface and the temperature range of the thermal plume near the surface would be within the typical range for Atlantic cod eggs, the NRC staff concludes that the heated effluent from Seabrook is not likely to adversely affect EFH for Atlantic cod eggs, juveniles, or adults during the remainder of the facility's operating license or during the proposed license renewal term. Because the thermal plume could exceed the typical range of temperatures that larvae inhabit, the NRC staff concludes that the heated thermal effluent may have minimal adverse effects on Atlantic cod larvae.

Loss of Forage Species. Juveniles and younger adults consume pelagic and benthic invertebrates, while adult cod feed on both crustaceans and other fish (Lough, 2004). In the Gulf of Maine, Bowman (1975 in Lough, 2004) found Atlantic herring to be a primary prey item for Atlantic cod. Link and Garrison (2002) determined that preferred prey in the Gulf of Maine include American sand lance, cancer crabs, and Atlantic herring. NextEra monitoring data show relatively similar trends in the abundance and density of benthic invertebrates (including cancer crabs) and most fish species prior to and during operations at sampling sites near the intake and discharge structures and 3−4 mi (5–8 km) away (NAI, 2010). Atlantic herring, a primary prey item for Atlantic cod in the Gulf of Maine, was the fifth most commonly entrained larval species, comprising 3.6 percent of all entrained larvae (NAI, 2010) (Table D-1-5). Atlantic herring comprised less than 1 percent of all impinged fish (NAI, 2010) (Table D-1-6). American sand lance, a preferred prey item for Atlantic cod, was the second most commonly entrained larval species, comprising 10 percent of all entrained larvae (NAI, 2010) (Table D-1-5). American sand lance was the 10th most commonly impinged fish species, comprising 4.3 percent of all impinged fish (NAI, 2010) (Table D-1-6).

Because some of the primary and preferred forage fish—such as Atlantic herring and American sand lance—are regularly entrained and impinged at Seabrook, operations at Seabrook may have a minimal adverse effect on prey abundance for Atlantic cod. Effects would likely be minimal since Atlantic cod consume a variety of species, many of which are not regularly entrained or impinged at Seabrook.

Loss of Habitat-forming Species. Complex substrate and vegetation provide refuge from predators for juvenile cod (Lough, 2004). Therefore, juvenile cod likely use macroalgae and shellfish beds near Seabrook. Monitoring studies suggest that Seabrook operations have adversely affected the density of several kelp species near Seabrook. Therefore, Seabrook operations may have a minimal adverse effect on juvenile Atlantic cod habitat. Effects would likely be minimal since juvenile Atlantic cod inhabit a variety of substrates and vegetation to find refuge from predators.

Combined Impacts (Monitoring Data). NextEra monitored the abundance of eggs, larvae, juvenile and adult Atlantic cod prior to and during operations at sampling sites near the intake and discharge structures and at sites 3–4 mi (5–8 km) away. Ichthyoplankton studies indicated that the density of Atlantic cod larvae decreased significantly at both nearfield and farfield sampling sites (NAI, 2010) (Table D-1-8). Monitoring data from trawl studies and gill net studies indicate that the abundance of juvenile and adult Atlantic cod also significantly decreased at both nearfield and farfield sampling sites (Tables D-1-9 and D-1-10). The decreased

abundance at both nearfield and farfield sampling sites suggest that Seabrook operations have not adversely affected EFH for Atlantic cod within 3–4 mi (5–8 km) of Seabrook.

Conclusion. Based on the above analysis, the NRC staff concludes that Seabrook operations may have minimal adverse effects on EFH for Atlantic cod larvae, juveniles, and adults, because Seabrook's cooling system regularly entrains and impinges preferred forage fish for Atlantic cod, the thermal plume could exceed the typical range of temperatures that larvae inhabit, and because juveniles may use algal habitats that have declined near Seabrook since operations began. Impacts would likely be minimal since Atlantic cod are not commonly entrained or impinged in the Seabrook cooling system, the thermal plume rises quickly to the surface, invertebrate forage species are not likely adversely affected by Seabrook operations, and monitoring data show similar trends at nearfield and farfield stations prior to and during operations.

*D-1.3.3.4 Atlantic herring (*Clupea harengus*) (Juvenile and Adult)*

Designated EFH in the Vicinity of Seabrook. The NMFS has designated juvenile and adult Atlantic herring EFH in the vicinity of Seabrook (NMFS, 2011b). NAI (2010) observed Atlantic herring in 1–10 percent of trawling samples, greater than 10 percent of gill net samples, and in 1–10 percent of seine pull samples (Table D-1-2).

Species Description. Adult Atlantic herring are pelagic, schooling fish that inhabit both the eastern and western Atlantic Ocean (Stevenson and Scott, 2005). Juveniles migrate nearshore to further offshore seasonally, whereas adult Atlantic herring migrate north-south along the U.S. and Canadian coasts for feeding, spawning, and overwintering.

Larvae develop into juveniles in the spring, at approximately 1.6–2.2 in. (40–55 millimeters (mm)) length (Stevenson and Scott, 2005). Schooling behavior begins once Atlantic herring develop into juveniles (Gallego and Heath, 1994). NOAA's Northeast Fishery Science Center (NEFSC) captured juveniles in waters from 35–54 degrees Fahrenheit (2–12 degrees Celsius) in the spring and from 41–63 degrees Fahrenheit (5–17 degrees Celsius) in the fall, during bottom trawl surveys from the Gulf of Maine to Cape Hatteras (Stevenson and Scott, 2005). Adults occurred in waters from 35–55 degrees Fahrenheit (2–13 degrees Celsius) in the spring and from 39–61 degrees Fahrenheit (4–16 degrees Celsius) in the fall (Stevenson and Scott, 2005).

Juvenile and adult Atlantic herring are opportunistic feeders and prey on zooplankton. The most common prey items for juveniles include copepods, decapods larvae, barnacle larvae, cladocerans, and molluscan larvae (Sherman and Perkins, 1971 in Stevenson and Scott 2005). Common prey items for adults include euphausiids, chaetognaths, and copepods (Bigelow and Schroeder, 1953; Maurer and Bowman, 1975 in Stevenson and Scott 2005). Adults also prey upon fish eggs and larvae, including larval Atlantic cod, herring, sand lance, and silversides (Munroe, 2002; Stevenson and Scott, 2005).

Atlantic herring are an important component of the Gulf of Maine food web and are preyed upon throughout their life cycle (Stevenson and Scott, 2005). Predators include a variety of fish (such as Atlantic cod, silver hake, thorny skate, bluefish, goosefish, weakfish, summer flounder, white hake, Atlantic halibut, red hake, and northern shortfin squid), marine mammals, and sea birds (Stevenson and Scott, 2005).

Status of the Fishery. In U.S. waters, NEFMC manage Atlantic herring as a single stock (Stevenson and Scott, 2005). In 2009, NEFMC did not consider Atlantic herring overfished (NMFS, 2010b).

Entrainment and Impingement. Although NMFS has not designated EFH for Atlantic herring eggs and larvae, entrainment and impingement can adversely affect recruitment of juveniles and adults. NAI (2010) did not observe entrainment of Atlantic herring eggs from 1990–2009. Entrainment of Atlantic herring larvae varied from 0.1 million in 1994 to 28.2 million in 2008 (NAI, 2010). Annual average entrainment of Atlantic herring larvae was 9.6 million per year from 1990–2009 (Table D-1-5). Atlantic herring larvae comprised approximately 3.6 percent of the total fish larvae entrained at Seabrook from 1990–2009.

Impingement of Atlantic herring varied from 0 in 1994–1995 to 582 in 1998 (NAI, 2010). Annual average impingement was 187 fish per year from 1994–2009 (Table D-1-6). Atlantic herring comprised less than 1 percent of all impinged fish at Seabrook from 1994–2009.

Because entrainment and impingement were relatively low for Atlantic herring compared to other species at Seabrook, the NRC staff concludes that entrainment and impingement are not likely to adversely affect EFH for juvenile and adult Atlantic herring during the remainder of the facility's operating license or during the proposed license renewal term.

Thermal Effects. Seabrook's thermal discharges may reduce available habitat to juvenile and adult Atlantic herring. The habitat most likely affected by the thermal plume would be the upper water column (within 10–16 ft (3–5 m) of the ocean surface) in the immediate vicinity of the discharge. At the surface, Padmanabhan and Hecker (1991) observed a temperature rise of 3 degrees Fahrenheit (1.7 degrees Celsius) or more in a 32-ac (12.9-ha) area surrounding the discharge. Seabrook's NPDES permit 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. Adult and juvenile Atlantic herring are most common near Seabrook from April–May, when the surface temperature near Seabrook ranges from 41–51 degrees Fahrenheit (5–10.7 degrees Celsius) and from October–December, when the surface temperature ranges from 42–57.7 degrees Fahrenheit (5.6–14.3 degrees Celsius) (NAI, 2001). NEFSC trawl surveys captured juveniles in waters up to 54 degrees Fahrenheit (12 degrees Celsius) in the spring and 63 degrees Fahrenheit (17 degrees Celsius) in the fall and adults up to 55 degrees Fahrenheit (13 degrees Celsius) in the spring and up to 61 degrees Fahrenheit (16 degrees Celsius) in the fall (Stevenson and Scott, 2005). With a temperature rise of 3–5 degrees Fahrenheit (1.7–2.8 degrees Celsius), the thermal plume near the surface could slightly exceed the typical range of temperature that Atlantic herring juveniles and adults inhabit. The habitat affected at the surface would likely be 32 ac (12.9 ha) or less (Padmanabhan and Hecker, 1991). Therefore, the NRC staff concludes that the increased temperatures at Seabrook may have a minimal adverse effect on EFH for adult and juvenile Atlantic herring during the remainder of the facility's operating license or during the proposed license renewal term.

Loss of Forage Species. Juvenile and adult Atlantic herring are opportunistic feeders and prey on a wide variety of zooplankton. Adults prey upon fish eggs and larvae, including larval Atlantic cod, herring, sand lance, and silversides (Munroe, 2002; Stevenson and Scott, 2005). NextEra's monitoring studies show relatively similar trends prior to and during operations at nearfield and farfield sampling sites for the zooplankton (NAI, 2010). American sand lance larvae, a common prey item for Atlantic herring, were the second most commonly entrained larval species, comprising 10 percent of all entrained larvae (NAI, 2010) (Table D-1-5). Other common larval prey, such as Atlantic herring and Atlantic cod larvae, comprised approximately

1 percent or less of the total fish larvae entrained at Seabrook. The NRC staff concludes that the potential loss of forage species at Seabrook is not likely to adversely affect EFH for adult and juvenile Atlantic herring during the remainder of the facility's operating license or during the proposed license renewal term. This conclusion is based on the fact that Atlantic herring prey upon a wide variety of fish larvae, and monitoring studies suggest that zooplankton abundance has not been adversely affected by Seabrook operations.

Loss of Habitat-forming Species. Adult and juvenile Atlantic herring are primarily pelagic (Stevenson and Scott, 2005), suggesting that they rarely use benthic habitats such as kelp and shellfish beds. Therefore, the NRC staff concludes that the potential loss of habitat-forming species is not likely to adversely affect Atlantic herring during the remainder of the facility's operating license or during the proposed license renewal term.

Combined Impacts (Monitoring Data). NextEra monitored the abundance of juvenile and adult Atlantic herring prior to and during operations at sampling sites in Hampton-Seabrook Estuary near a previous discharge location and at sites further away. Monitoring data indicate that the abundance of juvenile and adult Atlantic herring decreased at both nearfield and farfield sampling sites (Table D-1-11). Because NAI (2010) observed similar trends at all sampling sites, these monitoring results suggest that Seabrook operations have not adversely affected EFH for adult and juvenile Atlantic herring.

Conclusion. Because of the observations above, and because the thermal plume could increase the temperature near the surface to above the temperature range that Atlantic herring typically inhabit, the NRC staff concludes that Seabrook operations may have a minimal adverse effect on EFH for adult and juvenile Atlantic herring.

*D-1.3.3.5 Atlantic mackerel (*Scomber scombrus*) (All Life Stages)*

Designated EFH in the Vicinity of Seabrook. The NMFS has designated eggs, larvae, juvenile, and adult Atlantic mackerel EFH in the vicinity of Seabrook (NMFS, 2011b). NAI (2010) observed Atlantic mackerel eggs and larvae in greater than 10 percent of ichthyoplankton tows, juveniles and adults in less than 1 percent of trawling samples, juveniles and adults in greater than 10 percent of gill net samples, and juveniles and adults in less than 1 percent of seine pull samples (Table D-1-2).

Species Description. Atlantic mackerel are pelagic, schooling fish that inhabit the western Atlantic Ocean from the Gulf of St. Lawrence to North Carolina (Studholme et al., 1999). Adults are highly mobile.

In reviewing multiple studies, Studholme et al. (1999) indicated that the age of maturation varies from 1.7–3 years of age, depending on the location, size of the year class, and size of the adult stock. In the Gulf of Maine, females spawn from mid-April–June as they migrate from the south (Berrien, 1982 in Studholme et al. 1999). The Gulf of Maine is not one of the more important spawning grounds (Sette, 1950 in Studholme et al. 1999). Eggs are pelagic and float in the upper 33–49 ft (10–15 m) of surface waters (Studholme et al., 1999). NEFSC collected eggs near the surface at temperatures ranging from 41–73 degrees Fahrenheit (5–23 degrees Celsius) and larvae from 43–72 degrees Fahrenheit (6–22 degrees Celsius) as part of the Marine Resources Monitoring, Assessment, and Prediction (MARMAP) offshore ichthyoplankton survey.

Juveniles exhibit schooling behavior at about 1.2–2 in. (30–50 mm) (Sette, 1943 in Studholme et al. 1999). NEFSC captured juveniles from 39–72 degrees Fahrenheit (4–22 degrees Celsius)

and adults from 39–61 degrees Fahrenheit (4–16 degrees Celsius) during 1963–1997 bottom trawl surveys. Overholtz and Anderson (1976 in Studholme et al. 1999) conducted field studies that indicated that adult Atlantic mackerel are intolerant of temperatures greater than 61 degrees Fahrenheit (16 degrees Celsius).

Atlantic mackerel are opportunistic and filter feed or ingest prey. Larvae feed on copepod nauplii, copepods, and fish larvae (Studholme et al., 1999). Both juveniles and adults prey on a variety of crustaceans, although adults consume a wider variety of prey sizes and items, including fish. Peterson and Ausubel (1984) determined that fish greater than 0.2 in. (5 mm) feed on copepodites of *Acartia* and *Temora,* and fish greater than 0.24 in. (6 mm) feed on adult copepods.

Atlantic mackerel is prey to a wide variety of fish, sharks, squid, whales, dolphins, seals, porpoises. Common fish predators include other mackerel, dogfish, tunas, bonito, striped bass, Atlantic cod, swordfish, silver hake, red hake, bluefish, pollock, white hake, goosefish, and weakfish (Studholme et al., 1999).

Status of the Fishery. In U.S. waters, MAFMC and NFMS manage Atlantic mackerel as a single stock (Studholme et al., 1999). In 2009, MAFMC did not consider Atlantic mackerel overfished (NMFS, 2010b).

Entrainment and Impingement. Entrainment of Atlantic mackerel eggs varied from 0 in 1994 to 673.1 million in 1991 (NAI, 2010). Annual average entrainment of Atlantic mackerel eggs was 191.5 million per year from 1990–2009 (Table D-1-4). Atlantic mackerel eggs comprised approximately 21.3 percent of the total fish eggs entrained at Seabrook from 1990–2009. Entrainment of Atlantic mackerel larvae varied from 0 in several years to 25.7 million in 2009 (NAI, 2010). Annual average entrainment of Atlantic mackerel larvae was 2.6 million per year from 1990–2009 (Table D-1-5). Atlantic mackerel larvae comprised approximately 1 percent of the total fish larvae entrained at Seabrook from 1990–2009.

Impingement of Atlantic mackerel varied from 0 in several years to 4 in 2004–2005 (NAI, 2010). Annual average impingement was less than 3 fish per year from 1994–2009 (Table D-1-6). Atlantic mackerel comprised less than 1 percent of all impinged fish at Seabrook from 1994–2009.

Entrainment of Atlantic mackerel larvae and impingement of Atlantic mackerel is small compared to other species impinged at Seabrook. However, Atlantic mackerel is the second most entrained egg species, comprising 21.3 percent of the total fish eggs entrained at Seabrook. Therefore, the NRC staff concludes that entrainment of Atlantic mackerel eggs may have minimal adverse effects on EFH for Atlantic mackerel during the remainder of the facility's operating license or during the proposed license renewal term. Effects would likely be minimal since the amount of water (or habitat) entrained in the Seabrook cooling system would be a very small proportion of available habitat for Atlantic mackerel eggs.

Thermal Effects. Seabrook's thermal discharges may reduce available habitat to adult Atlantic mackerel. The habitat most likely affected by the thermal plume would be the upper water column (within 10–16 ft (3–5 m) of the ocean surface) in the immediate vicinity of the discharge. At the surface, Padmanabhan and Hecker (1991) observed a temperature rise of 3 degrees Fahrenheit (1.7 degrees Celsius) or more in a 32-ac (12.9-ha) area surrounding the discharge. Seabrook's NPDES permit 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. Atlantic mackerel are most common near Seabrook from June–November, when the surface

temperature near Seabrook ranges from 46–66 degrees Fahrenheit (8–18.8 degrees Celsius) (NAI, 2001). During ichthyoplankton and trawling surveys, NEFSC captured eggs, larvae, and juveniles in waters up to 72 degrees Fahrenheit (22 degrees Celsius) and adults in waters up to 61 degrees Fahrenheit (16 degrees Celsius) (Studholme et al., 1999). With a temperature rise of 3–5 degrees Fahrenheit (1.7–2.8 degrees Celsius), the thermal plume near the surface could exceed the typical temperature range that adult Atlantic mackerel inhabit. The habitat affected at the surface would likely be 32 ac (12.9 ha) or less (Padmanabhan and Hecker, 1991). Therefore, the NRC staff concludes that the increased temperatures at Seabrook may have a minimal adverse effect on EFH for adult Atlantic mackerel during the remainder of the facility's operating license or during the proposed license renewal term.

Loss of Forage Species. Atlantic mackerel are opportunistic feeders and prey includes plankton, small crustaceans (including copepods), and some fish for larger Atlantic mackerel (Studholme et al., 1999). NextEra's monitoring studies show similar trends prior to and during operations at nearfield and farfield sampling sites for changes in abundance, density, and species composition for phytoplankton, zooplankton (including copepods and fish larvae), invertebrates, and most fish species (NAI, 2010). Therefore, the NRC staff concludes that the potential loss of forage species at Seabrook is not likely to adversely affect EFH for Atlantic mackerel during the remainder of the facility's operating license or during the proposed license renewal term.

Loss of Habitat-forming Species. Adult and juvenile Atlantic herring are primarily pelagic (Studholme et al., 1999), which suggests that they rarely use benthic habitats such as kelp and shellfish beds. Therefore, the NRC staff concludes that the potential loss of habitat-forming species is not likely to adversely affect EFH for Atlantic herring during the remainder of the facility's operating license or during the proposed license renewal term.

Combined Impacts (Monitoring Data). NextEra monitored the abundance of Atlantic mackerel eggs, larvae, juveniles, and adults prior to and during operations at sampling sites near the intake and discharge structures and at sites 3–4 mi (5–8 km) away (NAI, 2010). Monitoring data indicate that the density of eggs and abundance of juveniles and adults increased or remained the same at both nearfield and farfield sampling sites (Tables D-1-8 and D-1-10). Larval density decreased at both nearfield and farfield sampling sites (Table D-1-8). Because NAI (2010) found similar trends at both the nearfield and farfield sites, these monitoring results suggest that Seabrook operations have not adversely affected EFH for Atlantic mackerel.

Conclusion. Based on the above analysis, the NRC staff concludes that Seabrook operations may have minimal adverse effects on EFH for Atlantic mackerel eggs and adults for the following reasons:

- The thermal plume could increase the temperature near the surface to above the temperature range that adult Atlantic mackerel typically inhabit.
- Atlantic mackerel is the second most entrained egg species, comprising 21.3 percent of the total fish eggs entrained at Seabrook.

The NRC staff concludes that Seabrook operations are not likely to adversely affect Atlantic mackerel larvae and juvenile for the following reasons:

- These life stages are not commonly entrained or impinged in the Seabrook cooling system.

- The thermal plume would not exceed the typical temperature range that juveniles inhabit.
- Forage species are not likely adversely affected by Seabrook operations.
- Monitoring data show similar trends at nearfield and farfield stations prior to and during operations.

*D-1.3.3.6 Atlantic sea scallop (*Placopecten magellanicus*) (All Life Stages)*

Designated EFH in the Vicinity of Seabrook. The NMFS has designated eggs, larvae, juvenile, and adult Atlantic sea scallop EFH in the vicinity of Seabrook (NMFS, 2011b). NAI (2010) observed a relatively low density of Atlantic sea scallop larvae in zooplankton tows (geometric mean density was approximately 3–4 scallops per 1,000 m^3 prior to 2001 and less than 1 scallop per 1,000 m^3 after 2001). Seabrook monitoring does not include juvenile and adult Atlantic sea scallops. Seabrook observations near the intake and discharge structures suggest that sea scallops are not common in this area (NAI, 2001).

Species Description. Atlantic sea scallops are bivalve mollusks that occur along the Canadian and U.S. coasts from the Gulf of St. Lawrence south to Cape Hatteras, NC (Hart and Chute, 2004).

Sea scallops produce gametes within the first or second year and are among the most fecund of bivalves (Langton et al., 1987). Spawning in Maine occurs from September–October. Eggs remain demersal until they develop into larvae. The first two larval stages are pelagic and drift with water currents (Hart and Chute, 2004). Larvae settle on the sea floor as spat and remain there throughout adult life. Spat that land on sedentary branching plants, animals, or on any other hard surface may have a higher survival rate than those that land in sandy bottom habitats subject to burial (Larsen and Lee, 1978).

Juvenile scallops move from the original substrate on which they have settled and attach to shells or bottom debris (Dow and Baird, 1960 in Hart and Chute 2004). Juveniles also swim to avoid predators and other natural or human-induced disturbances. Tagging studies suggest that adults remain sedentary once an aggregation has formed (Hart and Chute, 2004).

Sea scallops are filter feeders. Food particles filtered from water include phytoplankton, microzooplankton (such as ciliated protozoa), and particles of detritus, especially during periods of low phytoplankton concentrations (Shumway et al., 1987). Both fish and invertebrates prey upon Atlantic sea scallops (Hart and Chute, 2004).

Status of the Fishery. The Atlantic sea scallop is one of the most economically important species in the northeast U.S. (Hart and Chute, 2004). NEFMC manages the sea scallop fishery under the Sea Scallop Management Plan. In 2009, NEFMC did not consider the sea scallop fishery overfished (NMFS, 2010b).

Entrainment and Impingement. NAI (2010) did not monitor entrainment of invertebrate eggs from 1990–2009. Entrainment of Atlantic sea scallop larvae varied from 0 in 2003 and 2006 to 31 million in 1996 (Table D-1-7) (NAI, 2010). Annual average entrainment of Atlantic sea scallop larvae was 4.8 million per year from 1990–2009 (NAI, 2010). Atlantic sea scallop larvae comprised less than 1 percent of the total invertebrate larvae entrained at Seabrook from 1990–2009.

Because adult Atlantic sea scallops are sessile benthic organisms, impingement is not likely, and NextEra did not monitor impingement of Atlantic sea scallops.

Because entrainment was relatively low for Atlantic sea scallops compared to other invertebrate species at Seabrook, and because impingement is not likely, the NRC staff concludes that entrainment and impingement are not likely to adversely affect EFH for Atlantic sea scallops during the remainder of the facility's operating license or during the proposed license renewal term.

Thermal Effects. The NRC staff does not expect Seabrook's thermal discharges to reduce available habitat to Atlantic sea scallop. Atlantic sea scallops are primarily benthic (Chute and Hart, 2004), meaning that they spend most of the time residing near the seafloor. A relatively small area near the discharge structure in deep water experiences increased temperatures (NAI, 2001; Padmanabhan and Hecker, 1991). Because the buoyant thermal plume at the discharge points quickly rises toward the surface, the NRC staff concludes that the heated effluent from Seabrook is not likely to adversely affect EFH for Atlantic sea scallops during the remainder of the facility's operating license or during the proposed license renewal term.

Loss of Forage Species. Atlantic sea scallops are filter feeders, and prey includes phytoplankton, microzooplankton (such as ciliated protozoa), and particles of detritus. NextEra's monitoring studies show relatively similar trends prior to and during operations at nearfield and farfield sampling sites for plankton (NAI, 2010). Therefore, the NRC staff concludes that the potential loss of forage species at Seabrook is not likely to adversely affect EFH for Atlantic sea scallops during the remainder of the facility's operating license or during the proposed license renewal term.

Loss of Habitat-forming Species. Survival of newly settled Atlantic sea scallop appears to be higher in complex habitats that include sedentary branching animals, plants, and other hard surfaces (Larsen and Lee, 1978). Seabrook monitoring data indicate that the density of several species of kelp has decreased at nearfield sampling stations since operations began, but NextEra observed relatively similar trends for the density of benthic invertebrates at the nearfield and farfield sites prior to and during operations (NAI, 2010). Because the density of kelp is lower since operations began at Seabrook but Atlantic sea scallops use complex habitats other than kelp, the NRC staff concludes that Seabrook operations may have minimal adverse effects on habitat for newly settled Atlantic sea scallops.

Combined Impacts (Monitoring Data). Seabrook monitoring data do not provide data specific to the abundance of Atlantic sea scallop eggs, larvae, juveniles, or adults prior to and during operations. However, NextEra monitoring data show relatively similar trends of benthic invertebrate density prior to and during operations at sampling sites near the intake and discharge structures and 3–4 mi (5–8 km) away (NAI, 2010).

Conclusion. Because spat appear to have higher survival rates in complex habitats, such as kelp forests, and because Seabrook monitoring data suggests that operations have adversely affected the density of several species of kelp, the NRC staff concludes that Seabrook operations may have minimal adverse effects on juvenile sea scallops. Based on the above analysis, the NRC staff concludes that Seabrook operations are not likely to adversely affect EFH for eggs, larvae, and adult sea scallops for the following reasons:

- Entrainment and impingement are relatively low compared to other species at Seabrook.
- The thermal plume rises quickly to surface waters.

- Forage species are not likely to be adversely affected.
- Monitoring data show relatively similar trends of benthic invertebrate density prior to and during operations at sampling sites near the intake and discharge structures and 3–4 mi (5–8 km) away.

*D-1.3.3.7 Atlantic Surfclam (*Spisula solidissima*) (Juveniles and Adults)*

Designated EFH in the Vicinity of Seabrook. The NMFS has designated juvenile and adult Atlantic surf clam EFH in the vicinity of Seabrook (NMFS, 2011b). Seabrook monitoring does not include juvenile and adult Atlantic surf clams (NAI, 2010). NAI (2010) observed surface larvae near Seabrook and the geometric mean density was approximately 350–590 clams per 1,000 m^3 prior to 2001 and 120 clams per 1,000 m^3 after 2001.

Species Description. Atlantic surfclams are bivalve mollusks that inhabit sandy habitats from the southern Gulf of St. Lawrence to Cape Hatteras, NC (Merrill and Ropes 1969 in Cargnelli et al., 1999a). Clams feed by sucking in plankton, such as diatoms and ciliates, through their siphons (Cargnelli et al., 1999a). Predators include invertebrates (e.g., naticid snails, sea stars (*Asterias forbesi*), lady crabs (*Ovalipes ocellatus*), Jonah crabs (*Cancer borealis*), and horseshoe crabs (*Limulus polyphemus*)) and fish (e.g., haddock and Atlantic cod) (see review in Cargnelli et al., 1999a).

Status of the Fishery. MAFMC manages the Atlantic surfclam under the Atlantic surfclam and ocean quahog FMP. In 2009, MAFMC did not consider the Atlantic surfclam fishery overfished (NMFS, 2010b).

Entrainment and Impingement. NAI (2010) did not monitor entrainment of invertebrate eggs from 1990–2009. Entrainment of surf clam larvae varied from 0 in 1992 and 2006 to 175.5 million in 1999 (NAI, 2010). Annual average entrainment of Atlantic surf clam larvae was 48.9 million per year from 1990–2009 (Table D-1-7). Atlantic surf clam larvae comprised less than 1 percent of the total invertebrate larvae entrained at Seabrook from 1990–2009.

Because adult Atlantic surf clams are sessile benthic organisms, impingement is not likely, and NextEra did not monitor impingement of Atlantic surf clams.

Because entrainment was relatively low for Atlantic surf clams compared to other invertebrate species at Seabrook, and because impingement is not likely, the NRC staff concludes that entrainment and impingement are not likely to adversely affect EFH for Atlantic surf clams during the remainder of the facility's operating license or during the proposed license renewal term.

Thermal Effects. The NRC staff does not expect Seabrook's thermal discharges to reduce available habitat to Atlantic surfclams. Juvenile and adult Atlantic surfclams are benthic (Cargnelli et al., 1999a), meaning that they spend most of the time residing near the seafloor. A relatively small area near the discharge structure in deep water experiences increased temperatures (NAI, 2001; Padmanabhan and Hecker, 1991). Because the buoyant thermal plume at the discharge points quickly rises toward the surface, the NRC staff concludes that the heated effluent from Seabrook is not likely to adversely affect EFH for Atlantic surfclam during the remainder of the facility's operating license or during the proposed license renewal term.

Loss of Forage Species. Atlantic surfclams feed on plankton, such as diatoms and ciliates. NextEra's monitoring studies show relatively similar trends prior to and during operations at nearfield and farfield sampling sites for plankton (NAI, 2010). Therefore, the NRC staff

concludes that the potential loss of forage species at Seabrook is not likely to adversely affect Atlantic surfclam EFH during the remainder of the facility's operating license or during the proposed license renewal term.

Loss of Habitat-forming Species. Preferred habitat includes sandy bottom areas. Surfclams are not dependent on kelp forests. Therefore, the NRC staff concludes that loss of kelp at Seabrook is not likely to adversely affect EFH for juvenile and adult Atlantic surfclams during the remainder of the facility's operating license or during the proposed license renewal term.

Combined Impacts (Monitoring Data). Seabrook monitoring data do not provide data specific to the abundance of Atlantic surfclams prior to and during operations. However, NextEra monitoring data show relatively similar trends of benthic invertebrate density prior to and during operations at sampling sites near the intake and discharge structures and 3–4 mi (5–8 km) away (NAI, 2010).

Conclusion. Based on the above analysis, the NRC staff concludes that Seabrook operations are not likely to adversely affect juvenile and adult Atlantic surfclams for the following reasons:

- Entrainment and impingement are relatively low compared to other species at Seabrook.
- The thermal plume rises quickly to surface waters.
- Forage species are not likely to be adversely affected.
- Monitoring data show relatively similar trends of benthic invertebrate density prior to and during operations at sampling sites near the intake and discharge structures and 3–4 mi (5–8 km) away.

*D-1.3.3.8 Haddock (*Melanogrammus aeglefinus*) (Juvenile)*

Designated EFH in the Vicinity of Seabrook. The NMFS has designated juvenile haddock EFH in the vicinity of Seabrook (NMFS, 2011b). NAI (2010) observed haddock in greater than 10 percent of trawling samples and less than 1 percent of gill net samples (Table D-1-2).

Species Description. Haddock are demersal gadids that inhabit both sides of the North Atlantic Ocean (Brodziak, 2005). In the northwest Atlantic, haddock can be found from Cape May, NJ to the Strait of Belle Isle, Newfoundland (Klein-MacPhee, 2002). In the U.S., two stocks of haddock occur—one in the Gulf of Maine and one in Georges Bank (Brodziak, 2005).

Larvae metamorphose into juveniles once they reach 0.8–1.2 in. (2–3 cm) (Fahay, 1983). For the first 3–5 months, small juveniles live and feed in the upper part of the water column. Juveniles visit the seafloor in search of prey and remain on the ocean bottom once suitable habitat is located (Brodziak, 2005; Klein-MacPhee, 2002). Preferred benthic habitat includes include gravel, pebbles, clay, and smooth hard sand (Klein-MacPhee, 2002), which is more abundant in Georges Bank than in the Gulf of Maine (Broziak, 2005).

While inhabiting the upper part of the water column, small juveniles feed on phytoplankton, small crustaceans (primarily copepods and euphausiids), and invertebrate eggs (Brodziak, 2005; Kane, 1984). Benthic prey for larger juveniles include polychaetes, echinoderms, small decapods, and small fishes (Bowman et al., 1987; Broziak, 2005).

Status of the Fishery. By the early 1990s, haddock experienced several decades of declining spawning biomass and recruitment (Brodziak, 2005). Some considered the stock to be near

collapse (Brodziak, 2005). Since 1994, fishery management measures have helped to reduce fishing mortality (Brodziak, 2005). NEFMC currently manages haddock under the northeast multispecies FMP. In 2009, NEFMC considered haddock overfished (NMFS, 2010b).

Entrainment and Impingement. Although NMFS has not designated EFH for haddock eggs and larvae, entrainment and impingement can adversely affect recruitment of juveniles. Entrainment of haddock eggs varied from 0 in several years to 7.4 million in 1992 (NAI, 2010). Annual average entrainment of haddock eggs was 0.4 million per year from 1990–2009 (Table D-1-4). Entrainment of 100,000 haddock larvae occurred in 1992 and 2005. NAI (2010) did not observe entrainment of haddock larvae in any other year from 1990–2009 (Table D-1-5). Haddock eggs and larvae comprised less than 1 percent of the total fish eggs and larvae entrained at Seabrook from 1990–2009.

Impingement of haddock varied from 0 in several years to 397 in 1996 (NAI, 2010). Annual average impingement was 28 fish per year from 1994–2009 (Table D-1-6). Haddock comprised less than 1 percent of all impinged fish at Seabrook from 1994–2009.

Because entrainment and impingement were relatively low for haddock compared to other species at Seabrook, the NRC staff concludes that entrainment and impingement are not likely to adversely affect EFH for haddock during the remainder of the facility's operating license or during the proposed license renewal term.

Thermal Effects. The NRC staff does not expect Seabrook's thermal discharges to reduce available habitat to juvenile haddock. Young juvenile haddock remain pelagic for 3–5 months, at which point they travel to the seafloor in search of food and remain within this benthic habitat. A relatively small area near the discharge structure in deep water experiences increased temperatures (NAI, 2001; Padmanabhan and Hecker, 1991). Because the buoyant thermal plume at the discharge points quickly rises toward the surface, the NRC staff concludes that the heated effluent from Seabrook is not likely to adversely affect EFH for juvenile haddock during the remainder of the facility's operating license or during the proposed license renewal term.

Loss of Forage Species. Juvenile haddock feed on a variety of organisms, including phytoplankton, copepods, euphausiids, invertebrate eggs, polychaetes, echinoderms, small decapods, and small fishes (Bowman et al., 1987; Broziak, 2005; Kane, 1984). NextEra's monitoring studies show relatively similar trends prior to and during operations at nearfield and farfield sampling sites for the abundance, density, and species composition of phytoplankton, zooplankton (including copepods), invertebrates, and most fish species (NAI, 2010). Therefore, the NRC staff concludes that the potential loss of forage species at Seabrook is not likely to adversely affect EFH for juvenile haddock during the remainder of the facility's operating license or during the proposed license renewal term.

Loss of Habitat-forming Species. Juvenile haddock do not use kelp habitats (Broziak, 2005). Therefore, loss of kelp due to Seabrook operations are not likely to adversely affect EFH for juvenile haddock.

Combined Impacts (Monitoring Data). Seabrook monitoring data does not provide data specific to the abundance of juvenile haddock prior to and during operations (NAI, 2010).

Conclusion. Based on the above analysis, the NRC staff concludes that Seabrook operations are not likely to adversely affect juvenile haddock or its habitat for the following reasons:

- Impingement and entrainment are relatively low for haddock.

- The thermal plume rises quickly to surface waters
- Forage species are not likely to be adversely affected by Seabrook operations.
- Preferred habitat does not include kelp or shellfish beds.

*D-1.3.3.9 Monkfish/Goosefish (*Lophius americanus*) (All Life Stages)*

Designated EFH in the Vicinity of Seabrook. The NMFS has designated eggs, larvae, juvenile, and adult goosefish EFH in the vicinity of Seabrook (NMFS, 2011b). NAI (2010) observed goosefish eggs in less than 1 percent of ichthyoplankton tows, goosefish larvae in 1–10 percent of ichthyoplankton tows, juveniles and adults in 1–10 percent of trawling samples, and juveniles and adults in less than 1 percent of gill net samples (Table D-1-2).

Species Description. Goosefish are large, slow-growing benthic fish (Steimle et al., 1999a). In the Gulf of Maine, goosefish larger than 7.9 in. (20 cm) move offshore in the winter and spring to avoid cold coastal conditions, whereas smaller goosefish migrate offshore in the fall (Hartley, 1995 in Steimle et al. 1999a).

Adults mature at approximately 4 years for males and 5 years for females (Almeida et al., 1995). Spawning occurs from May–June in the Gulf of Maine (Hartley, 1995 in Steimle et al. 1999a). Females shed relatively large eggs (0.6–0.7 in. (1.6–1.8 mm)) within buoyant, ribbon-like, non-adhesive, mucoid veils or rafts (Martin and Drewry, 1978 in Steimle et al. 1999a). Egg veils float on the surface (Steimle et al., 1999a). Larvae are also pelagic. Juveniles settle to the bottom of the ocean and remain demersal as adults. Young juveniles often hide from predators within algae covered rocks. Adults prefer open sandy bottoms where they can partially bury themselves and then ambush prey (Steimle et al., 1999a).

Prey varies depending on lifestage. Larval prey includes zooplankton, such as copepods, crustacean larvae, and chaetognaths (Bigelow and Schroeder, 1953). Small juveniles eat pelagic fish but switch to invertebrates, especially crustaceans, once settling on the seafloor (Steimle et al., 1999a). Larger juveniles and adults consume more fish than invertebrates (Armstrong et al., 1996). NEFSC analyzed the stomach contents of goosefish and primary prey included crustaceans, squid, and fish. Common fish prey include spiny dogfish (*Squalus acanthias*), skates (*Raja* spp.), eels, sand lance, herring, Atlantic menhaden (*Brevoortia tyrannus*), smelt (Osmeridae), mackerel (*Scomber* spp.), weakfish (*Cynoscion regalis*), cunner, tautog (*Tautoga onitis*), black sea bass (*Centropristis striata*), butterfish, pufferfish, sculpins, sea raven (*Hemitripterus americanus*), searobins (*Prionotus* spp.), silver hake (*Merluccius bilinearis*), Atlantic tomcod (*Microgadus tomcod*), cod, haddock, hake (*Urophycis* spp.), witch and other flounders, and other goosefish (Bigelow and Schroeder, 1953; Steimle et al., 1999a).

Status of the Fishery. In U.S. waters, NEFMC manages goosefish under the northeast multispecies FMP. In 2009, NMFS (2010b) reported that goosefish was not overfished.

Entrainment and Impingement. Entrainment of goosefish eggs varied from 0 in most years to 0.9 million in 1998 and 2000 (NAI, 2010). Annual average entrainment of goosefish eggs was 0.1 million per year from 1990–2009 (Table D-1-4). Entrainment of goosefish larvae varied from 0 in most years to 2 million in 2000 (NAI, 2010). Annual average entrainment of goosefish larvae was 0.1 million per year from 1990–2009 (Table D-1-5). Goosefish eggs and larvae comprised less than 1 percent of the total fish eggs and larvae entrained at Seabrook from 1990–2009.

Impingement of goosefish varied from 0 in several years to 59 in 2001 (NAI, 2010). Annual average impingement was 10 fish per year from 1994–2009 (Table D-1-6). Goosefish comprised less than 1 percent of all impinged fish at Seabrook from 1994–2009.

Because entrainment and impingement were relatively low for goosefish compared to other species at Seabrook, the NRC staff concludes that entrainment and impingement are not likely to adversely affect EFH for goosefish during the remainder of the facility's operating license or during the proposed license renewal term.

Thermal Effects. The NRC staff does not expect Seabrook's thermal discharges to reduce available habitat to juvenile or adult goosefish. Seabrook's thermal discharge may slightly reduce available habitat to goosefish eggs and larvae.

Goosefish eggs and larvae are pelagic (Steimle et al., 1999a). Scott and Scott (1988 in Steimle et al., 1999a) reported 63–64 degrees Fahrenheit (17–18 degrees Celsius) as the upper temperature limit for normal egg hatching. NEFSC MARMAP ichthyoplankton surveys collected most larvae from 52–59 degrees Fahrenheit (11–15 degrees Celsius), but as high as 68 degrees Fahrenheit (20 degrees Celsius) (Steimle et al., 1999a). Surface waters near the thermal plume typically range as high as 65.8 degrees Fahrenheit (18.8 degrees Celsius) (NAI, 2001). With a temperature rise of 3–5 degrees Fahrenheit (1.7–2.8 degrees Celsius), the thermal plume near the surface could exceed the typical range of temperatures that goosefish eggs and larvae inhabit. The habitat affected at the surface would likely be 32 ac (12.9 ha) or less (Padmanabhan and Hecker, 1991).

Adult and juvenile goosefish are primarily benthic, meaning that they spend most of the time residing near the seafloor (Steimle et al. 1999a). A relatively small area near the discharge structure in deep water experiences increased temperatures (NAI, 2001; Padmanabhan and Hecker, 1991).

Because the thermal plume could exceed the typical range of temperatures that larvae inhabit, the NRC staff concludes that the heated thermal effluent may have minimal adverse effects on Atlantic cod larvae. Because the buoyant thermal plume at the discharge points quickly rises toward the surface, the NRC staff concludes that the heated effluent from Seabrook is not likely to adversely affect EFH for goosefish during the remainder of the facility's operating license or during the proposed license renewal term.

Loss of Forage Species. Goosefish feed on a variety of organisms, including zooplankton, invertebrates, and several fish species (Bigelow and Schroeder, 1953; Steimle et al., 1999a). NextEra's monitoring studies show relatively similar trends prior to and during operations at nearfield and farfield sampling sites for the abundance, density, and species composition of zooplankton, invertebrates, and most fish species (NAI, 2010). Therefore, the NRC staff concludes that the potential loss of forage species at Seabrook is not likely to adversely affect EFH for goosefish during the remainder of the facility's operating license or during the proposed license renewal term.

Loss of Habitat-forming Species. Newly settled juveniles may hide within algae covered rocks (Steimle et al., 1999a). Seabrook monitoring data indicate that the density of several species of kelp has decreased at nearfield sampling stations since operations began (NAI, 2010). Therefore, Seabrook operations may have minimal adverse effects on juvenile goosefish habitat. Effects would likely be minimal because juvenile goosefish would likely inhabit algae (other than kelp) that have not declined near Seabrook (NAI, 2001).

Combined Impacts (Monitoring Data). Seabrook monitoring data do not provide data specific to the density or abundance of goosefish eggs, larvae, juveniles, or adults prior to and during operations (NAI, 2010).

Conclusion. Because the thermal plume could exceed the typical range of temperatures that eggs and larvae inhabit, and because juveniles may use algal habitats that have declined near Seabrook since operations began, the NRC staff concludes that Seabrook may have minimal adverse effects on EFH for goosefish eggs, larvae, and juveniles near Seabrook. Based on the above analysis, Seabrook is not likely to affect goosefish adults or its habitat because entrainment and impingement are relatively low compared to other species at Seabrook, the thermal plume rises quickly to surface waters, and forage species are not likely to be adversely affected.

*D-1.3.3.10 Ocean pout (*Macrozoarces americanus*) (All Life Stages)*

Designated EFH in the Vicinity of Seabrook. The NMFS has designated eggs, larvae, juvenile, and adult ocean pout EFH in the vicinity of Seabrook (NMFS, 2011b). NAI (2010) observed ocean pout larvae in 1–10 percent of ichthyoplankton tows, juveniles and adults in greater than 10 percent of trawling samples, and juveniles and adults in less than 1 percent of gill net samples (Table D-1-2).

Species Description. Ocean pout inhabit the Atlantic continental shelf of North America and are common off the coast of southern New England (Chang, 1990). Ocean pout are benthic and use both open and rough habitats (Steimle et al., 1999b).

In the fall, ocean pout spawn in rock crevices, man-made artifacts, or other protected areas where they lay eggs in nests (Steimle et al., 1999b). Eggs remain demersal, and nests are guarded by one or both parents (Bigelow and Schroeder, 1953). Once hatched, larvae generally remain near or at the bottom of the seafloor (Bigelow and Schroeder, 1953). Juveniles and adults are also demersal. Bigelow and Schroeder (1953) reported that juveniles occur in shallow coastal waters around rocks and attached algae and in rivers with saline bottom waters in the Gulf of Maine. Juveniles may also use scallop or quahog shells for cover. Adults use a variety of habitats including rocky crevices, soft bottom habitats, gravel covered areas, and shellfish beds (Steimle et al., 1999b).

Ocean pout prey on benthic organisms in soft sandy bottom habitats either by sorting mouthfuls of sediments for infaunal species (MacDonald, 1983) or by ambushing prey (Auster et al., 1995). Sedberry (1983 in Steimle et al. 1999b) found that juveniles feed on gammarid amphipods and polychaetes. Adults prey on a variety of benthic invertebrates, such as polychaetes, mollusks, crustaceans, and echinoderms (see review in Steimle et al., 1999b). Langton and Watling (1990 in Steimle et al. 1999b) reported that ocean pout primarily eat bivalve mollusks off the coast of southern Maine. Ocean pout and American plaice may compete for prey in the Gulf of Maine (MacDonald and Green, 1986). Predators of juvenile ocean pout include squid, spiny dogfish, sea raven, cod, barndoor skate (*Raja laevis*), harbor seals, and cormorants (Steimle et al., 1999).

Status of the Fishery. NEFMC currently manages ocean pout as two stocks, one in northern Gulf of Maine and one south of this area (Wigley, 1998). In 2009, NEFMC reported that ocean pout was not overfished (NMFS, 2010b).

Entrainment and Impingement. NAI (2010) did not observe entrainment of ocean pout eggs from 1990–2009 (Table D-1-4). Seabrook entrained less than 10,000 ocean pout larvae in 2003

(NAI, 2010). NAI (2010) did not observe entrainment of ocean pout larvae during any other year from 1990–2009 (Table D-1-5).

Impingement of ocean pout varied from 0 in several years to 21 in 2001 (NAI, 2010). Annual average impingement was 4 fish per year from 1994–2009 (Table D-1-6). Ocean pout comprised less than 1 percent of all impinged fish at Seabrook from 1994–2009.

Because entrainment and impingement were relatively low for ocean pout compared to other species at Seabrook, the NRC staff concludes that entrainment and impingement are not likely to adversely affect EFH for ocean pout during the remainder of the facility's operating license or during the proposed license renewal term.

Thermal Effects. The NRC staff does not expect Seabrook's thermal discharges to reduce available habitat to eggs, larvae, juvenile, or adult ocean pout. Ocean pout are primarily benthic (Steimle et al., 1999b), meaning that they spend most of the time residing near the seafloor. A relatively small area near the discharge structure in deep water experiences increased temperatures (NAI, 2001; Padmanabhan and Hecker, 1991). Because the buoyant thermal plume at the discharge points quickly rises toward the surface, the NRC staff concludes that the heated effluent from Seabrook is not likely to adversely affect EFH for all life stages of ocean pout during the remainder of the facility's operating license or during the proposed license renewal term.

Loss of Forage Species. Ocean pout feed on a variety of invertebrates, including gammarid amphipods, polychaetes, mollusks, echinoderms, and other crustaceans (Langton and Watling, 1990 in Steimle et al. 1999b; Steimle et al., 1999b). NextEra's monitoring studies show relatively similar trends prior to and during operations at nearfield and farfield sampling sites for the abundance, density, and species composition of zooplankton and benthic invertebrates (NAI, 2010). Therefore, the NRC staff concludes that the potential loss of forage species at Seabrook is not likely to adversely affect EFH for ocean pout during the remainder of the facility's operating license or during the proposed license renewal term.

Loss of Habitat-forming Species. Juveniles may use habitats with algae, and both juveniles and adults may use shellfish beds (Bigelow and Schroeder, 1953; Steimle et al., 1999b). Seabrook monitoring data indicate that the density of several species of kelp has decreased at nearfield sampling stations since operations began, but Seabrook observed similar trends in the density of benthic invertebrates at the nearfield and farfield sites prior to and during operations (NAI, 2010). Because the density of kelp is lower since operations began at Seabrook, but juvenile ocean pout use complex habitats other than kelp, the NRC staff concludes that Seabrook operations may have minimal adverse effects on juvenile ocean pout and its habitat. Because Seabrook operations have not adversely affected the density or species diversity of benthic invertebrates, including shellfish beds, Seabrook operations are not likely to adversely affect adult ocean pout habitat.

Combined Impacts (Monitoring Data). NextEra monitored the abundance of ocean pout eggs, larvae, juveniles, and adults prior to and during operations at sampling sites near the intake and discharge structures and at sites 3–4 mi (5–8 km) away (NAI, 2010). Icthoplankton trawls did not capture ocean pout eggs and captured larvae in less than 10 percent of all samples (Table D-1-2). Monitoring data indicate that the abundance of juveniles and adult increased or remained the same at both nearfield and farfield sampling sites (Table D-1-9). Because NAI (2010) found similar trends at both the nearfield and farfield sites, these monitoring results suggest that Seabrook operations have not adversely affected EFH for ocean pout.

Conclusion. Because juveniles may use algal habitats and other complex habitats, and because the density of several kelp species has declined near Seabrook since operations began, NRC staff concludes that Seabrook may have minimal adverse effects on juvenile ocean pout and its habitat near Seabrook. Based on the above analysis, Seabrook is not likely to affect EFH for ocean pout eggs, larvae, or adults for the following reasons:

- Entrainment and impingement are relatively low compared to other species at Seabrook.
- The thermal plume rises quickly to surface waters.
- Forage species and shellfish beds are not likely to be adversely affected by Seabrook operations.
- Monitoring data indicate that the abundance trends for ocean pout were similar at nearfield and farfield sties.

*D-1.3.3.11 Pollock (*Pollachius virens*) (Juvenile)*

Designated EFH in the Vicinity of Seabrook. The NMFS has designated juvenile pollock EFH in the vicinity of Seabrook (NMFS, 2011b). NAI (2010) observed pollock in greater than 10 percent of trawling samples, in greater than 10 percent of gill net samples, and in 1–10 percent of seine pull samples (Table D-1-2) (NAI, 2010).

Species Description. Pollock are gadoids that occur on both sides of the North Atlantic (Cargnelli et al., 1999). Within the western Atlantic, pollock are relatively common within the Gulf of Maine (Cargnelli et al., 1999).

Juveniles migrate to and from offshore waters to nearshore habitats, such as the rocky subtidal and intertidal, until they remain offshore as adults (Cargnelli et al., 1999). Juveniles use a wide variety of habitats, including sand, mud, or rocky bottom and vegetation (Hardy, 1978 in Cargnelli et al. 1999). NEFSC trawl surveys captured juveniles at temperatures ranging from 34–64 degrees Fahrenheit (1–18 degrees Celsius).

Juveniles consume crustaceans, such as euphausiids and mollusks, and fish (Bowman and Michaels, 1984). Ojeda and Dearborn (1991) determined that fish, such as young Atlantic herring, dominated the diet of subtidal juveniles in the Gulf of Maine.

Status of the Fishery. NEFMC manages pollock as a single unit under the northeast multispecies FMP. In 2009, NEFMC determined that pollock was not overfished (NMFS, 2010b).

Entrainment and Impingement. Although NMFS has not designated EFH for pollock eggs and larvae, entrainment and impingement can adversely affect recruitment of juveniles. Entrainment of pollock eggs varied from 0 in 1990 to 8.5 million in 2007 (NAI, 2010). Annual average entrainment of pollock eggs was 1.4 million per year from 1990–2009 (Table D-1-4). Entrainment of pollock larvae varied from 0 in most years to 0.8 million in 2007 (NAI, 2010). Annual average entrainment of pollock larvae was 0.2 million per year from 1990–2009 (Table D-1-5). Pollock eggs and larvae comprised less than 1 percent of the total fish eggs and larvae entrained at Seabrook from 1990–2009.

Impingement of pollock varied from 72 in 2006 to 11,392 in 1999 (NAI, 2010). Annual average impingement was 1,273 fish per year from 1994–2009 (Table D-1-6). Pollock was the sixth

most commonly impinged fish species and comprised 6.1 percent of all impinged fish at Seabrook from 1994–2009.

Entrainment of pollock is small compared to other species entrained at Seabrook. However, pollock is the sixth most impinged fish species, comprising 6.1 percent of the total fish impinged at Seabrook. Therefore, the NRC staff concludes that impingement may have minimal adverse effects on EFH for pollock during the remainder of the facility's operating license or during the proposed license renewal term. Effects would likely be minimal since the amount of water (or habitat) captures in the Seabrook cooling system would be a very small proportion of available habitat for pollock juveniles and adults.

Thermal Effects. The NRC staff does not expect Seabrook's thermal discharges to reduce available habitat to juvenile pollock. Juvenile pollock use primarily benthic habitats in the nearshore, such as rocky subtidal or intertidal area, although some may also travel throughout the water column (Cargnelli et al., 1999). A relatively small area near the discharge structure in deep water experiences increased temperatures (NAI, 2001; Padmanabhan and Hecker, 1991). From May–June and October–December, when pollock density was highest in Seabrook monitoring studies, the surface temperature reached 57.7 degrees Fahrenheit (14.3 degrees Celsius) near Seabrook (NAI, 2010). NEFSC trawl surveys captured juveniles at temperatures ranging from 34–64 degrees Fahrenheit (1–18 degrees Celsius). With a temperature rise of 3–5 degrees Fahrenheit (1.7–2.8 degrees Celsius), the thermal plume near the surface would be within the typical range of temperatures that juvenile pollock inhabit. The NRC staff concludes that the increased temperatures at Seabrook are not likely to adversely affect EFH for juvenile pollock during the remainder of the facility's operating license or during the proposed license renewal term. This conclusion is based on the findings that the buoyant thermal plume at the discharge points quickly rises toward the surface, and the temperature range within the thermal plume at the surface would be within the typical range for juvenile pollock.

Loss of Forage Species. Juveniles consume crustaceans, such as euphausiids and mollusks, and fish, such as Atlantic herring (Bowman and Michaels, 1984; Ojeda and Dearborn, 1991). NextEra's monitoring studies show relatively similar trends prior to and during operations at nearfield and farfield sampling sites for the abundance and density of zooplankton, benthic invertebrates, and most fish species (NAI, 2010). Entrainment and impingement were relatively low for Atlantic herring, primary fish prey for juvenile pollock, compared to other species at Seabrook. Therefore, the NRC staff concludes that the potential loss of forage species at Seabrook is not likely to adversely affect pollock during the remainder of the facility's operating license or during the proposed license renewal term.

Loss of Habitat-forming Species. Juveniles use a wide variety of habitats, including sand, mud, or rocky bottom and vegetation (Hardy, 1978 in Cargnelli et al. 1999). Seabrook monitoring data indicate that the density of several species of kelp has decreased at nearfield sampling stations since operations began, but NextEra observed similar trends for the density of benthic invertebrates at the nearfield and farfield sampling sites prior to and during operations (NAI, 2010). Because the density of kelp is lower since operations began at Seabrook, but juvenile pollock use complex habitats other than kelp, the NRC staff concludes that Seabrook operations may have minimal adverse effects on juvenile pollock habitat.

Combined Impacts (Monitoring Data). NextEra monitored the abundance of juvenile pollock prior to and during operations at sampling sites near the intake and discharge structures and at sites 3–4 mi (5–8 km) away and within Hampton-Seabrook Estuary (NAI, 2010). Monitoring data indicate that the abundance of juvenile pollock decreased or remained the same at both

nearfield and farfield sampling sites (Tables D-1-10 and D-1-11). Because NAI (2010) found similar trends at both the nearfield and farfield sites, these monitoring results suggest that Seabrook operations have not adversely affected EFH for juvenile pollock.

Conclusion. Based on the above analysis, the NRC staff concludes that Seabrook may have minimal adverse effects on EFH for juvenile pollock because juveniles may use algal habitats that have declined near Seabrook since operations began, and pollock is the sixth most impinged fish species, comprising 6.1 percent of the total fish impinged at Seabrook. Impacts would likely be minimal for the following reasons:

- Pollock are not commonly entrained in the Seabrook cooling system.
- The thermal plume rises quickly to the surface.
- The temperature range within the thermal plume at the surface would be within the typical range for juvenile pollock.
- Forage species are not likely adversely affected by Seabrook operations.
- Monitoring data show similar trends at nearfield and farfield stations prior to and during operations.

*D-1.3.3.12 Red hake (*Urophycis chuss*) (All Life Stages)*

Designated EFH in the Vicinity of Seabrook. The NMFS has designated eggs, larvae, juvenile, and adult red hake EFH in the vicinity of Seabrook (NMFS, 2011b). NAI (2010) observed *Urophycis* spp. (mostly red and white (*U. tenuis*) hake and to a lesser extent spotted hake (*U. regia*)) egg and larvae in greater than 10 percent of ichthyoplankton tows, juveniles and adults in greater than 10 percent of trawling samples, in 1–10 percent of gill net samples, and in more than 10 percent of seine pull samples (Table D-1-2).

Species Description. Red hake are demersal fish that occur along the U.S. and Canadian costs from North Carolina to Southern Newfoundland (Sosebee, 1998). Red hake migrate seasonally to various depths to inhabit waters with relatively consistent temperatures—they migrate to waters deeper than 328 ft (100 m) in the fall and waters less than 328 ft (100 m) in warmer months (Steimle et al., 1999c).

Southern Gulf of Maine is not a common spawning ground for red hake (Steimle et al., 1999c). Eggs are buoyant and float near the surface (Steimle et al., 1999c). Larvae are also pelagic and inhabit the upper water column. NEFSC MARMAP ichthyoplankton surveys collected larvae at temperatures ranging from 46–73 degrees Fahrenheit (8–23 degrees Celsius)(Steimle et al., 1999c). Surveys indicate that larvae are more abundant in the Middle Atlantic Bight than the Gulf of Maine (Steimle et al., 1999c). Juveniles remain pelagic for approximately 2 months before they settle to the sea floor. Bottom trawl surveys captured juveniles in waters up to 72 degrees Fahrenheit (22 degrees Celsius) (Steimle et al., 1999c). Benthic habitat structure for shelter—such as sea scallop shells, Atlantic surf clams, seabed depressions, or other structure—is important habitat for juveniles (Steiner et al., 1982). Adult red hake commonly inhabit areas with soft sediments bottoms that contain shellfish beds or depressions as well as natural and artificial reefs (Steimle et al., 1999c).

Prey varies by life stage. Larvae consume mainly copepods and other microcrustaceans (Steimle et al., 1999c). Juvenile red hake consume small benthic and pelagic crustaceans, such as larval and small decapod shrimp and crabs, mysids, euphausiids, and amphipods

(Steimle et al., 1999c). Similar to juveniles, adults consume crustaceans but also prey on a variety of demersal and pelagic fish and squid.

Status of the Fishery. NEFMC manages the red hake fishery under the northeast multispecies FMP. In 2009, NEFMC did not consider the red hake fishery overfished (NMFS, 2010b).

Entrainment and Impingement. Entrainment of red, white, and spotted hake at Seabrook was recorded under a single category for *Urophycis* spp. (NAI, 2010). Entrainment of hake eggs varied from 0.6 million in 1994 to 213.2 million in 1996 (NextEra, 2010a). Annual average entrainment of hake eggs was 45.7 million per year from 1990–2009 (Table D-1-4). Hake was the fourth most commonly entrained taxa, comprising 5.1 percent of all entrained fish eggs at Seabrook from 1990–2009.

Entrainment of hake larvae varied from 0 in most years to 29.8 million in 2000 (NAI, 2010). Annual average entrainment of hake larvae was 2.8 million per year from 1990–2009 (Table D-1-5). Hake larvae comprised 1 percent of the total fish larvae entrained at Seabrook from 1990–2009.

Impingement of red hake varied from 1 in 1994 to 1,478 in 1996 (NAI, 2010). Annual average impingement was 509 fish per year from 1994–2009 (Table D-1-6). For hakes, which included red hake, white hake, and spotted hake, impingement varied from 4 in 1998 to 3,216 in 2008 (NAI, 2010). Annual average impingement was 866 fish per year from 1994–2009 (Table D-1-6). The red hake and hake categories comprised 6.5 percent of all impinged fish at Seabrook from 1994–2009.

Because entrainment and impingement of hake were relatively common at Seabrook, the NRC staff concludes that entrainment and impingement may minimal adverse effects on EFH for red hake during the remainder of the facility's operating license or during the proposed license renewal term. Effects would likely be minimal since the amount of water (or habitat) captured in the Seabrook cooling system would be a very small proportion of available habitat for all life stages of red hake.

Thermal Effects. The NRC staff does not expect Seabrook's thermal discharges to reduce available habitat to red hake. Larvae and young juveniles inhabit pelagic waters up to 72–73 degrees Fahrenheit (22–23 degrees Celsius) (Steimle et al., 1999c). Surface waters near the thermal plume typically range as high as 65.8 degrees Fahrenheit (18.8 degrees Celsius) (NAI, 2001). With a temperature rise of 3–5 degrees Fahrenheit (1.7–2.8 degrees Celsius), the thermal plume near the surface would be within the typical range of temperatures that larvae and young juveniles inhabit. Older juvenile and adult red hake are benthic (Steimle et al., 1999c). A relatively small area near the discharge structure in deep water experiences increased temperatures (NAI, 2001; Padmanabhan and Hecker, 1991). The NRC staff concludes that the heated effluent from Seabrook is not likely to adversely affect EFH for red hake during the remainder of the facility's operating license or during the proposed license renewal term. This conclusion is based on the fact that the buoyant thermal plume at the discharge points quickly rises toward the surface, and the temperature range within the thermal plume at the surface would be within the typical range for larvae and young juvenile red hake.

Loss of Forage Species. Red hake consume a variety of prey items, including copepods, shrimp, crabs, euphausiids, amphipods, and other crustaceans, and a variety of demersal and pelagic fish and squid (Steimle et al., 1999c). NextEra's monitoring studies show relatively similar trends in abundance prior to and during operations at nearfield and farfield sampling sites for zooplankton, benthic invertebrates, and most fish species (NAI, 2010). Therefore, the

NRC staff concludes that the potential loss of forage species at Seabrook is not likely to adversely affect EFH for red hake during the remainder of the facility's operating license or during the proposed license renewal term.

Loss of Habitat-forming Species. Juvenile and adult red hake commonly use shellfish bed for shelter, as well as other natural and artificial structures. Seabrook observed similar trends in the density of benthic invertebrates at the nearfield and farfield sites prior to and during operations (NAI, 2010). Therefore, the NRC staff concludes that the potential loss of habitat-forming species at Seabrook is not likely to adversely affect EFH for red hake during the remainder of the facility's operating license or during the proposed license renewal term.

Combined Impacts (Monitoring Data). NextEra monitored the abundance of hake eggs, juveniles, and adults prior to and during operations at sampling sites near the intake and discharge structures and at sites 3–4 mi (5–8 km) away (NAI, 2010). This category included *Urophycis* spp. (mostly red and white hake) and to a lesser extent spotted hake (NAI, 2010). Monitoring data indicate that the abundance of hake eggs, juveniles, and adults decreased at both nearfield and farfield sampling sites (Tables D-1-8 and D-1-9). Because NAI (2010) found similar trends at both the nearfield and farfield sites, these monitoring results suggest that Seabrook operations have not adversely affected EFH for hake.

Conclusion. Based on the above analysis, the NRC staff concludes that entrainment and impingement may have minimal adverse effects on EFH for red hake eggs, larvae, juvenile, and adults during the remainder of the facility's operating license or during the proposed license renewal term because entrainment and impingement of hake were relatively common at Seabrook. Impacts would likely be minimal for the following reasons:

- Thermal plume rises quickly to surface waters and is within the typical range of surface temperatures for larvae and young juveniles.
- Forage species and shellfish beds are not likely to be adversely affected.
- Monitoring data show similar trends in the abundance of red hake at nearfield and farfield sties prior to and during operations.

*D-1.3.3.13 Scup (*Stenotomus chrysops*) (Juvenile and Adult)*

Designated EFH in the Vicinity of Seabrook. The NMFS has designated juvenile and adult scup EFH in the vicinity of Seabrook (NMFS, 2011b). NAI (2010) observed scup in 1–10 percent of trawling samples and less than 1 percent of gill net samples (Table D-1-2).

Species Description. Scup are demersal fish that primarily occur primarily along the U.S. coast from Massachusetts to South Carolina, and have been observed as far north as the Bay of Fundy (Steimle et al., 1999d). Scup migrate south of New Jersey during the winter.

During the summer and early fall, juveniles and adults inhabit larger estuaries and coastal areas. Baird (1873 in Steimle et al. 1999d) reported habitat for juveniles to include sand, silty-sand, shell, mud, mussel beds, and eelgrass (*Zosteria marina*). Adults exhibit schooling behavior and also use a variety of habitats, including open sandy bottom and structured habitats such as mussel beds, reefs, or rough bottom (Steimle et al., 1999d).

Juveniles prey on small crustaceans, such as amphipods, polychaetes, and copepods (Steimle et al., 1999d). Adults consume a variety of prey, including small zooplankton, polychaetes, mollusks, other crustaceans, small squid, vegetable detritus, insect larvae, hydroids, sand

dollars, and small fish (Bigelow and Schroeder, 1953; Steimle et al., 1999d). Predators of scup include a variety of fish and sharks, such as bluefish (*Pomatomus saltatrix*), Atlantic halibut, cod, striped bass (*Morone saxitilus*), weakfish, goosefish, silver hake, and other coastal fish predators (see review in Steimle et al., 1999d).

Status of the Fishery. MAFMC manages the scup fishery under the summer flounder, scup, and black sea bass FMP. In 2009, MAFMC did not consider the scup fishery overfished (NMFS, 2010b).

Entrainment and Impingement. Although NMFS has not designated EFH for scup eggs and larvae, entrainment and impingement can adversely affect recruitment of juveniles and adults. NAI (2010) did not observe scup eggs or larvae in entrainment studies from 1990–2009. Impingement of scup varied from 0 in multiple years to 21 in 2005 (NAI, 2010). Annual average impingement was 7 fish per year from 1994–2009 (Table D-1-6). Scup comprised less than 1 percent of all impinged fish at Seabrook from 1994–2009.

Because NAI (2010) did not observe scup entrainment, and because impingement is small compared to other species entrained at Seabrook, the NRC staff concludes that entrainment and impingement are not likely to adversely affect EFH for scup during the remainder of the facility's operating license or during the proposed license renewal term.

Thermal Effects. The NRC staff does not expect Seabrook's thermal discharges to reduce available habitat to juvenile or adult scup. Juvenile and adult scup are primarily benthic (Steimle et al., 1999d). A relatively small area near the discharge structure in deep water experiences increased temperatures (NAI, 2001; Padmanabhan and Hecker, 1991). Because the buoyant thermal plume at the discharge points quickly rises toward the surface, the NRC staff concludes that the heated effluent from Seabrook is not likely to adversely affect EFH for scup during the remainder of the facility's operating license or during the proposed license renewal term.

Loss of Forage Species. Scup consume a variety of prey including zooplankton, amphipods, polychaetes, copepods, mollusks, other crustaceans, small squid, vegetable detritus, insect larvae, hydroids, sand dollars, and small fish (Bigelow and Schroeder, 1953; Steimle et al., 1999d). NextEra's monitoring studies show relatively similar trends prior to and during operations at nearfield and farfield sampling sites for the abundance, density, and species composition of zooplankton, benthic invertebrates, and most fish species (NAI, 2010). Therefore, the NRC staff concludes that the potential loss of forage species at Seabrook is not likely to adversely affect EFH for scup during the remainder of the facility's operating license or during the proposed license renewal term.

Loss of Habitat-forming Species. Juvenile and adult scup use a variety of habitats, including open areas and areas with structure such as mussel beds and eelgrass (*Zosteria marina*) (Steimle et al., 1999d). Seabrook monitoring data indicate that the density of several species of kelp has decreased at nearfield sampling stations since operations began, but Seabrook observed similar trends in the density of benthic invertebrates at the nearfield and farfield sites prior to and during operations (NAI, 2010). Because scup inhabit a wide variety of habitats and kelp are not a primary or preferred habitat, the NRC staff concludes that the potential loss of habitat-forming species at Seabrook is not likely to adversely affect EFH for scup during the remainder of the facility's operating license or during the proposed license renewal term.

Combined Impacts (Monitoring Data). Seabrook monitoring data do not provide data specific to the abundance of juvenile or adult scup prior to and during operations (NAI, 2010).

Conclusion. Based on the above analysis, the NRC staff concludes that Seabrook operations are not likely to adversely affect EFH for juvenile or adult scup for the following reasons:

- Impingement and entrainment are relatively low for scup.
- The thermal plume quickly rises to the surface.
- Forage species and shellfish beds are not likely to be adversely affected by Seabrook operations.
- Scup use a wide variety of habitats other than kelp.

*D-1.3.3.14 Summer flounder (*Paralicthys dentatus*) (Adult)*

Designated EFH in the Vicinity of Seabrook. The NMFS has designated adult summer flounder EFH in the vicinity of Seabrook (NMFS, 2011b). NAI (2010) observed summer flounder in less than 1 percent of trawling samples (Table D-1-2).

Species Description. Summer flounder are benthic fish that occurs from Nova Scotia to Florida (Packer et al., 1999). Adult summer flounder migrate seasonally, whereby summer flounder normally inhabit shallow coastal and estuarine waters during summer and remain offshore during the fall and winter (Lux and Nichy, 1981 in Packer et al., 1999; Packer et al., 1999).

Adults prefer sandy habitats. Lascara (1981 in Packer et al., 1999) showed that adults remain along the vegetative perimeter of eelgrass patches and capture prey that move from within the grass. Adult summer flounder are opportunistic feeders and prey upon a variety of fish and crustaceans (Bigelow and Schroeder, 1953; Packer et al., 1999). Common prey items include windowpane, winter flounder, northern pipefish, Atlantic menhaden, bay anchovy, red hake, silver hake, scup, Atlantic silverside, American sand lance, bluefish, weakfish, mummichog, rock crabs, squids, shrimps, small bivalve and gastropod mollusks, small crustaceans, marine worms, and sand dollars (Packer et al., 1999). Predators of summer flounder include large sharks, rays, and goosefish.

Status of the Fishery. MAFMC manages the summer flounder fishery under the summer flounder, scup, and black sea bass FMP. In 2009, MAFMC did not consider the summer flounder fishery overfished (NMFS, 2010b).

Entrainment and Impingement. Although NMFS has not designated EFH for summer flounder eggs and larvae, entrainment and impingement can adversely affect recruitment of adults. NAI (2010) did not observe summer flounder eggs in entrainment studies from 1990–2009. NAI (2010) observed entrainment of less than 100,000 summer flounder larvae during 3 years from 1990–2009 (Table D-1-5). NAI (2010) observed three impinged fish in 1994 and four impinged fish in 2006 (Table D-1-6).

Because entrainment and impingement of summer flounder were relatively rare at Seabrook, the NRC staff concludes that entrainment and impingement are not likely to adversely affect EFH for summer flounder during the remainder of the facility's operating license or during the proposed license renewal term.

Thermal Effects. The NRC staff does not expect Seabrook's thermal discharges to reduce available habitat to adult summer flounder. Summer flounder are primarily benthic (Packer et al., 1999). A relatively small area near the discharge structure in deep water experiences increased temperatures (NAI, 2001; Padmanabhan and Hecker, 1991). Because the buoyant

thermal plume at the discharge points quickly rises toward the surface, the NRC staff concludes that the heated effluent from Seabrook is not likely to adversely affect EFH for summer flounder during the remainder of the facility's operating license or during the proposed license renewal term.

Loss of Forage Species. Adult summer flounder are opportunistic feeders and prey upon a variety of fish and crustaceans (Bigelow and Schroeder, 1953; Packer et al., 1999). NextEra's monitoring studies show relatively similar trends prior to and during operations at nearfield and farfield sampling sites for the abundance, density, and species composition of benthic invertebrates and most fish species (NAI, 2010). Therefore, the NRC staff concludes that the potential loss of forage species at Seabrook is not likely to adversely affect summer flounder EFH during the remainder of the facility's operating license or during the proposed license renewal term.

Loss of Habitat-forming Species. Adult summer flounder use open sandy areas and patches of eelgrass for feeding (Packer et al., 1999). Near the intake and discharge structures, it is reasonable to assume that patches of kelp may play a similar ecological role as eelgrass for summer flounder to ambush predators. Seabrook monitoring data indicate that the density of several species of kelp has decreased at nearfield sampling stations because operations began (NAI, 2010). Because summer flounder use patches of vegetation to ambush predators, the NRC staff concludes that the potential loss of habitat-forming species at Seabrook may have minimal adverse effects on EFH for adult summer flounder during the remainder of the facility's operating license or during the proposed license renewal term. Effects would likely be minimal since adult summer flounder inhabit a variety of habitats and vegetation other than kelp.

Combined Impacts (Monitoring Data). Seabrook monitoring data do not provide data specific to the abundance of adult summer flounder prior to and during operations (NAI, 2010).

Conclusion. Because summer flounder may use algal habitats that have declined near Seabrook since operations began, the NRC staff concludes that Seabrook may have minimal adverse effects on EFH for summer flounder near Seabrook. Impacts would likely be minimal because impingement and entrainment are relatively rare for summer flounder, the thermal plume quickly rises to the surface, and forage species and shellfish beds are not likely to be adversely affected by Seabrook operations.

*D-1.3.3.15 Whiting/Silver hake (***Merluccius bilinearis***) (All life stages)*

Designated EFH in the Vicinity of Seabrook. The NMFS has designated eggs, larvae, juvenile, and adult silver hake EFH in the vicinity of Seabrook (NMFS, 2011b). NAI (2010) observed silver hake egg and larvae in greater than 10 percent of ichthyoplankton tows, juveniles and adults in greater than 10 percent of trawling samples, in greater than 10 percent of gill net samples, and in less than 1 percent of seine pull samples (Table D-1-2).

Species Description. Silver hake are schooling gadids (Lock and Packer, 2004). Two stocks occur in the western Atlantic Ocean—one stock ranges from the Gulf of Maine to northern Georges Bank and the other stock ranges from southern Georges Bank to Cape Hatteras.

Coastal Gulf of Maine is a major spawning area for silver hake. Brodziak (2001) reported peak spawning from July–August in the northern stock of silver hake. Eggs and newly hatched larvae are pelagic (Lock and Packer, 2004). After 3–5 months, larvae descend towards benthic habitats (Jeffrey and Taggart, 2000). NEFSC MARMAP ichthyoplankton surveys captured eggs

at temperatures ranging from 41–73 degrees Fahrenheit (5–23 degrees Celsius) and larvae from 41–66 degrees Fahrenheit (5–19 degrees Celsius) (Lock and Packer, 2004).

Juvenile and adult silver hake make seasonal migrations, moving offshore as water temperatures decline in the fall and returning to shallow waters in spring and summer to spawn. Juvenile and adult silver hake are primarily benthic but will move up into the water column for feeding (Koeller et al., 1989; Lock and Packer, 2004). Lock and Packer (2004) consider silver hake use and preference of various bottom habitats a future research need. NEFSC bottom trawl surveys captured juveniles at temperatures ranging from 36–70 degrees Fahrenheit (2–21 degrees Celsius) and adults from 36–63 degrees Fahrenheit (2–17 degrees Celsius) (Lock and Packer, 2004).

Silver hake are an important predator species due to their dominant biomass and high prey consumption (Bowman, 1984; Garrison and Link, 2000). Silver hake diet varies with life stage, size, sex, season, migration, spawning, and age. Larvae prey on plankton such as copepod larvae and younger copepodites (Lock and Packer, 2004). Juveniles generally consume euphausiids, shrimp, amphipods, and decapods (Bowman, 1984). Adults and older juveniles mainly prey on schooling fish, such as young herring, mackerel, menhaden, alewives, sand lance, or silversides, although crustaceans and squids are also consumed (Bowman, 1984; Garrison and Link, 2000; Lock and Packer, 2004). Predators include offshore, silver, white, red, and spotted hakes and to a lesser extent demersal gadids, pelagic fish species, and squids (Lock and Packer, 2004).

Status of the Fishery. NEFMC manages the silver hake fishery. In 2009, NEFMC did not consider the silver hake fishery overfished (NMFS, 2010b).

Entrainment and Impingement. Entrainment of silver hake eggs varied from 0.6 million in 1991 to 341.4 million in 2002 (NAI, 2010). Annual average entrainment of silver hake eggs was 81.1 million per year from 1990–2009 (Table D-1-4). Silver hake was the third most commonly entrained egg species, comprising 9 percent of all entrained fish eggs at Seabrook from 1990−2009.

Entrainment of silver hake larvae varied from 0 in several years to 69 million in 1997 (NAI, 2010). Annual average entrainment of silver hake larvae was 8.1 million per year from 1990–2009 (Table D-1-5). Silver hake larvae was the ninth most commonly entrained larval species, comprising 3 percent of the total fish larvae entrained at Seabrook from 1990–2009.

Impingement of silver hake varied from 0 in 1994 to 1,177 in 2002 (NAI, 2010). Annual average impingement was 167 fish per year from 1994–2009 (Table D-1-6). Silver hake comprised less than 1 percent of all impinged fish at Seabrook from 1994–2009.

Because entrainment of silver hake was relatively common at Seabrook, the NRC staff concludes that entrainment may have minimal adverse effects on EFH for silver hake during the remainder of the facility's operating license or during the proposed license renewal term. Effects would likely be minimal since the amount of water (or habitat) entrained in the Seabrook cooling system would be a very small proportion of available habitat for silver hake eggs and larvae.

Thermal Effects. The NRC staff does not expect Seabrook's thermal discharges to reduce available habitat to silver hake. NEFSC MARMAP ichthyoplankton surveys captured eggs at temperatures ranging from 41–73 degrees Fahrenheit (5–23 degrees Celsius) and larvae from 41–66 degrees Fahrenheit (5–19 degrees Celsius) (Lock and Packer, 2004). Juveniles and

adults are primarily benthic but may move into the water column for feeding (Lock and Packer, 2004). NEFSC bottom trawl surveys captured juveniles at temperatures ranging from 36–70 degrees Fahrenheit (2–21 degrees Celsius) and adults from 36–63 degrees Fahrenheit (2–17 degrees Celsius) (Lock and Packer, 2004). Surface waters near the thermal plume typically range as high as 65.8 degrees Fahrenheit (18.8 degrees Celsius) (NAI, 2001). With a temperature rise of 3–5 degrees Fahrenheit (1.7–2.8 degrees Celsius), the thermal plume near the surface would be within the typical range of temperatures that eggs and juveniles inhabit. However, the thermal plume may exceed the typical range of temperatures that larvae and adults inhabit. A relatively small area near the discharge structure in deep water experiences increased temperatures (NAI, 2001; Padmanabhan and Hecker, 1991). The NRC staff concludes that the heated thermal effluent from Seabrook is not likely to adversely affect EFH for eggs and juveniles during the remainder of the facility's operating license or during the proposed license renewal term. This conclusion is based on the fact that the buoyant thermal plume at the discharge points quickly rises toward the surface, and the temperature range within the thermal plume at the surface would be within the typical range for eggs and juvenile silver hake. Because the thermal plume could exceed the typical range of temperatures that larvae and adults inhabit, the NRC staff concludes that the heated thermal effluent may adversely affect EFH for silver hake larvae and adults.

Loss of Forage Species. Silver hake consume a variety of prey, including copepod larvae, copepodites, euphausiids, shrimp, amphipods, decapods, and other crustaceans and schooling fish (e.g., young herring, mackerel, menhaden, alewives, sand lance, and silversides) and squids (Bowman, 1984; Garrison and Link, 2000; Lock and Packer, 2004). NextEra's monitoring studies show relatively similar trends in abundance prior to and during operations at nearfield and farfield sampling sites for zooplankton, benthic invertebrates, and most fish species (NAI, 2010). Therefore, the NRC staff concludes that the potential loss of forage species at Seabrook is not likely to adversely affect silver hake EFH during the remainder of the facility's operating license or during the proposed license renewal term.

Loss of Habitat-forming Species. Lock and Packer (2004) consider silver hake use and preference of various bottom habitats a future research need. A recent literature search by NRC staff did not indicate that silver hake prefer or heavily rely on shellfish beds or algae covered areas.

Combined Impacts (Monitoring Data). NextEra monitored the abundance of silver hake eggs, larvae juveniles, and adults prior to and during operations at sampling sites near the intake and discharge structures and at sites 3–4 mi (5–8 km) away (NAI, 2010). Monitoring data indicate that the abundance of silver hake eggs and larvae increased at both nearfield and farfield sampling sites (Table D-1-8). Gill net surveys indicate that abundance of silver hake within the water column decreased at both nearfield and farfield sites (Table D-1-10). Trawling surveys indicate that silver hake abundance near the sea floor decreased at the nearfield site but increased at the farfield sites (Table D-1-9). NAI (2010) did not report the statistical significance of this relationship. Because adult and juvenile silver hake decreased at nearfield trawling sites but increased at farfield trawling sites, these monitoring results suggest that Seabrook operation may adversely affect bottom habitat for adult and juvenile silver hake.

Conclusion. Based on the above analysis, the NRC staff concludes that Seabrook operations may adversely affect EFH for silver hake eggs, larvae, juveniles, and adults for the following reasons:

- Entrainment of silver hake eggs was relatively common at Seabrook.

- The thermal plume could exceed the typical range of temperatures that larvae and adults inhabit.
- Adult and juvenile silver hake decreased at nearfield trawling sites but increased at farfield trawling sites in NextEra monitoring studies.

*D-1.3.3.16 Windowpane flounder (*Scopthalmus aquosus*) (Juveniles and Adults)*

Designated EFH in the Vicinity of Seabrook. The NMFS has designated juvenile and adult windowpane flounder EFH near Seabrook (NMFS, 2011b). NAI (2010) observed windowpane flounder in greater than 10 percent of trawling samples, less than 1 percent of gill net samples, and 1–10 percent of seine pull samples (Table D-1-2).

Species Description. Windowpane flounder inhabit estuaries, coastal waters, and oceans over the continental shelf along the Atlantic coast from the Gulf of Saint Lawrence to Florida. This species is most abundant from Georges Bank to Chesapeake Bay (Chang et al., 1999). North of Cape Cod Bay, windowpane flounder inhabit nearshore waters, and distribution patterns within estuaries is not well documented (Chang et al., 1999).

Windowpane flounder spawn in estuaries. Juveniles migrate from estuaries to coastal waters during autumn, and they overwinter offshore in deeper waters. Adults remain offshore throughout the year but inhabit nearshore waters in spring and autumn (Chang et al., 1999). Langton et al. (1994) reported that adult windowpane occur primarily on sandy or muddy substrates in the Gulf of Maine.

Juvenile and adult windowpane flounder have similar food sources, including small crustaceans (especially shrimp) and fish larvae of hakes and tomcod. Predators include spiny dogfish, thorny skate (*Amblyraja radiata*), goosefish, Atlantic cod, black sea bass (*Centropristis striata*), weakfish (*Cynoscion regalis*), and summer flounder (Chang et al., 1999).

Status of the Fishery. The NEFMC manages windowpane flounder under the northeast multispecies FMP. Windowpane flounder have never been widely directly targeted as a commercial species but have been harvested in mixed-species fisheries since the 1900s. In the 1950s, landings were estimated to be as high as 2.04 million lb (924 MT) per year (Hendrickson, 2006). Landings ranged from 1.1–2.0 million lb (500–900 MT) per year from 1975–1981, increased to a record high of 4.6 million lb (2,100 MT) in 1985, and they have since steadily declined (Hendrickson, 2006). The windowpane stock structure has never been formally quantified, and windowpane bycatch and discards from other fisheries are unknown and may account for a significant portion of annual windowpane catch. Currently, NEFMC consider the New England and Mid-Atlantic stock overfished (NMFS, 2010b).

Entrainment and Impingement. Although NMFS has not designated EFH for windowpane eggs and larvae, entrainment and impingement can adversely affect recruitment of juveniles and adults. Entrainment of windowpane eggs varied from 0.1 million in 1994 to 61.8 million in 2009 (NAI, 2010). Annual average entrainment of windowpane eggs was 31.7 million per year from 1990–2009 (Table D-1-4). Windowpane was the eighth most commonly entrained egg species, comprising 3.5 percent of all entrained fish eggs at Seabrook.

Entrainment of windowpane larvae varied from 0.05 in 1991 to 6.5 million in 2002 (NAI, 2010). Annual average entrainment of windowpane larvae was 2.3 million per year from 1990–2009 (Table D-1-5). Windowpane larvae comprised less than 1 percent of the total fish larvae entrained at Seabrook from 1990–2009.

Impingement of windowpane varied from 161 in 2001 to 4,749 in 2003 (NAI, 2010). Annual average impingement was 1,297 fish per year from 1994–2009 (Table D-1-6). Windowpane was the fifth most commonly impinged fish species, comprising 6.2 percent of all impinged fish at Seabrook from 1994–2009.

Because entrainment of windowpane eggs and impingement of juveniles and adults was relatively common at Seabrook, the NRC staff concludes that entrainment and impingement may have minimal adverse effects on EFH for windowpane during the remainder of the facility's operating license or during the proposed license renewal term. Effects would likely be minimal since the amount of water (or habitat) captured in the Seabrook cooling system would be a very small proportion of available habitat for all stages of windowpane.

Thermal Effects. The NRC staff does not expect Seabrook's thermal discharges to reduce available habitat to juvenile or adult windowpane. Juvenile and adult windowpane are primarily benthic (Chang et al., 1999). A relatively small area near the discharge structure in deep water experiences increased temperatures (NAI, 2001; Padmanabhan and Hecker, 1991). Because the buoyant thermal plume at the discharge points quickly rises toward the surface, the NRC staff concludes that the heated effluent from Seabrook is not likely to adversely affect EFH for juvenile or adult windowpane during the remainder of the facility's operating license or during the proposed license renewal term.

Loss of Forage Species. Juvenile and adult windowpane flounder prey on small crustaceans (especially shrimp) and fish larvae of hakes and tomcod. NextEra's monitoring studies show relatively similar trends in abundance prior to and during operations at nearfield and farfield sampling sites for zooplankton and invertebrates (NAI, 2010). Therefore, the NRC staff concludes that the potential loss of forage species at Seabrook is not likely to adversely affect EFH for windowpane flounder during the remainder of the facility's operating license or during the proposed license renewal term.

Loss of Habitat-forming Species. Juvenile and adult windowpane flounder do not appear to use shellfish bed or algae for habitat. Therefore, the NRC staff concludes that the potential loss of habitat-forming species at Seabrook is not likely to adversely affect windowpane EFH during the remainder of the facility's operating license or during the proposed license renewal term.

Combined Impacts (Monitoring Data). NextEra monitored the abundance of windowpane juveniles and adults prior to and during operations at sampling sites near the intake and discharge structures and at sites 3–4 mi (5–8 km) away (NAI, 2010). Trawling surveys indicate that windowpane flounder decreased at the nearfield site but increased at the farfield sites (Table D-1-9). However, the confidence intervals overlapped, suggesting that this relationship would not be statistically significant. NAI (2010) did not report whether or not the relationship was statistical significant. These monitoring results suggest that Seabrook operation is not likely to adversely affect EFH of adult and juvenile windowpane.

Conclusion. Because entrainment of windowpane eggs and impingement of juveniles and adults were relatively common at Seabrook, the NRC staff concludes that Seabrook operation may have minimal adverse effects on EFH for windowpane during the remainder of the facility's operating license or during the proposed license renewal term. Impact would be minimal because the thermal plume quickly rises to the surface, forage species and shellfish beds are not likely to be adversely affected by Seabrook operations, and monitoring data shows similar trends at nearfield and farfield sites.

*D-1.3.3.17 Winter flounder (*Pleuronectes americanus*) (All Life Stages)*

Designated EFH in the Vicinity of Seabrook. The NMFS has designated eggs, larvae, juvenile, and adult winter flounder EFH in the vicinity of Seabrook (NMFS, 2011b). NAI (2010) observed winter flounder larvae in greater than 10 percent of ichthyoplankton tows, juveniles and adults in greater than 10 percent of trawling samples, in 1–10 percent of gill net samples, and in more than 10 percent of seine pull samples (Table D-1-2).

Species Description. There are three stocks of winter flounder in the Atlantic—the Gulf of Maine, southern New England and the Middle Atlantic, and Georges Bank (Pereira et al., 1999). In New England, winter flounder are common in inshore and nearshore waters (Pereira et al., 1999). Adult winter flounder are a small-mouthed, right-eyed flounder that grow to 23 in. (58 cm) in total length and live up to 15 years (Pereira et al., 1999).

Adult winter flounder migrate inshore to bays and estuaries in the fall and early winter to spawn and may remain inshore year-round in areas where temperatures are 59 degrees Fahrenheit (15 degrees Celsius) or lower and enough food is available (Pereira et al., 1999). Studies vary widely on the age of maturity of winter flounder. Generally, sexual maturity is dependent on size rather than age, and southern individuals reach spawning size more rapidly than northern fish. North of Cape Cod, O'Brien et al. (1993) determined that the median age of maturity was 11.7 in. (29.7 cm) for females and 10.9 in. (27.6 cm) for males. In the Hampton-Seabrook area, winter flounder spawn in coastal waters from February–April. Females spawn at depths of 7–60 ft (2–79 m) over sandy substrates in inshore coves and inlets at salinities of 31–32.5 parts per thousand (ppt) (Buckley, 1989; Pereira et al., 1999). Eggs are demersal, stick to the substrate (such as gravel or algal fronds), and are most often found at salinities between 10–30 ppt (Buckley, 1989; Crawford and Cary, 1985). Larvae initially are planktonic but become increasingly benthic as they develop (Pereira et al., 1999). Juveniles and adults are completely benthic. Able et al. (1989 in Pereira et al., 1999) reported that juveniles use macroalgae. Juveniles move seaward as they grow, remaining in estuaries for the first year (Buckley, 1989; Grimes et al., 1989). Adult winter flounder tolerate salinities of 5–35 ppt and prefer waters temperatures of 32–77 degrees Fahrenheit (0–25 degrees Celsius).

Winter flounder larvae feed on small invertebrates, invertebrate eggs, and phytoplankton (Buckley, 1989; Pereira et al., 1999). Adults feed on benthic invertebrates such as polychaetes, cnidarians, mollusks, and hydrozoans. Adults and juveniles are an important food source for predatory fish such as the striped bass (*Morone saxatilis*), bluefish, goosefish, spiny dogfish, and other flounders, and birds such as the great cormorant (*Phalacrocorax carbo*), great blue heron (*Ardea herodias*), and osprey (*Pandion haliaetus*) (Buckley, 1989).

Status of the Fishery. Winter flounder are highly abundant in estuarine and coastal waters and, therefore, are one of the most important species for commercial and recreational fisheries on the Atlantic coast (Buckley, 1989). Winter flounder are, generally, commercially harvested using otter trawl, but the species is also a popular recreational fish. Commercial landings of winter flounder peaked in the 1980s throughout its range and declined through the early 2000s (Brown and Gabriel, 1998; Pereira et al., 1999). Commercial landings reached a record low in 2005 at 2.98 million lb (1,350 MT) but have increased slightly since, with landings at 3.58 million lb (1,622 MT) in 2007 (NEFSC, 2008).

The NEFMC manages the winter flounder in Federal waters under the northeast multispecies FMP. As of 2009, the NEFMC reported that the Gulf of Maine winter flounder stock is overfished (NOAA, 2010).

Entrainment and Impingement. Entrainment of winter flounder eggs varied from 0 in most years to 1.05 million in 2008 (NAI, 2010). Annual average entrainment of winter flounder eggs was 96,500 per year from 1990–2009 (Table D-1-4). Winter flounder eggs comprised less than 1 percent of the total fish eggs entrained at Seabrook from 1990–2009.

Entrainment of winter flounder larvae varied from 0 in 1994 to 34.8 million in 2004 (NAI, 2010). Annual average entrainment of winter flounder larvae was 9.2 million per year from 1990–2009 (Table D-1-5). Winter flounder larvae was the eighth most commonly entrained species, comprising 3.4 percent of the total fish larvae entrained at Seabrook from 1990–2009.

Impingement of winter flounder varied from 102 in 2000 to 10,491 in 2003 (NAI, 2010). Annual average impingement was 2,082 fish per year from 1994–2009 (Table D-1-6). Winter flounder was the third most commonly impinged fish species, comprising 10 percent of all impinged fish at Seabrook from 1994–2009.

Because entrainment of winter flounder larvae and impingement of juveniles and adults were relatively common at Seabrook, the NRC staff concludes that entrainment and impingement may have minimal adverse effects on EFH for winter flounder during the remainder of the facility's operating license or during the proposed license renewal term. Effects would likely be minimal since the amount of water (or habitat) captured in the Seabrook cooling system would be a very small proportion of available habitat for all stages of winter flounder.

Thermal Effects. The NRC staff does not expect Seabrook's thermal discharges to reduce available habitat to eggs, larvae, juvenile, or adult winter flounder. Winter flounder are primarily benthic (Pereira et al., 1999.) A relatively small area near the discharge structure in deep water experiences increased temperatures (NAI, 2001; Padmanabhan and Hecker, 1991). Because the buoyant thermal plume at the discharge points quickly rises toward the surface, the NRC staff concludes that the heated effluent from Seabrook is not likely to adversely affect EFH for winter flounder during the remainder of the facility's operating license or during the proposed license renewal term.

Loss of Forage Species. Winter flounder feed on phytoplankton, small invertebrates, invertebrate eggs, and benthic invertebrates such as polychaetes, cnidarians, mollusks, and hydrozoans. NextEra's monitoring studies show relatively similar trends prior to and during operations at nearfield and farfield sampling sites for the abundance, density, and species composition of zooplankton and invertebrates (NAI, 2010). Therefore, the NRC staff concludes that the potential loss of forage species at Seabrook is not likely to adversely affect winter flounder EFH during the remainder of the facility's operating license or during the proposed license renewal term.

Loss of Habitat-forming Species. Window flounder eggs may be deposited on macroalgae (Crawford and Carey, 1985), but spawning occurs in estuaries and NAI (2010) did not observe winter flounder eggs in monitoring studies near Seabrook, likely due to its offshore location. Able et al. (1989 in Pereira et al., 1999) reported that juveniles use macroalgae habitat, along with other types of habitats. Seabrook monitoring data indicate that the density of several species of kelp has decreased at nearfield sampling stations since operations began (NAI, 2010). Because juvenile winter flounder may utilize macroalgae habitat, along with other types of aquatic vegetation, the NRC staff concludes that the potential loss of habitat-forming species at Seabrook may have minimal adverse effects on juvenile winter flounder EFH during the remainder of the facility's operating license or during the proposed license renewal term.

Combined Impacts (Monitoring Data). NextEra monitored the abundance of winter flounder larvae, juveniles, and adults prior to and during operations at sampling sites near the intake and discharge structures and at sites 3–4 mi (5–8 km) away (NAI, 2010). Monitoring data indicate that the abundance of larvae decreased at both nearfield and farfield sampling sites (Table D-1-8). Trawling data for juveniles and adults indicated different trends at the nearfield and farfield sites (NAI, 2010). At the nearfield site, the abundance of winter flounder significantly decreased over time from a mean CPUE of 5.5 prior to operations to 2.3 during operations (Table D-1-9). However, at both farfield sampling sites, 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. Based on monitoring data, NRC concludes that Seabrook operation has adversely affected EFH for winter flounder because 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.

Conclusion. Based on the above analysis, the NRC staff concludes that Seabrook operations may adversely affect EFH for winter flounder larvae, juveniles, and adults for the following reasons:

- Entrainment of winter flounder larvae and impingement of juveniles and adults were relatively common at Seabrook.
- Juveniles may use algal habitats that have declined near Seabrook since operations began.
- Ault and juvenile winter flounder abundance decreased at nearfield trawling sites but increased at farfield trawling sites in NextEra monitoring studies.

*D-1.3.3.18 Yellowtail flounder (*Pleuronectes ferruginea*) (Juveniles and Adults)*

Designated EFH in the Vicinity of Seabrook. The NMFS has designated juvenile and adult yellowtail flounder EFH in the vicinity of Seabrook (NMFS, 2011b). NAI (2010) observed yellowtail flounder in greater than 10 percent of trawling samples, in less than 1 percent of gill net samples, and in less than 1 percent of seine pull samples (Table D-1-2).

Species Description. Yellowtail flounder occur along the U.S. and Canadian coasts from the Gulf of St. Lawrence, Labrador, and Newfoundland to the Chesapeake Bay (Bigelow and Schroeder, 1953; Johnson et al., 1999). Juveniles and adults are asymmetrical benthic flatfish (Johnson et al., 1999). Preferred habitat includes areas covered in sand or sand-mud sediments where demersal prey inhabits (Bowering and Brodie, 1991; Johnson et al., 1999).

Juvenile yellowtail flounder consume primarily polychaetes while adult yellowtail flounder consume primarily crustaceans, such as amphipods and sand dollars (*Echinarachius parma*) (Johnson et al., 1999). Predators include spiny dogfish, winter skate, Atlantic cod, Atlantic halibut, fourspot flounder, goosefish, little skate, smooth skate, silver hake, bluefish, and sea raven (Johnson et al., 1999).

Status of the Fishery. Yellowtail first became commercial desirable in the 1930s and is currently a highly targeted fish (Johnson et al., 1999). In 2009, NEFMC considered yellowtail overfished (NMFS, 2010b).

Entrainment and Impingement. Although NMFS has not designated EFH for yellowtail flounder eggs and larvae, entrainment and impingement can adversely affect recruitment of juveniles

and adults. Entrainment of yellowtail flounder eggs varied from 0 in multiple years to 569.2 million in 1991 (NextEra, 2010a). Annual average entrainment of yellowtail flounder eggs was 42.8 million per year from 1990–2009 (Table D-1-4). Yellowtail flounder eggs was the sixth most commonly entrained fish egg species, comprising 4.8 percent of the total fish eggs entrained at Seabrook from 1990–2009.

Entrainment of yellowtail flounder larvae varied from 0 in 1994 to 2.7 million in 2007 (NAI, 2010). Annual average entrainment of winter flounder larvae was 0.4 million per year from 1990–2009 (Table D-1-5). Yellowtail flounder larvae comprised less than 1 percent of the total fish larvae entrained at Seabrook from 1990–2009.

Impingement of yellowtail flounder varied from 0 in several years to 1,149 in 1995 (NAI, 2010). Annual average impingement was 83 fish per year from 1994–2009 (Table D-1-6). Yellowtail flounder comprised less than 1 percent of all impinged fish at Seabrook from 1994–2009.

Because entrainment of yellowtail flounder eggs was relatively common at Seabrook, the NRC staff concludes that entrainment may have minimal adverse effects on EFH for yellowtail flounder during the remainder of the facility's operating license or during the proposed license renewal term. Effects would likely be minimal since the amount of weather (or habitat) entrained in the Seabrook cooling system would be a very small proportion of available habitat for yellowtail flounder eggs.

Thermal Effects. The NRC staff does not expect Seabrook's thermal discharges to reduce available habitat to juvenile or adult yellowtail flounder. Juvenile and adult yellowtail flounder are benthic flatfish (Johnson et al., 1999). A relatively small area near the discharge structure in deep water experiences increased temperatures (NAI, 2001; Padmanabhan and Hecker, 1991). Because the buoyant thermal plume at the discharge points quickly rises toward the surface, the NRC staff concludes that the heated effluent from Seabrook is not likely to adversely affect EFH for yellowtail flounder during the remainder of the facility's operating license or during the proposed license renewal term.

Loss of Forage Species. Juvenile yellowtail flounder consume primarily polychaetes while adult yellowtail flounder consume primarily crustaceans, such as amphipods and sand dollars (Johnson et al., 1999). NextEra's monitoring studies show relatively similar trends in abundance prior to and during operations at nearfield and farfield sampling sites for invertebrates (NAI, 2010). Therefore, the NRC staff concludes that the potential loss of forage species at Seabrook is not likely to adversely affect yellowtail flounder EFH during the remainder of the facility's operating license or during the proposed license renewal term.

Loss of Habitat-forming Species. Juvenile and adult yellowtail flounder do not commonly use kelp or shellfish beds. Therefore, the NRC staff concludes that the potential loss of habitat-forming species at Seabrook is not likely to adversely affect yellowtail flounder EFH during the remainder of the facility's operating license or during the proposed license renewal term.

Combined Impacts (Monitoring Data). NextEra monitored the abundance of yellowtail flounder juveniles and adults prior to and during operations at sampling sites near the intake and discharge structures and at sites 3–4 mi (5–8 km) away (NAI, 2010). Monitoring data indicate that the abundance of juveniles and adults decreased at both nearfield and farfield sampling sites (Table D-1-9). Because NAI (2010) found similar trends at both the nearfield and farfield sites, these monitoring results suggest that Seabrook operations have not adversely affected EFH for juvenile or adult yellowtail.

Conclusion. Because entrainment of yellowtail flounder eggs was relatively common at Seabrook, Seabrook operation may have minimal adverse effects on EFH for juvenile and adult yellowtail flounder during the remainder of the facility's operating license or during the proposed license renewal term. Impacts would be minimal for the following reasons:

- Impingement and entrainment are relatively low for yellowtail flounder.
- The thermal plume quickly rises to the surface.
- Forage species and shellfish beds are not likely to be adversely affected by Seabrook operations.
- Monitoring data show similar trends at nearfield and farfield sites.

D-1.3.3.19 Essential Fish Habitat Species Not Likely to Regularly Occur Near Seabrook

The NMFS has designated EFH for eggs, larvae, juvenile and adult Atlantic halibut; adult bluefin tuna; larvae, juvenile, and adult redfish; and juvenile and adult longfin inshore squid and northern shortfin squid in the vicinity of Seabrook (NMFS, 2011b). NAI (2010) never, rarely, or occasionally observed Atlantic halibut, bluefin tuna, redfish, northern shortfin squid, and longfin inshore squid during monitoring, entrainment, and impingement studies from the 1970s–2009. For example, NAI (2010) rarely identified Atlantic halibut in trawling surveys and did not report Atlantic halibut in any other monitoring surveys or any impingement or entrainment studies. NAI (2010) occasionally identified redfish in trawling surveys and did not report redfish in other monitoring surveys or any impingement or entrainment studies. Bluefin tuna were not reported in any monitoring, entrainment, or impingement studies. Seabrook did not explicitly include longfin inshore squid and northern shortfin squid in its entrainment and impingement studies. However, field technicians did not recall any time that squid have been impinged at Seabrook (NRC, 2011). Longfin inshore squid lay eggs on the seafloor and larvae are often found near the surface, whereas the intake structure is located in deeper water (Jacobson, 1995). Northern shortfin squid eggs and larvae are pelagic, but primarily occur within the Gulf Stream (Hendrickson and Holmes, 2004).

Bluefin tuna, longfin inshore squid, and northern shortfin squid are pelagic and, therefore, could encounter the thermal plume when passing by Seabrook. Surface waters near the thermal plume typically range as high as 65.8 degrees Fahrenheit (18.8 degrees Celsius) (NAI, 2001). NEFSC trawl data indicate that northern shortfin squid inhabit waters up to as 66 degrees Fahrenheit (19 degrees Celsius), and longfin inshore squid inhabit waters up to as 79 degrees Fahrenheit (26 degrees Celsius) (NAI, 2001). With a temperature rise of 3–5 degrees Fahrenheit (1.7–2.8 degrees Celsius), the thermal plume near the surface could exceed the typical temperature range for northern shortfin squid but would be within the typical temperature range for longfin inshore squid. Bluefin tuna have never been captured in any of NextEra's monitoring study; therefore, the relatively small size of the thermal plume is not likely to adversely affect large amounts of EFH for bluefin tuna if any happen to pass by Seabrook. The thermal plume is not likely to adversely affect EFH for Atlantic halibut or redfish because both of these species are pelagic and the thermal plume rises quickly to the surface.

Bluefin tuna, longfin inshore squid, and northern shortfin squid are pelagic and, therefore, not likely to regularly inhabit benthic habitats such as kelp forest or shellfish beds. Redfish and Atlantic halibut may use kelp near Seabrook, along with other habitats that provide structure. Seabrook monitoring data indicate that the density of several species of kelp has decreased at

nearfield sampling sites since operations began (NAI, 2010). Because the density of kelp is lower since operations began at Seabrook, but Atlantic halibut and redfish rarely or occasionally use habitat near Seabrook, the NRC staff concludes that Seabrook operations may have minimal adverse effects on Atlantic halibut and redfish.

Forage species for Atlantic halibut, bluefin tuna, redfish, longfin inshore squid, and northern shortfin squid are not likely to be adversely affected near Seabrook. Typical prey includes copepods, euphausiids, crabs, polychaetes, shrimp, and fish. NextEra's monitoring studies show relatively similar trends in abundance prior to and during operations at nearfield and farfield sampling sites for zooplankton, benthic invertebrates, and most fish species (NAI, 2010). Therefore, the NRC staff concludes that the potential loss of forage species at Seabrook is not likely to adversely affect EFH for Atlantic halibut, bluefin tuna, redfish, longfin inshore squid, or northern shortfin squid during the remainder of the facility's operating license or during the proposed license renewal term.

Based on the above analysis, the NRC staff concludes that Seabrook operations may have minimal adverse effects on EFH for northern shortfin squid because the thermal plume near the surface could exceed the typical temperature range for northern shortfin squid. Seabrook operations may have minimal adverse effects on EFH for redfish and Atlantic halibut because both species may use kelp beds near Seabrook. Seabrook operations are not likely to affect EFH for longfin inshore squid or bluefin tuna.

D-1.4 Cumulative Effects to Essential Fish Habitat

This section addresses the direct and indirect effects of license renewal on EFH 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, the offshore intake and discharge structures, the Hampton-Seabrook Estuary, and the rivers that drain into the Hampton-Seabrook Estuary.

Section 2.2.6.2 of the SEIS summarizes 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). Fishing has caused 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 those listed below (Eberhardt and Burdick, 2009):

- 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
- building roads, jetties, commercial buildings, and residential areas in the 1900s and 2000s

The increased urbanization in the past 100 years has caused 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 EFH in the area surrounding Seabrook. Potential biological stressors include continued entrainment, impingement, and potential heat shock from Seabrook (if the license renewal is granted), and fishing mortality, climate change, energy development, and urbanization, as described below.

Fishing. 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 (2002b) 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. Other commercially important and EFH 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, 2002b). Federal, regional, and State agencies manage many of these fisheries, 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.

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 on EFH.

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 EFH. 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 because this species inhabits cold waters (USGCRP, 2009). USGCRP (2009) projects that the Georges Bank Atlantic cod fishery will likely diminish 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 because spawning time is often correlated with a distinct temperature ranges. 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 and EFH, including the reduction or redistribution of kelp, eelgrass, and wetland communities. Aquatic vegetation is particularly susceptible to sea level rise because 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.

The ocean absorbs nearly one-third of the carbon dioxide (CO_2) released into the atmosphere (NMFS, 2011d). As atmospheric CO_2 increases, there is a concurrent increase in CO_2 levels in the ocean (NMFS, 2011d). 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., Atlantic sea scallops and Atlantic surf 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 adversely affect 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, energy development may contribute to future cumulative impacts in a variety of ways.

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 surrounded 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).

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 (Johnson et al., 2008; NHNHB, 2009). 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 adversely affected, 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 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 adversely affect EFH 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 may adversely affect the EFH of most species, especially Atlantic cod due to climate change.

D-1.5 Essential Fish Habitat Conservation Measures

NextEra prepared a proposal for information collection (PIC) as a first step to comply with EPA's 2004 proposed Phase II rule of Section 316(b) of CWA (NAI and ARCADIS, 2008). In this document, NextEra identified three types of mitigation that are now in place and 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 being trapped and drowning (NextEra, 2010a). 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.

D-1.6 Conclusion

Table D-1-13 summarizes NRC conclusions on the effect of Seabrook operation on habitat for the 23 EFH species that may occur within the vicinity of Seabrook.

Table D-1-13. Summary of NRC conclusions Regarding the Effect on Habitat by Species and Life Stages

Species	Eggs	Larvae	Juveniles	Adults	Rational for adverse impact
American plaice			NL[(a)]	NL	
Atlantic butterfish	NL	NL	NL	NL	
Atlantic cod	NL	MIN[(b)]	MIN	MIN	Some of the primary and preferred forage fish, such as Atlantic herring and American sand lance, are regularly entrained and impinged at Seabrook; the thermal plume near the surface could slightly exceed the typical range of temperatures that Atlantic cod inhabit; juvenile cod likely use kelp beds near Seabrook.
Atlantic halibut	NL	NL	MIN	MIN	Atlantic halibut may use algal habitats that have

Species	Eggs	Larvae	Juveniles	Adults	Rational for adverse impact
					declined near Seabrook since operations began.
Atlantic herring			MIN	MIN	The thermal plume near the surface could slightly exceed the typical range of temperatures that Atlantic herring juveniles and adults inhabit.
Atlantic mackerel	MIN	NL	NL	MIN	Atlantic mackerel is the second most entrained egg species, comprising 21.3 percent of the total fish eggs entrained at Seabrook. The thermal plume near the surface could exceed the typical temperature range that adult Atlantic mackerel inhabit.
Atlantic sea scallop	NL	NL	MIN	NL	Newly settled Atlantic sea scallops may use algal habitats that have declined near Seabrook since operations began.
Atlantic surf clam			NL	NL	
Bluefin tuna				NL	
Haddock			NL		
Longfin inshore squid			NL	NL	
Monkfish/Goosefish	MIN	MIN	MIN	NL	The thermal plume near the surface could slightly exceed the typical range of temperatures that goosefish eggs and larvae inhabit; juveniles may use algal habitats that have declined near Seabrook since operations began.
Northern shortfin squid			MIN	MIN	The thermal plume near the surface could exceed the typical temperature range for northern shortfin squid.
Ocean pout	NL	NL	MIN	NL	Juveniles may use algal habitats that have declined near Seabrook since operations began.
Pollock			MIN		Pollock is the sixth most impinged fish species, comprising 6.1 percent of the total fish impinged at Seabrook. Juveniles may use algal habitats that have declined near Seabrook since operations began.
Redfish		NL	MIN	MIN	Redfish may use algal habitats that have declined near Seabrook since operations began.
Red hake	MIN	MIN	MIN	MIN	The hake (which includes red, white, and spotted hake) comprised 6.2 percent of all entrained fish eggs and 6.5 percent of all impinged fish at Seabrook.
Scup			NL	NL	
Summer flounder				MIN	Summer flounder may use algal habitats that have declined near Seabrook since operations began.
Whiting/Silver hake	ADV[c]	ADV	ADV	ADV	Silver hake was the third most commonly entrained egg species, comprising 9 percent of all entrained fish eggs at Seabrook. The thermal plume could exceed the typical range of temperatures that larvae and adults inhabit, and adult and juveniles decreased at nearfield trawling sites but increased at farfield trawling sites in NextEra monitoring studies.
Windowpane			MIN	MIN	Windowpane comprised 3.5 percent of all entrained eggs and 6.2 percent of all impinged fish at

Species	Eggs	Larvae	Juveniles	Adults	Rational for adverse impact
flounder					Seabrook
Winter flounder	NL	ADV	ADV	ADV	Winter flounder was the third most commonly impinged fish species, comprising 10 percent of all impinged fish. Winter flounder larvae was the eighth most commonly entrained species, comprising 3.4 percent of the total fish larvae entrained. Winter flounder may use algal habitats that have declined near Seabrook since operations began. Adult and juvenile winter flounder abundance decreased at nearfield trawling sites but increased at farfield trawling sites in NextEra monitoring studies.
Yellowtail flounder			MIN	MIN	Yellowtail flounder eggs was the sixth most commonly entrained fish egg species, comprising 4.8 percent of the total fish eggs entrained at Seabrook.

[(a)] NL= Seabrook operation is not likely to affect EFH.

[(b)] MIN= Seabrook operation may have minimal adverse effects on EFH.

[(c)] ADV= Seabrook operation may adversely affect EFH.

D-1.7 References

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APPENDIX E
CHRONOLOGY OF ENVIRONMENTAL REVIEW

E CHRONOLOGY OF ENVIRONMENTAL REVIEW CORRESPONDENCE

This appendix contains a chronological listing of correspondence between the U.S. Nuclear Regulatory Commission (NRC) and external parties as part of its environmental review for Seabrook Station (Seabrook). All documents, with the exception of those containing proprietary information, are available electronically from the NRC's Public Electronic Reading Room, found on the Internet at the following Web address: http://www.nrc.gov/reading-rm.html. From this site, the public can gain access to the NRC's Agencywide Documents Access and Management System (ADAMS), which provides text and image files of NRC's public documents. The ADAMS accession number for each document is included below.

E.1 Environmental Review Correspondence

March 3, 2010	Letter from Ms. Brona Simon, State Historic Preservation Officer, Commonwealth of Massachusetts, Massachusetts Historical Commission, indicating that the Massachusetts Historical Commission had completed its review of the proposed Seabrook license renewal and had no concerns (ADAMS Accession No. ML100880129)
May 25, 2010	Letter from NextEra Energy Seabrook, LLC (NextEra) forwarding the application for renewal of the operating license for Seabrook, requesting an extension of the operating license for an additional 20 years (ADAMS Accession No. ML101590099)
May 25, 2010	Applicant's Environmental Report (ER), cover through page B-90 (ADAMS Accession No. ML101590092)
May 25, 2010	Applicant's ER page C-1 through page F.A-5 (ADAMS Accession No. ML101590089)
May 28, 2010	Letter from NextEra to the State of New Hampshire Department of Environmental Services, "Seabrook, Federal Coastal Zone Consistency Certification for License Renewal" (ADAMS Accession No. ML101550353)
May 31, 2010	Report submitted by Mr. Brian Valimont, New England Archaeology Co, LLC, "Enclosure, Cultural Resources Management Plan Seabrook Nuclear Power Plant Seabrook and Hampton Falls, New Hampshire" (ADAMS Accession No. ML103280393)
June 1, 2010	Letter to Ms. Ann Robinson, Town of Seabrook, NH, "Maintenance of Reference Materials at the Seabrook Library in Regards to the Review of the Seabrook Station License Renewal Application" (ADAMS Accession No. ML101180134)
June 1, 2010	Letter to Ms. Patricia DeTullio, Town of Amesbury, MA, "Maintenance of Reference Materials at the Amesbury Public Library in Regards to the Review of the Seabrook Station License Renewal Application" (ADAMS Accession No. ML101260102)
June 10, 2010	Letter from NRC to NextEra, "Receipt and Availability of the License Renewal Application for the Seabrook Station Nuclear Power Plant" (ADAMS Accession No. ML101320273)
June 10, 2010	Federal Register Notice, "Notice of Receipt and Availability for Seabrook Station License Renewal Application" (ADAMS Accession No. ML101330049)
July 13, 2010	Letter from NRC to NextEra, "Notice of Intent to Prepare an Environmental Impact Statement and Conduct the Scoping Process for License Renewal for Seabrook Station" (ADAMS Accession No. ML101680410)
July 13, 2010	Federal Register Notice, "Notice of Intent to Prepare an Environmental Impact Statement and Conduct the Scoping Process for License Renewal for Seabrook Station" (ADAMS Accession No. ML101680427)
July 13, 2010	Letter from NRC to NextEra, "Determination of Acceptability and Sufficiency for Docketing, Proposed Review Schedule, and Opportunity for a Hearing Regarding the Application from NextEra Energy Seabrook, LLC, for Renewal of the Operating License for Seabrook Station, Unit 1" (ADAMS Accession No. ML101690417)

July 13, 2010	Federal Register Notice, "Notice of Acceptance for Docketing of the Application and Notice of Opportunity for Hearing Regarding Renewal of Facility Operating License No. NPF-086 for an Additional 20-year Period" (ADAMS Accession No. ML101690449)
July 16, 2010	Letter from NRC to Mr. Reid Nelson, Director, Office of Federal Agency Programs, Advisory Council On Historic Preservation, regarding the Seabrook License Renewal (ADAMS Accession No. ML101760128)
July 16, 2010	Letter from NRC to Ms. Patricia Kurkul, Regional Administrator, Northeast Region, National Marine Fisheries Service (NMFS), "Request for List of Protected Species and Essential Fish Habitat Within the Area Under Evaluation for the Seabrook Station License Renewal Application Review" (ADAMS Accession No. ML101760221)
July 16, 2010	Letter from NRC to Ms. Elizabeth Muzzey, State Historic Preservation Officer, State of New Hampshire, Division of Historical Resources, "Seabrook Station License Renewal Application Review" (ADAMS Accession No. ML101790273)
July 16, 2010	Letter from NRC to Mr. Marvin Moriarty, U.S. Fish and Wildlife Service (USFWS), "Request for List of Protected Species Within the Area Under Evaluation for the Seabrook Station License Renewal Application Review" (ADAMS Accession No. ML101790278)
July 16, 2010	Summary of telephone conference call held between NRC and NextEra concerning the review of acceptability of docketing of the Seabrook license renewal application (LRA) (ADAMS Accession No. ML101800207)
July 16, 2010	Letter from NRC to Mr. Thomas Burack, Commissioner, State of New Hampshire, Department of Environmental Services, "Seabrook Station License Renewal Application Review" (ADAMS Accession No. ML101900093)
July 20, 2010	Federal Register Notice, "Forthcoming Meeting to Discuss the License Renewal Process and Environmental Scoping for Seabrook Station License Renewal Application Review" (ADAMS Accession No. ML101900013)
July 20, 2010	NRC press release announcing an opportunity for a hearing on the application to renew the operating license for Seabrook (ADAMS Accession No. ML102010170)
July 27, 2010	Letter from Edna Feighner, State of New Hampshire, Division of Historical Resources, regarding the Seabrook license renewal (ADAMS Accession No. ML102160299)
August 4, 2010	NRC Press Release announcing the public meetings to discuss the process for the review of the Seabrook LRA at to seek input on the environmental review (ADAMS Accession No. ML102160633)
August 5, 2010	Letter from Ms. Patricia Kurkul, Regional Administrator, Northeast Region, NMFS, "Scoping Letter Response From NMFS Regarding the Seabrook License Renewal Application" (ADAMS Accession No. ML102240108)
August 12, 2010	Email from NRC to Ms. Emily Holt, Commonwealth of Massachusetts, Division of Fisheries and Wildlife (DFW), "Email to [Massachusetts] DFW re State-Listed Rare Species Near Seabrook Station" (ADAMS Accession No. ML102240484)
August 18, 2010	Email from Ms. Emily Holt, Commonwealth of Massachusetts, Division of Fisheries and Wildlife, "E-mail from MA DFW re State-Listed Species Near Seabrook Station" (ADAMS Accession No. ML102360545)
August 19, 2010	Letter from Ms. Maggie Hassan, Senator, State of New Hampshire, regarding the Seabrook license renewal (ADAMS Accession No. ML102420037)
August 19, 2010	Transcript of the Seabrook license renewal public meeting—afternoon session, August 19, 2010 (ADAMS Accession No. ML102520183)
August 19, 2010	Transcript of the Seabrook license renewal public meeting—evening session, August 19, 2010 (ADAMS Accession No. ML102520207)
August 23, 2010	Letter from Mr. William Harris regarding the Seabrook license renewal (ADAMS Accession No. ML102500271)
August 25, 2010	Letter from Mr. William Harris regarding the Seabrook license renewal (ADAMS Accession No. ML102420043)

August 26, 2010	Letter from NRC to Ms. Melissa Coppola, State of New Hampshire, New Hampshire Natural Heritage Bureau, "Seabrook Station License Renewal Application Review" (ADAMS Accession No. ML102290417)
September 1, 2010	Letter from Mr. Geordie Vining regarding the Seabrook license renewal (ADAMS Accession No. ML102450525)
September 1, 2010	Letter from Mr. Thomas Chapman, USFWS, "Scoping Letter from USFWS Regarding the Seabrook [license renewal application] LRA [supplemental environmental impact statement] SEIS" (ADAMS Accession No. ML102630180)
September 7, 2010	Letter from NRC to NextEra, "Environmental Site Audit Regarding Seabrook Station License Renewal Application" (ADAMS Accession No. ML102390177)
September 7, 2010	Memoranda from Ms. Melissa Coppola, State of New Hampshire, New Hampshire Natural Heritage Bureau, "NH NHB State-Listed Species and Communities [in support of] Seabrook LRA SEIS" (ADAMS Accession No. ML102520087)
September 13, 2010	Memoranda from Ms. Melissa Coppola, State of New Hampshire, New Hampshire Natural Heritage Bureau, "NH NHB State-Listed Species in T-Lines[in support of] Seabrook LRA SEIS" (ADAMS Accession No. ML102600341)
September 20, 2010	Summary of Seabrook License Renewal Overview and Environmental Scoping Meetings held on August 19, 2010 (ADAMS Accession No. ML102520222)
September 20, 2010	Letter from Ms. Joyce Kemp regarding the Seabrook license renewal (ADAMS Accession No. ML102640371)
September 20, 2010	Letter from Mr. Joseph Fahey, Director, Office of Community and Economic Development, Town of Amesbury, Massachusetts, regarding the Seabrook license renewal (ADAMS Accession No. ML102650486)
September 20, 2010	Letter from Mr. Andrew Port, Director of Planning and Development, City of Newburyport, MA, regarding the Seabrook license renewal (ADAMS Accession No. ML102660331)
September 21, 2010	Letter from Mr. Doug Bogen, Executive Director, Seacoast Anti-Pollution League, regarding the Seabrook license renewal (ADAMS Accession No. ML102670048)
October 15, 2010	Letter from NRC to the Abenaki Nation of New Hampshire, Cowasuck Band of Pennacook-Abenaki People, Abenaki Nation of Missisquoi, and Wampanoag Tribe of Gay Head-Aquinnah, "Request for Scoping Comments Concerning the Seabrook Station License Renewal Application Review" (ADAMS Accession No. ML102730657)
October 29, 2010	Letter from NRC to NextEra, "Request for Additional Information for the Review of the Seabrook Station License Renewal Application Environmental Review (TAC NO. ME3959)" (ADAMS Accession No. ML102861217)
November 4, 2010	Letter from Mr. Christian Williams, State of New Hampshire, Department of Environmental Services, to NextEra, regarding the Seabrook Coastal Zone Management Act Certification (ADAMS Accession No. ML103080880)
November 8, 2010	Letter from NRC to NextEra, "Environmental Project Manager Change for the License Renewal of Seabrook Station, Unit 1 (TAC ME3959)" (ADAMS Accession No. ML103070056)
November 10, 2010	Summary of the site audit related to the review of the Seabrook LRA, October 5-7, 2010 (ADAMS Accession No. ML102950271)
November 16, 2010	Letter from NRC to NextEra, "Request for Additional Information for the Review of the Seabrook Station License Renewal Application-[Severe Accident Mitigation Alternative] SAMA Review (TAC ME3959)" (ADAMS Accession No. ML103090215)
November 23, 2010	Letter from NextEra, "Seabrook Station—Response to Request for Additional Information—NextEra Energy Seabrook License Renewal Environmental Report" (ADAMS Accession No. ML103350639)
November 23, 2010	Letter from NextEra, "Attachment 2, Vol. 5, to SBK-L-10185, Seabrook Station Response to Request for Additional Information NextEra Energy Seabrook License Renewal Environmental Report, References Requested for Docketing at the Seabrook Station Environmental Site Audit" (ADAMS Accession No. ML103360298)

November 23, 2010	Letter from NextEra, “Attachment 2, Vol. 7, to SBK-L-10185, Seabrook Station Response to Request for Additional Information NextEra Energy Seabrook License Renewal Environmental Report, References Requested for Docketing at the Seabrook Station Environmental Site Audit” (ADAMS Accession No. ML103360300)
November 23, 2010	Letter from NextEra, “Attachment 2, Vol. 4, to SBK-L-10185, Seabrook Station Response to Request for Additional Information NextEra Energy Seabrook License Renewal Environmental Report, References Requested for Docketing at the Seabrook Station Environmental Site Audit” (ADAMS Accession No. ML103360306)
November 23, 2010	Letter from NextEra, “Attachment 2, Vol. 2, to SBK-L-10185, Seabrook Station Response to Request for Additional Information NextEra Energy Seabrook License Renewal Environmental Report, References Requested for Docketing at the Seabrook Station Environmental Site Audit, Continued” (ADAMS Accession No. ML103360311)
November 23, 2010	Letter from NextEra, “Attachment 2, Vol. 6, to SBK-L-10185, Seabrook Station Response to Request for Additional Information NextEra Energy Seabrook License Renewal Environmental Report, References Requested for Docketing at the Seabrook Station Environmental Site Audit” (ADAMS Accession No. ML103360326)
November 23, 2010	Letter from NextEra “Attachment 2, Vol. 3, to SBK-L-10185, Seabrook Station Response to Request for Additional Information NextEra Energy Seabrook License Renewal Environmental Report, References Requested for Docketing at the Seabrook Station Environmental Site Audit” (ADAMS Accession No. ML103370092)
November 23, 2010	Letter from NextEra, “Attachment 3 to SBK-L-10185, Seabrook Station Response to Request for Additional Information, NextEra Energy Seabrook License Renewal Environmental Report” (ADAMS Accession No. ML103370167)
November 23, 2010	Letter from NextEra, “Attachment 2, Vol. 2, to SBK-L-10185, Seabrook Station Response to Request for Additional Information NextEra Energy Seabrook License Renewal Environmental Report, References Requested for Docketing at the Seabrook Station Environmental Site Audit” (ADAMS Accession No. ML103370169)
November 23, 2010	Letter from NextEra, “Attachment 2, Vol. 1, to SBK-L-10185, Seabrook Station Response to Request for Additional Information NextEra Energy Seabrook License Renewal Environmental Report, References Requested for Docketing at the Seabrook Station Environmental Site Audit” (ADAMS Accession No. ML110100311)
November 23, 2010	Letter from NextEra, “Attachment 2, Vol. 1, to SBK-L-10185, Seabrook Station Response to Request for Additional Information NextEra Energy Seabrook License Renewal Environmental Report, References Requested for Docketing at the Seabrook Station Environmental Site Audit” (ADAMS Accession No. ML110100312)
November 23, 2010	Letter from NextEra, “Attachment 1 to SBK-L-10185, "Seabrook Station Response to Request for Additional Information NextEra Energy Seabrook License Renewal Environmental Report” (ADAMS Accession No. ML110100315)
December 3, 2010	Summary of the telephone conference between NRC and NextEra concerning the draft request for information pertaining to the Seabrook SAMAs review, November 8 and 10, 2010 (ADAMS Accession No. ML103260521)
December 21, 2010	Summary of the telephone conference call between NRC and NextEra concerning the draft request for additional information pertaining to the Seabrook LRA, October 21, 2010 (ADAMS Accession No. ML102980693)
January 3, 2011	Summary of the telephone conference call between NRC and NextEra concerning the draft request for additional information pertaining to the Seabrook LRA, December 21, 2010 (ADAMS Accession No. ML103570401)
January 13, 2011	Letter from NextEra, “Seabrook—Response to Request for Additional Information, NextEra Energy License Renewal Application” (ADAMS Accession No. ML110140810)
February 18, 2011	Letter from NextEra, “Seabrook Station Environmental Permit Renewals, NextEra Energy Seabrook License Renewal Environmental Report” (ADAMS Accession No. ML110550161)
February 28, 2011	Summary of telephone conference calls held between NRC and NextEra concerning the responses to the SAMA RAIs, February 15, 2011 (ADAMS Accession No. ML110490165)

March 1, 2011	Summary of telephone conference call held between NRC and NextEra concerning the essential fish habitat in the vicinity of Seabrook, February 3, 2011 (ADAMS Accession No. ML1105603625)
March 1, 2011	Letter from NRC to NextEra, “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)” (ADAMS Accession No. ML110100113)
March 4, 2011	Letter from NRC to NextEra, “Schedule Revision and Request for Additional Information for the Review of the Seabrook Station License Renewal Application Environmental Review (TAC ME3959)” (ADAMS Accession No. ML110590638)
March 16, 2011	Letter from NextEra to NRC, “Seabrook Station—Response to Request for Additional Information, NextEra Energy Seabrook License Renewal Environmental Report” (ADAMS Accession No. ML110820121)
April 8, 2011	Summary of telephone conference call held between NRC and NextEra to clarify responses to RAIs, March 21, 2011 (ADAMS Accession No. ML110811326)
April 18, 2011	Letter from NextEra, “Seabrook—Response to Request for Additional Information, NextEra Energy Seabrook License Renewal Application” (ADAMS Accession No. ML11122A075)
May 12, 2011	Letter from NRC to NextEra, “Schedule Revision for the Environmental Review of the Seabrook Station License Renewal Application (TAC Number ME3959)” (ADAMS Accession No. ML110890319)
June 10, 2011	Letter from NextEra, “Seabrook—Supplement to Response to Request for Additional Information, NextEra Energy Seabrook License Renewal Application” (ADAMS Accession No. ML11166A255)

APPENDIX F
U.S. NUCLEAR REGULATORY COMMISSION STAFF EVALUATION OF SEVERE ACCIDENT MITIGATION ALTERNATIVES FOR SEABROOK STATION UNIT 1 IN SUPPORT OF LICENSE RENEWAL APPLICATION REVIEW

F U.S. NUCLEAR REGULATORY COMMISSION STAFF EVALUATION OF SEVERE ACCIDENT MITIGATION ALTERNATIVES FOR SEABROOK STATION UNIT 1 IN SUPPORT OF LICENSE RENEWAL APPLICATION REVIEW

F.1 Introduction

NextEra Energy Seabrook, LLC (NextEra), submitted an assessment of severe accident mitigation alternatives (SAMAs) for the Seabrook Station (Seabrook) Unit 1 as part of its environmental report (ER) (NextEra, 2010). This assessment was based on the most recent Seabrook probabilistic risk assessment (PRA) available at that time, 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 (NRC, 1998a), 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 SAMA candidates 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 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 and therefore the SAMA is 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 a review of the SAMA assessment, the U.S. Nuclear Regulatory Commission (NRC) issued requests for additional information (RAIs) to NextEra by letters dated November 16, 2010 (NRC, 2010a), and March 4, 2011 (NRC, 2011b). Key questions in these RAIs concerned the following:

- additional details regarding the plant-specific PRA model and changes to internal and external event CDF and LERF since the IPE

- the process used to map Level 1 PRA results into the Level 2 analysis and group containment event tree (CET) end states into release categories[1]
- the process for selecting the representative Modular Accident Analysis Program (MAAP) case for each release category and the release characteristics of each representative case
- changes to the fire and seismic PRA models since the IPEEE
- the impact of updated seismic hazard curves
- the sensitivity of the SAMA results to assumptions used in the Level 3 analysis
- the use of Level 2 importance analysis and industry SAMA analyses in identifying plant-specific SAMAs
- further information on the cost-benefit analysis of several specific candidate SAMAs and low-cost alternatives

NextEra submitted additional information to the NRC by letters dated January 13, 2011 (NextEra, 2011a), and April 18, 2011 (NextEra, 2011b). NextEra provided additional information in a telephone conference call with the NRC staff on February 15, 2011 (NRC, 2011a). In response to the RAIs, NextEra provided the following:

- the internal and external event contribution to CDF and LERF for each version of the Seabrook PRA model and model changes that most impacted CDF and LERF
- a description of the CET and the process for determining the frequency of each release category
- a description of the process for selecting representative MAAP cases for each release category and the characteristics of each plume in each release category
- changes to the fire and seismic PRA models since the IPEEE
- a sensitivity analysis of the impact on the SAMA analysis from updated seismic hazard curves
- the results of the sensitivity analyses performed on the assumptions used in the Level 3 analysis
- listings of the important basic events for the most risk-significant release categories
- the SAMA candidates that mitigate each important basic event
- a review of the applicability of industry cost-effective SAMA candidates to Seabrook
- additional information regarding several specific SAMAs

NextEra's responses addressed the NRC staff's concerns and resulted in the identification of additional potentially cost-beneficial SAMAs.

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)

An assessment of SAMAs for Seabrook is presented below.

F.2 Estimate of Risk for Seabrook

NextEra's estimates of offsite risk at Seabrook are summarized in Section F.2.1. The summary is followed by the NRC staff's review of NextEra's risk estimates in Section F.2.2.

F.2.1 NextEra's Risk Estimates

Two distinct analyses are combined 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. 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.

The Seabrook CDF is approximately 1.5×10^{-5} per year for both internal and external events as determined from quantification of the Level 1 PRA model. A truncation level of 1×10^{-14} per year was used when quantifying event tees, and a truncation value of 1×10^{-12} per year was used when quantifying fault tees, except for the service water system (SWS) (NextEra, 2011a). The SWS was divided into two trains, which were each solved at a truncation level of 1×10^{-12} per year. The CDF is based on the risk assessment for internally-initiated events, which include internal flooding, and external events, which include fire and seismic events. The internal events CDF is approximately 1.1×10^{-5} per year, and the external events CDF (i.e., fire and seismic events) is approximately 4.5×10^{-6} per year (NextEra, 2011a).

The breakdown of CDF by initiating event is provided in Table F-1 and includes internal, fire, and seismic initiating events. As shown in Table F-1, the largest single contributor to the total CDF is loss of offsite power (LOOP) due to weather. NextEra identified that station blackout (SBO) contributes approximately 5.3×10^{-6} per year, or 35 percent, and anticipated transients without scram (ATWS) contribute approximately 4.6×10^{-7} per year, or 3 percent, to the total internal and external events CDF.

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). The current Level 2 model uses a single CET that is used to address internal, fire, and seismic events. The CET addresses both phenomenological and systemic events. The Level 1 core damage sequences are linked directly with the CET, so all Level 1 sequences are evaluated by the CET (NRC, 2011a). The CET probabilistically evaluates the progression of the damaged core with respect to release to the environment. CET nodes are evaluated using supporting fault trees and logic rules. The CET end states then are examined for considerations of timing and magnitude of release and assigned to release categories.

Table F-1. Seabrook CDF for internal and external events

Internal initiating event	CDF (per year)	% contribution to total CDF [(a)]
LOOP due to weather	1.5×10^{-6}	10
Loss of essential alternating current (AC) power 4 kilovolt (kV) 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
Small LOCA	1.9×10^{-7}	1
Reactor trip with no condenser cooling	1.7×10^{-7}	1
Other internal events[(b)]	1.0×10^{-6}	7
Total internal events CDF[(c)]	**1.1×10^{-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[(d)]	2.3×10^{-7}	2
Total fire events CDF[(e)]	**1.3×10^{-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 ATWS	1.1×10^{-7}	1

Internal initiating event	CDF (per year)	% contribution to total CDF [a]
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[e]	**3.1×10^{-6}**	**21**
Total CDF (internal and external events)[g]	**1.5×10^{-5}**	**100**

[a] May not total to 100 percent due to round off

[b] Obtained by subtracting the sum of the internal initiating event contributors to internal event CDF from the total internal events CDF

[c] 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

[d] Obtained by subtracting the sum of the fire initiating event contributors to fire event CDF from the total fire events CDF

[e] Provided in response to conference call clarification #2 (NRC, 2011a)

[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 quantified CET 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 (NextEra, 2011a). The frequency of each source term category was obtained by summing the frequency of the individual accident progression CET endpoints, or release categories, assigned to each source term category. Source terms were developed for 5 of the 10 release categories using the results of 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 results for Seabrook are provided in Table F.3.4.3-2 to the ER (NextEra, 2010).

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).

In the ER, 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. The breakdown of the total population dose by containment release mode is summarized in Table F-2 (NextEra, 2011a). Small early and large late releases are the dominant contributors to population dose risk at Seabrook.

Table F-2. Breakdown of population dose by containment release mode

Containment release mode	Population dose (person-rem[(a)] per year)	Percent 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

F.2.2 Review of NextEra's Risk Estimates

NextEra's determination of offsite risk at Seabrook is based on the following major elements of analysis:

- the Level 1 and 2 risk models that form the bases for the 1991 IPE submittal (NHY, 1991) and the external event analyses of the 1992 IPEEE submittal (NAESC, 1992), and the major modifications to the IPE and IPEEE models that have been incorporated in the Seabrook PRA, including a complete revision of the Level 2 risk model
- the MACCS2 analyses performed to translate fission product source terms and release frequencies from the Level 2 PRA model into offsite consequence measures (essentially this equates to a Level 3 PRA)

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

The first Seabrook PRA was completed in December 1983, its purpose being 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.

The NRC staff's review of the Seabrook IPE is described in an NRC report dated March 1, 1992 (NRC, 1992). Based on a review of the original IPE submittal and responses to RAIs, the NRC staff concluded that the IPE submittal met the intent of Generic Letter (GL) 88-20 (NRC, 1988). That is, the licensee demonstrated an overall appreciation of severe accidents, had an understanding of the most likely severe accident sequences that could occur at Seabrook, and had gained a quantitative understanding of core damage and fission product release. 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 and is discussed further in Section F.3.2.

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. Figure 11.6 of NUREG-1560 shows that the IPE-based internal events CDF for these plants range 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 (LRAs), 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 3 revisions to the PRA model, as discussed previously, 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). A listing of the major changes in each revision of the PRA, and the associated change in internal and external event CDF, was provided in the ER (NextEra, 2010) and in response to an NRC staff RAI (NextEra, 2011a) and is summarized in Table F-3. 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). This decrease results from the significant changes shown, 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).

Table F-3. Seabrook PRA historical summary

PRA version	Summary of significant changes from prior model[a]	Total CDF (per year)	Internal events CDF (per year)[b]	External events CDF (per year)[b]
SSPSA-PLG-0300 (1983)	Original model—includes internal, fire, and seismic events	2.3×10^{-4}	1.8×10^{-4}	4.6×10^{-5}
SSPSS-1986	• Updated allowed outage times to reflect current technical specifications • Revised models of the inservice test pump test frequency; turbine driven emergency feedwater (EFW) pump atmospheric relief valves (ARVs); boron injection tank, pump, and lines; enclosure building air handling system; reactor trip breakers; & reactor cooling pump (RCP) thermal barrier CS • Improved quantification traceability & documentation • Updated seismic fragilities • Expanded common cause treatment	2.9×10^{-4}	Not provided	Not provided
SSPSS-1989	• Updated initiating event frequencies • Updated common cause & maintenance distributions • Revised electric power recovery model using current data • Added recovery actions into event model	1.4×10^{-4}	9.5×10^{-5}	4.5×10^{-5}
SSPSS-1990	IPE submittal • Added modeling of ATWS mitigation system • Updated electric power recovery model	1.1×10^{-4}	6.1×10^{-5}	5.0×10^{-5}

PRA version	Summary of significant changes from prior model[a]	Total CDF (per year)	Internal events CDF (per year)[b]	External events CDF (per year)[b]
	• Updated RCP seal LOCA analysis • Added new recovery actions • Revised CET to explicitly model induced SGTR & direct containment heating			
SSPSS-1993	IPEEE submittal • Added plant-specific data for main safety pumps & diesel generators (DGs) • Improved fire event modeling, including modeling operator actions & addition of new fire hazard initiating events • Revised startup feed pump (SUFP) model to conservatively require manual startup • Improved modeling of high-pressure injection (HPI) and event tree logic	8.0×10^{-5}	4.4×10^{-5}	3.6×10^{-5}
SSPSS-1996	• Improved common cause modeling of primary closed cooling (PCC) with opposite PCC train failure • Updated ATWS model to account for change from an 18-month to 24-month fuel cycle • Increased use of plant-specific data • Changed definition of LERF to include steam leak from SGTR • Increased failure likelihood for small containment penetrations in seismic sequences • Added credit for manual operator action to close RCP seal return line motor-operated valve (MOV)	4.3×10^{-5}	2.1×10^{-5}	2.2×10^{-5}
SSPSS-1999	• Updated LOCA initiator frequencies • Updated ATWS model to account for change from a 24-month to an 18-month fuel cycle and to use more current failure rates • Updated event tree to explicitly incorporate RCP seal LOCA model & related power recovery models • Changed emergency diesel generator (EDG) mission time from 6 hours to 24 hours for weather-related LOOP & similar initiators • Moved LOOP & internal flooding models from external to internal events model • Modified common cause factors & mission times for PCC system & SWS • Updated human error probability (HEP) event tree rules & quantification	4.6×10^{-5}	2.7×10^{-5}	1.9×10^{-5}
SSPSS-2000	• Transitioned PRA software from DOS-based RISKMAN 9.2 to Windows-based RISKMAN 3.0	4.6×10^{-5}	2.7×10^{-5}	1.9×10^{-5}

PRA version	Summary of significant changes from prior model[a]	Total CDF (per year)	Internal events CDF (per year)[b]	External events CDF (per year)[b]
SSPSS-2001	• Changed system initiator models	4.8×10^{-5}	2.8×10^{-5}	2.0×10^{-5}
SSPSS-2002	• Integrated shutdown & low power risk models into all-modes model	4.8×10^{-5}	2.5×10^{-5}	2.0×10^{-5}
SSPSS-2004	• Updated the human reliability analysis (HRA) • Added credit for the supplemental electric power system (SEPS) DG • Updated the LERF model to include consequential SGTR	3.0×10^{-5}	1.7×10^{-5}	1.3×10^{-5}
SSPSS-2005	• Revised success criteria & operator timing • Updated the seismic PRA • Updated DG failure rate & unavailability data • Updated the Level 2 analysis including modeling of severe accident management guideline (SAMG) actions	1.4×10^{-5}	9.5×10^{-6}	4.5×10^{-6}
SSPSS-2006[c]	• Updated the Mode 4, 5, & 6 shutdown model • Revised modeling of PCC & SWS initiators	1.5×10^{-5}	1.1×10^{-5}	4.5×10^{-6}
SSPSS-2009	• Updated plant-specific data & generic data distributions • Incorporated electric power convolution model • Expanded the steam generator model to include condenser cooling, circulating water, & condenser steam dump • Revised operator action modeling	1.2×10^{-5}	7.1×10^{-6}	4.9×10^{-6}

[a] Summarized from information provided in the ER and in response to an NRC staff RAI (NextEra, 2011a)

[b] Estimated from percent contribution to total CDF provided in response to an NRC staff RAI (NextEra, 2011a)

[c] PRA model revision used in the SAMA analysis

The NRC staff considered the peer reviews performed for the Seabrook PRA and the potential impact of the review findings on the SAMA evaluation. In the ER (NextEra, 2010), NextEra identifies 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). In response to an NRC staff RAI, NextEra clarified the scope of these peer reviews with the 1999 peer review. It provided a full review of the technical elements of the Level 1 and 2 LERF internal events models, including internal flooding and the 2005 peer review providing a focused scope examination of Level 1 internal events accident sequences, success criteria, post-initiating event HRA, and configuration control (NextEra, 2011a). Neither the 1999 nor the 2005 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 4 Category A and B F&Os.[2] The applicant provides the resolution of each of the 34 F&Os in the ER and states that all have been dispositioned and implemented in the PRA model.

The NRC staff requested that NextEra clarify how the resolution to F&O 3—aggressive load shedding and the available cross tie can extend battery life from 8–12 hours—addresses the F&O. The NRC asked NextEra to assess the ability of the operators to successfully cool the core using the EFW pump without underfeeding the steam generators (NRC, 2010a). In response to the RAI, NextEra clarified that during an extended SBO condition, the normal control instrumentation and procedures for which operators are trained and with which they are familiar would be used to maintain long-term control of steam generator water level (NextEra, 2011a).

The NRC staff asked NextEra to summarize the scope and unresolved findings from any other reviews performed on the Seabrook PRA (NRC, 2010a). In response to the RAI, NextEra explained that many other internal reviews—including vendor-assisted reviews—have been performed on specific model updates, and comments from these reviews—along with plant changes and potential model enhancements—are tracked through a model change database to assure 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 they are not significant to the results and conclusions of the PRA and were judged not to have a significant impact on the SAMA evaluation.

The NRC staff asked NextEra to identify any changes to the plant, including physical and procedural modifications, since the SSPSA-2006 PRA model that could have a significant impact on the results of the SAMA analysis (NRC, 2010a). In response to the RAI, NextEra stated that there have been no major plant changes since PRA model SSPSS-2006 was issued that could significantly impact the SAMA analysis. NextEra further 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 a SAMA, “install a globe valve or flow limiting orifice upstream in the fire protection system,” to mitigate the risk of control building flooding, which is discussed further in Section F.6.2. Based on the reduction in the total CDF since revision SSPSS-2006 of the Seabrook PRA model used for the SAMA analysis and that revision SSPSS-2009 of the PRA model does not change the relative importance of initiating events and plant components, the NRC staff concludes that PRA model and plant changes made since SSPSA-2006, other than

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)

changes made to the internal flooding model, are not likely to impact the results of the SAMA analysis.

The NRC staff asked NextEra to describe the PRA quality control process used at Seabrook (NRC, 2010a). NextEra responded that an existing administrative procedure defines the quality control process for updates to the Seabrook PRA, and the process is consistent with requirements of the ASME 2009 PRA standard (ASME, 2009) 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 the 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.

The Seabrook PRA model is an integrated internal and external events model in that it includes seismic-initiated, fire-initiated, and external flooding-initiated events as well as internal initiating events. The external events models have been integrated with the internal events model 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 updated external events CDF results are described in a response to an NRC staff RAI (NextEra, 2011a) and are included in Table F-3 along with the internal events results.

The Seabrook IPEEE was submitted 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 in regard to the 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).

The Seabrook IPEEE seismic analysis used a seismic PRA following NRC guidance (NRC, 1991a). The seismic PRA included a seismic hazard analysis, a seismic fragility assessment, seismic quantification to yield initiating event frequencies and conditional system failure probabilities, and plant model assembly to integrate seismic initiators and seismic-initiated component failures with random hardware failures and maintenance unavailabilities.

The seismic hazard analysis estimated the annual frequency of exceeding different levels of ground motion. Seabrook seismic CDFs were determined for site-specific, Electric Power Research Institute (EPRI) EPRI (EPRI, 1989) and Lawrence Livermore National Laboratory (LLNL) (NRC, 1994) hazard curves. The seismic fragility assessment was performed by walkdowns that were conducted at the time of the original seismic PRA in 1982–1983, walkdowns performed for a revised fragility analysis in 1986, and supplemental walkdowns

performed in 1991 for the IPEEE, using procedures and screening caveats in EPRI's seismic margin assessment methodology (EPRI, 1988). Fragility calculations were made for about 82 components using a screening criterion of median peak ground acceleration (PGA) of 2.0 g, which corresponds to a high confidence (95 percent) low probability (5 percent) of failure (HCLPF) capacity. A total of 15 components and 2 sets of relay groups were further assessed. Fragility calculations were also made for eight buildings and structures and HCLPF values determined. The seismic systems analysis defined the potential seismic induced structure and equipment failure scenarios that could occur after a seismic event and lead to core damage. The Seabrook IPE event tree and fault tree models were used as the starting point for the seismic analysis. Quantification of the seismic models consisted of convoluting the seismic hazard curve with the appropriate structural and equipment seismic fragility curves to obtain the frequency of the seismic damage state. The conditional probability of core damage, given each seismic damage state, was then obtained from the IPE models with appropriate changes to reflect the seismic damage state. The CDF was given based on the product of the seismic damage state probability and the conditional core damage probability.

Quantification of the seismic CDF for Seabrook was performed in nine discrete ground acceleration ranges between 0.1–2.0 g. 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 and is discussed further in Section F.3.2.

Subsequent to the IPEEE, NextEra updated the seismic PRA analysis. The NRC staff asked NextEra to describe the changes to the seismic analysis incorporated in the PRA model SSPSA-2005 update and to explain the reasons for any significant changes to the seismic CDF (NRC, 2011a). In response to the RAI, NextEra stated that the most significant changes to the IPEEE seismic model made in the SSPSA-2005 update of the Seabrook PRA were as follows (NextEra, 2011a):

- The fragility analysis was updated to extend the fragility screening of equipment from greater than 2.0 g to the range from 2.0–2.5 g and greater than 2.5 g to better capture seismic risk.
- The EPRI hazard curve was adopted and used to update the equipment fragilities. The site-specific hazard curve was replaced with the EPRI hazard curve because the EPRI uniform hazard spectrum (UHS) developed for the Seabrook site is more current and realistic than that used in the original 1983 and the IPEEE PRA. In response to a followup NRC staff RAI, NextEra further clarified that the EPRI UHS was judged to be more realistic and representative of the best estimate hazard because of overall general improvement in seismic technology from the early 1980s to 1989, when the EPRI hazard curve was developed (NextEra, 2011b). The probabilistic estimates of seismic capacity of structures and components were updated to reflect component-specific fragility information and the EPRI UHS.
- Several new component fragilities were added to the seismic PRA model, including seismic fragilities for the SEPS DGs, which had been added to the plant since the IPEEE.

- Modeling and documentation of operator actions credited in the seismic PRA were improved.

NextEra also compared the dominant contributors to the seismic CDF from the IPEEE PRA model and to the dominant contributors from the current seismic PRA analysis or SSPSA-2009 model, which is presented in Table F-4. NextEra clarified in a conference call 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 F-4. 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 LLOCA total	10	11
Other seismic groups	1	1
Total seismic CDF	**1.2×10^{-5}**	**3.1×10^{-6}**

[(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 the most recognizable conservatism in the seismic model is the use of complete correlation of the fragility between identical components, such as both EDGs are assumed to fail at the same seismic hazard level (NextEra, 2011a). NextEra further stated that extensive internal technical reviews of the seismic PRA analysis were performed for the original 1983 PRA, 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).

The NRC staff noted that, in the attachments to NRC Information Notice 2010-18, Generic Issue 199 (NRC 2010b), the NRC staff estimated a seismic CDF for Seabrook of between 5.9×10^{-6} per year and 2.2×10^{-5} per year using updated seismic hazard curves developed by the U.S. Geological Survey (USGS) in 2008 (USGS, 2008). The NRC staff asked that NextEra provide an assessment of the impact of the updated USGS seismic hazard curves on the SAMA evaluation (NRC, 2010a). In response to the RAI, NextEra provided a revised SAMA evaluation using multipliers of 2.1 and 2.6 to account for the maximum GI-199 seismic CDF of 2.2×10^{-5} per year, which is discussed further below (NextEra, 2011a; NextEra, 2011b).

Considering the following points, 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:

- 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.
- NextEra has satisfactorily addressed NRC staff RAIs regarding the seismic PRA.

The Seabrook IPEEE fire analysis, which was significantly updated from the original fire analysis completed in 1983, employed EPRI's fire-induced vulnerability evaluation (FIVE) methodology (EPRI, 1992) to calculate area fire frequencies, quantitatively screen areas, and provide hazards analysis for resulting critical areas. The quantification of CDF was obtained by propagating fire-induced initiating events through the PRA used for the IPE.

The IPEEE fire areas were based on definitions of Appendix R fire areas for Seabrook. Qualitative screening was performed using a spatial database specifically developed for the IPEEE fire analysis that identified equipment important in initiating or mitigating an accident. Of the 73 fire areas, 13 were determined to contain important equipment (pumps, valves, and cabling, etc.) and were further assessed. Quantitative screening used industry fire data and the assumption that a fire in a compartment damaged all equipment and cables in the compartment. The resulting fire-initiating events are propagated through the appropriate event tree models. Using fire frequencies and conditional core damage probabilities from the internal events PRA, all but eight fire areas were screened as contributing less than 1×10^{-6} per year to the CDF.

Based on the FIVE fire methodology analysis, the unscreened areas were assessed by considering possible targets, fire sources and combustibles, possible fire scenarios (e.g., target-in-plume), and detection and suppression systems to determine the probability of damage given a fire. Credit was explicitly taken for automatic and manual fire suppression. Calculation of automatic fire suppression unavailability was supported by fault tree modeling. Calculation of manual suppression unavailability was supported by HRA. Consideration of fires on containment performance was also addressed. Final quantification used the Seabrook IPE PRA model to determine plant responses and CDFs. The resulting fire-induced CDF was calculated to be 1.2×10^{-5} per year. While no physical plant changes were found to be necessary as a result of the IPEEE fire analysis, fire potential plant improvements to improve fire risk were identified. Four of the plant improvements have been implemented. The one improvement not implemented is addressed by a SAMA in the current evaluation and is discussed further in Section F.3.2.

NextEra updated the fire PRA subsequent to the IPEEE. The NRC staff asked NextEra to describe the changes to the fire analysis since the IPEEE and to explain the reasons for any significant changes to the fire CDF (NRC, 2011a). In response to the RAI, NextEra explained that the most recent update of the fire PRA was in support of the SSPSA-2004 PRA update, and the fire analysis methodology used is essentially the same, with some variations, as that described previously for the IPEEE fire analysis (NextEra, 2011a). Specific changes made to the Seabrook fire PRA since the IPEEE are listed below:

- including current plant data and procedures
- performing detailed walkdowns to verify locations of the major fire sources and important targets
- updating data to the EPRI fire database that includes fire records through December 2000
- developing updated severity factors for cabinets, pumps, control room panels, and transients

- revisiting the quantitative screening results
- using new data on cabinet heat release rates
- quantitatively evaluating the total area heat-up rate

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. This comparison is presented in Table F-5. NextEra clarified in a conference call 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). As discussed earlier, NextEra stated that there was no significant shift in the relative importance of initiating events or components between the SSPSA-2006 and SSPSA-2009 PRA models. The dominant fire zone areas in these fire analyses are the control room, essential switchgear rooms, turbine building, and primary auxiliary building.

Table F-5. 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}**	**1.7×10^{-6}**

[(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 the most significant conservatism in the fire analysis is the assumption that small fires, typical of the generic fire events database, are assumed to grow to cause the maximum damage. However, because these fire sequences have such low frequencies and large uncertainties, NextEra claimed the impact of this conservatism on the overall fire CDF is difficult to determine (NextEra, 2011a). NextEra further stated that extensive internal technical reviews of the fire PRA analysis were performed for the original 1983 PRA, 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).

In a followup RAI, the NRC staff asked NextEra to clarify if fire-induced failures of components and human actions credited with mitigating the initiator were assessed and to describe how hot short probabilities were considered in the fire analysis (NRC, 2011b). In response to the RAI, NextEra clarified that, for fire initiators that are not screened and are evaluated in detail, the

probability of fire damage to components due to the fire is included in the analysis and that this probability is dependent upon the presence of combustible material and the success of suppression (NextEra, 2011b). NextEra also stated that the probability of additional failures needed for core damage was also evaluated, including unavailability of redundant systems and components and failure of operator actions, and component failures not impacted by the fire are modeled as random. Regarding the hot short probability question, NextEra explained that a hot short probability of 0.1 was used in the screening evaluation for important valves and components. NextEra also described the results of an evaluation to assess the sensitivity of the SAMA results to using a hot short probability of 0.6. This evaluation determined that the fire event screening evaluation is insensitive to this increase in the potential for hot shorts and that, while the contribution to CDF does increase due to the higher probability, the contribution compared to the CDF contribution of similarly modeled internal events remains relatively low. Specifically, NextEra evaluated 18 fire events and determined that 3 of the events contributed in the range of 10–20 percent of the corresponding internal events CDF, and the remaining 15 fire events contributed less than 10 percent. Based on this result, NextEra determined that the increase in hot short potential does not have a significant effect on the SAMA analysis (NextEra, 2011b).

The NRC staff noted that the fire ignition frequencies for a fire in Switchgear Room B—Loss of Bus E6 and Switchgear Room A—Loss of Bus E5, which were reported to be about 1.0×10^{-3} per year each, appeared to be low unless the fire only involved the associated buses. The NRC staff asked that NextEra justify these values (NRC, 2010a). NextEra responded that the ignition frequency for Switchgear Room B—Loss of Bus E6 includes the cumulative fire ignition frequencies for 21 Bus E6 cabinets and 170 other electrical cabinets. Switchgear Room A—Loss of Bus E5 similarly includes the cumulative fire ignition frequencies for 21 Bus E5 cabinets and 86 other electrical cabinets (NextEra, 2011a). NextEra explained that the cited value of 1.0×10^{-3} per year was more than just “frequency,” i.e., it included not only fire ignition frequency of 4.6×10^{-5} per year per cabinet but also a severity factor of 0.2 and a manual non-suppression probability of 0.1 for fires in the other electrical cabinets. Therefore, the calculated total fire ignition frequency for each of the two switchgear rooms is the same as that reported in the ER. The NRC staff considers NextEra’s assumptions reasonable.

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.

The Seabrook IPEEE analysis of high winds, tornadoes, external floods, and other (HFO) external events followed the screening and evaluation approaches specified in Supplement 4 to GL 88-20 (NRC, 1991) and concluded that Seabrook meets the 1975 Standard Review Plan (SRP) criteria (NRC, 1975). Two external event frequencies exceeded the 1.0×10^{-6} per year screening criterion (NAESC, 1992). One of these events is flooding resulting from a storm surge caused by a hurricane, which is modeled in the PRA and described in the ER (NextEra, 2010) as event EXFLSW in which the SW pumps are flooded. This sequence was reported in the ER to contribute just 2×10^{-8} per year to the total Seabrook CDF. The second event is an external initiating event involving a truck crash into the SF6 transmission lines. In response to an NRC staff RAI, NextEra explained that this event has been mitigated by the installation of jersey barriers and guard rails that further limit the possibility of a truck crash impacting the transmission lines and that, as a result, this initiating event 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—modify several exterior doors so that they will be able to withstand the design pressure differential resulting from high winds. NextEra clarified in response to an NRC staff RAI that this suggested improvement has been implemented (NextEra, 2011a).

The NRC staff noted that while the risk of flooding resulting from a storm surge caused by a hurricane is included in the PRA, the impact of hurricane-force winds does not appear to be addressed, and the staff requested that NextEra provide an assessment of the risk of this event on the Seabrook site (NRC, 2010a). In response to the RAI, NextEra explained that the high winds associated with a hurricane that might accompany a storm surge are screened from consideration because the site design basis criteria for high winds and tornadoes meets the 1975 SRP criteria (NextEra, 2011a). The NRC staff considered this explanation acceptable.

The Seabrook IPEEE submittal also stated that as a result of the Seabrook IPE, cost-benefit analyses are being performed for many potential plant improvements, which may also reduce external event risk because they address functional failures. Five potential plant improvements to improve internal event risk that may also reduce external event risk were identified. Four of the plant improvements have been implemented. The one improvement not implemented is addressed by a SAMA in the current evaluation and is discussed further in Section F.3.2.

NextEra estimated the benefits for both internal and external events using the integrated Seabrook PRA model. However, as discussed previously, an NRC staff assessment of the USGS 2008 seismic hazard curves yielded an upper bound seismic CDF for Seabrook of 2.2×10^{-5} per year, which is substantially greater than the 3.1×10^{-6} per year seismic CDF used in the SAMA evaluation. The NRC staff requested that NextEra provide an assessment of the impact of this higher seismic CDF on the SAMA evaluation (NRC, 2010a; NRC, 2011b). In response to the RAIs, NextEra noted that the NRC staff's estimate of the seismic CDF using the USGS 2008 seismic hazard curves did not include credit for the SEPS DGs installed at Seabrook in 2004, which have a median seismic fragility of 1.23 g (NextEra, 2011b). NextEra stated that the SEPS DGs were modeled in the Seabrook seismic PRA in 2005 and reduced the seismic CDF by approximately 26 percent by avoiding SBO sequences, and a corresponding reduction in the NRC staff estimate of the seismic CDF using the USGS 2008 seismic hazard curves to 1.6×10^{-5} per year would be expected. NextEra also provided a sensitivity analysis using a multiplier of 2.1 to account for the revised higher seismic CDF. This multiplier is based on an increased seismic CDF of 1.3×10^{-5} per year (upper bound seismic CDF of 1.6×10^{-5} per year minus seismic CDF of 3.1×10^{-6} per year used in the SAMA evaluation) and a total estimated CDF of 1.2×10^{-5} per year for PRA model SSPSA-2009 (NextEra, 2011b). The NRC staff concurs that a seismic CDF of 1.6×10^{-5} per year for Seabrook is reasonable and agrees that the licensee's use of a multiplier of 2.1 to account for the additional risk from seismic events is reasonable for the purposes of the SAMA evaluation. This is discussed further in Section F.6.2.

The NRC staff reviewed the general process used by NextEra to translate the results of the Level 1 PRA into containment releases, as well as the results of the Level 2 analysis, as described in the ER and in response to NRC staff RAIs (NextEra, 2011a). The Level 2 model was significantly revised in the 2005 PRA update (i.e., PRA model SSPSA-2005) from that used in the IPE and reflects the Seabrook plant as designed and operated as of 2006. In response to an NRC staff RAI, NextEra identified the following major changes to the PRA that most impacted the LERF (NextEra, 2011a):

- change in definition of LERF to include steam leak from a SGTR
- higher failure likelihood for small containment penetrations in seismic sequences
- update to credit manual operator action to close the RCP seal return line MOV
- expansion of the LERF model by adding a steam line break to SGTR and consideration of ATWS sequences
- updates to the Level 2 analysis to reflect current state of knowledge including SAMGs
- revisions to incorporate plant-specific data
- update of data distributions
- revisions to operator action modeling

In response to an NRC staff RAI, NextEra explained that the quantification of the Level 1 and Level 2 models is done using a linked event tree method approach and does not employ plant damage states (NextEra, 2011a). Therefore, all Level 1 sequences are evaluated by the CET, making it unnecessary to summarize and group similar sequences into Level 1 plant damage states before they are input to 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. In response to another NRC staff RAI, NextEra clarified that the CET has 37 branching events, which include 10 hardware-related, 13 human action-related, and 13 phenomena-related events, along with a single mapping event (NextEra, 2011a). CET branch point split fraction numerical values are determined based on the type of event. The CET event success criterion is defined, and split fraction logic rules are used to apply the correct event split fraction values during CET quantification. Included in the response to the NRC staff RAI, NextEra provided a description of each of the 37 CET branching events. 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. In response to another NRC staff RAI, NextEra clarified that the frequency of each release category was obtained by summing the frequency of the individual accident progression CET end states binned into the release category (NextEra, 2011a).

The quantified CET sequences binned into the 16 release categories are subsequently grouped into 10 source term categories that provide the input to the Level 3 consequence analysis. In response to an NRC staff RAI, NextEra explained that the 16 release categories were reduced to 10 source term categories by grouping release categories that occur due to different phenomena, but the consequence is essentially the same (e.g., thermally-induced SGTR and pressure-induced SGTR) (NextEra, 2011a). For two of the source term categories, two release categories were binned together to form the combined source term category, and the source term for the release category having the highest release frequency was used as the source term for the combined category. In each of these cases, the release frequency for the selected representative release category is 4–5 orders of magnitude larger than the release frequency for the other release category (e.g., approximately 1×10^{-7} per year compared to approximately 1×10^{-11} per year). One source term category was created from the binning of three release categories. For this source term category, the release category having the highest consequence source term was selected as the representative release category, i.e., the choice was not based on the relative release frequencies but rather on the most conservative consequence. For the one source term category representing intact containment, two release

categories are analyzed separately, and the results are combined for reporting purposes. One release category was eliminated because it was not a credible scenario at Seabrook.

Source terms were developed for each of the source term categories. In response to an NRC staff RAI, NextEra clarified that 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. The release fractions and timing for the other five source term categories are based on analyses performed for the original 1983 Seabrook PRA (NextEra, 2011a). NextEra generally selected the representative MAAP case based on that which resulted in the most realistic timing and source term release. In response to another NRC staff RAI, NextEra further clarified that the release fractions and timing for the five original release categories are based on WASH-1400 (NRC, 1975), the Industry Degraded Core Rule-Making (IDCOR) Program MAAP analysis for the Zion plant, and Seabrook-specific MAAP runs (NextEra, 2011a). The source term categories and their frequencies and release characteristics are presented in Tables F.3.2.1-1 and F.3.4.3-2 of Appendix F to the ER (NextEra, 2010) and in response to an NRC staff RAI (NextEra, 2011a).

As indicated above, the current Seabrook Level 2 PRA model is an update of that used in the IPE. The IPE did not identify any severe accident vulnerabilities associated with containment performance. Risk-related insights and improvements discussed in the IPE submittal were discussed previously. 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, it met the IPE requirements, and there were no obvious or significant problems or errors.

The LERF model was included in the 1999 industry peer review discussed previously. Seven of the F&Os from this review addressed the LERF analysis. The applicant provides in the ER the resolution of each of the seven F&Os and states that all have been dispositioned and implemented in the PRA model.

The NRC staff noted that the LERF reported for Seabrook is less than one percent of the CDF and asked NextEra to explain this apparently very low LERF (NRC, 2010a). In response to the RAI, NextEra explained that Seabrook has a very large-volume and strong containment building in comparison to most other nuclear power plant containment designs (NextEra, 2011a). As a result of the containment design median failure pressure of 187 pounds per square inch (psia) (dry) and 210 psia (wet), 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.

The NRC staff requested that NextEra explain how fire-induced ISLOCAs and fire-induced containment impacts are addressed in the fire analysis (NRC, 2010a; NRC, 2011b). In response to the RAIs, NextEra explained that containment performance was evaluated in three areas: (1) containment structure, (2) containment response to a core damage event, and (3) containment isolation failure (NextEra, 2011a). Fires were determined to have no impact on containment structure integrity. Fire-initiated core damage events were determined to have the same impact on containment response as internal-initiated events; thus, they are handled through the CET. The potential for containment isolation failure was assessed by evaluating the potential for fire-induced failure of important isolation valves, as follows:

- Because the containment isolation valves (CIVs) are located both inside and outside containment, NextEra concluded that only a fire in the control room or cable spreading

room could affect CIVs both inside and outside containment and that, in this event, important CIVs could be controlled locally at the valve or from the remote shutdown panel (RSP). CIVs located outside containment could be controlled both locally at the valve and from the RSP, that CIVs located inside containment could be controlled from the RSP, and that no credit is taken for local control of valves inside containment (NextEra, 2011b).

- Because the letdown system has three normally open, air-operated valves (AOVs) in series, NextEra concluded that hot shorting in all three valves is not credible. NextEra clarified that failure to isolate the letdown system for an extended period of time is judged to not be credible for the following reasons (NextEra, 2011b):
  - There are three AOVs inside containment and one AOV outside containment.
  - All four AOVs fail to the closed position upon loss of air or control power.
  - Shorts to ground in the control cables for these AOVs will also result in the AOVs failing to the closed position.
  - There are two MOVs inside containment that are available to provide isolation.
- The potential for fire-induced failures of several other potential isolation pathways was also evaluated (e.g., large residual heat removal (RHR) suction line MOVs, RCP seal return line isolation valves, and containment on-line purge valves) and determined to not be credible.

Based on the above, NextEra concluded that the only credible impact of fires on containment performance is to fail a single train of isolation. For isolation failure of one or more valves in a single train, either redundant isolation would be available or the ability to remove power from fail closed valves to provide isolation is available (NextEra, 2011a). NextEra further clarified that, since Seabrook is designed with divisional cable separation, power to the fail closed valves can be removed, if necessary, by removing its divisional power supply, thus ensuring that the valves fail closed and are prevented from being failed opened due to hot shorting (NextEra, 2011b). NextEra further concluded that the frequency of fires that could cause this level of damage is sufficiently low compared to hardware failures that this scenario does not contribute significantly to containment isolation failure and that, as a result, no fire impacts on containment isolation components are included in the PRA (NextEra, 2011a).

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.

As indicated in the ER, the reactor core radionuclide inventory used in the consequence analysis corresponds to the end-of-cycle values for Seabrook operating at 3,659 MWt. This bounds the current Seabrook rated power of 3,648 MWt. The core radionuclide inventory is provided in Table F.3.4.3-1 of Appendix F of the ER (NextEra, 2010). In response to an NRC staff RAI, NextEra clarified that a Seabrook-specific core inventory was calculated using ORIGEN2.1 except for Cobalt-58 and Cobalt-60 (NextEra, 2011a). NextEra noted that the ORIGEN calculations did not provide isotopic inventories for Cobalt-58 and Cobalt-60. Therefore, these isotope inventories were estimated using the MACCS2 sample problem inventory corrected by the ratio of Seabrook's power level to the MACCS2 sample problem A power level (i.e., 3,659 MWt/3,412 MWt). Based on this clarification, the NRC staff concludes

that the reactor core radionuclide inventory assumptions for estimating consequences are reasonable and acceptable for purposes of the SAMA evaluation.

The NRC staff reviewed the process used by NextEra to extend the containment performance (Level 2) portion of the PRA to an assessment of offsite consequences (essentially a Level 3 PRA). This included consideration of the source terms used to characterize fission product releases for the applicable containment release categories and the major input assumptions used in the offsite consequence analyses. Version 1.13.1 of the MACCS2 code was used to estimate offsite consequences (NRC, 1998). Plant-specific input to the code includes the source terms for each release category and the reactor core radionuclide inventory (both discussed above), site-specific meteorological data, projected population distribution within an 80-km (50-mi) radius for the year 2050, emergency evacuation planning, and economic parameters including agricultural production. This information is provided in Section F3.4 of Attachment F to the ER (NextEra, 2010).

All releases were modeled as occurring at the top height of the containment building. Sensitivity cases were run assuming ground level release, as well as releases at 25 percent, 50 percent, and 75 percent of the containment building height. In response to an NRC staff RAI, NextEra reported that decreasing the release height from the top of the reactor building to ground level decreased the population dose risk and offsite economic cost risk by up to 3 percent and 4 percent, respectively (NextEra, 2011a). The thermal content of each of the releases was assumed to be the same as ambient (that is a non-buoyant plume). A sensitivity analysis was performed assuming a 1 MW and 10 MW heat release plume. In response to an NRC staff RAI, NextEra reported that increasing the release heat decreased the population dose risk by 2 percent and 12 percent, and the offsite economic cost risk decreased by 1 percent and 9 percent for the 1 MW and 10 MW heat release, respectively (NextEra, 2011a). Wake effects for the containment building were included in the model. A sensitivity analysis was performed assuming the wake size was one-half and double the baseline wake size. In response to an NRC staff RAI, NextEra reported that decreasing the wake size by one-half decreased the population dose risk by 1 percent and did not change the offsite economic cost risk, while doubling the wake size increased both the population dose risk and offsite economic cost risk by 1 percent (NextEra, 2011a). The NRC staff notes that these results are consistent with previous SAMA analyses that have shown only minor sensitivities to release height, buoyancy, and building wake effects. Based on the information provided, the staff concludes that the release parameters used are acceptable for the purposes of the SAMA evaluation.

NextEra used site-specific meteorological data for the year 2005 as input to the MACCS2 code. The development of the meteorological data is discussed in Section F.3.4.5 of the ER (NextEra, 2010). Data from 2004–2008 were also considered, but the 2005 data were chosen because the results of a MACCS2 sensitivity analysis indicated that the 2005 data produced more conservative results (i.e., the 2005 data set was found to result in the largest population dose risk and offsite economic cost risk). In response to an NRC staff RAI, NextEra reported that the results of the meteorological data sensitivity analysis, which was performed for each of the years 2004–2008, showed a decrease in population dose risk in the range of 5–13 percent and a range of 3–12 percent decrease in offsite economic cost risk (NextEra, 2011a). Missing data were estimated using data substitution methods. These methods include substitution of missing data with corresponding data from another level on the meteorological tower, interpolation between data from the same level, or data from the same hour and a nearby day of a previous year. Hourly stability was classified according to the system used by the NRC (NRC, 1983). The baseline analysis assumes perpetual rainfall in the 40–50 mi segment surrounding the site. A sensitivity analysis was performed assuming measured rainfall rather

than perpetual rainfall in the 40–50 mi spatial segment. This resulted in a decrease in population dose risk of 14 percent and a decrease in offsite economic cost risk of 17 percent. The NRC staff notes that these results are consistent with previous SAMA analyses that have shown little sensitivity to year-to-year differences in meteorological data. Based on the information provided, the NRC staff concludes that the use of the 2005 meteorological data in the SAMA analysis is reasonable.

The population distribution the licensee used as input to the MACCS2 analysis was estimated for the year 2050 using year 2000 census data as accessed by SECPOP2000 (NRC, 2003). The baseline population was determined for each of 160 sectors, consisting of the 16 directions for each of 10 concentric distance rings with outer radii at 1, 2, 3, 4, 5, 10, 20, 30, 40, and 50 mi surrounding the site. County population growth estimates were applied to year 2000 census data to develop year 2050 population distribution. The distribution of the population is given for the 10-mi radius from Seabrook and for the 50-mi radius from Seabrook in the ER (NextEra, 2010). In response to an NRC staff RAI, NextEra clarified that the year 2000 population was exponentially extrapolated to year 2050. The NRC staff noted that the total population of 4,157,215 identified in Section 2.6.1 of the ER was different than the 4,232,394 reported in ER Table F.3.4.1 (NRC, 2010a). In response to the NRC staff RAI, this difference was attributed to the following factors (NextEra, 2011a):

- choice of distribution centroids between the two references
- including transient population in the population extrapolation for ER Table F.3.4.1-1 but not in ER Section 2.6.1
- where the 50-mile radius bisects the census block groups, the population fraction is assumed equal to the land area fraction

The NRC staff also requested clarification of why some sectors showed zero or (small) negative population growth (NRC, 2010a). NextEra clarified that this was attributed to the geographic information system (GIS) land layers not being detailed enough to account for the existence of some small islands, and the GIS water sectors were projected as zero populations (NRC, 2011a). Also, the direction distribution used in the 2050 projection was slightly offset from the existing population, resulting in some sectors being considered all water, and thus zero population. In fact, a portion of those sectors include the coastline and, therefore, have a population. The population projections were refined to account for the above and to include the most recent county population growth rates (the sensitivity case above). A sensitivity analysis was performed using the refined population projections and the population distribution centroid for ER Table F.3.4.1-1. This resulted in an overall population decrease of about 4 percent, resulting in a corresponding decrease in population dose risk and economic cost risk of 5 percent and 6 percent, respectively. The NRC staff considers the methods and assumptions for estimating population reasonable and acceptable for purposes of the SAMA evaluation.

The emergency evacuation model was modeled as a single evacuation zone extending out 16 km (10 mi) from the plant. NextEra assumed that 95 percent of the population would evacuate. This assumption is conservative relative to the NUREG-1150 study (NRC, 1990), which assumed evacuation of 99.5 percent of the population within the emergency planning zone (EPZ). The evacuated population was assumed to move at an average speed of approximately 0.4 meters per second (0.9 miles per hour (mph)) with a delayed start time of 120 minutes after declaration of a general emergency. The evacuation speed was derived from the projected time to evacuate the entire EPZ under adverse weather conditions during the year 2000 (NextEra, 2010) and then adjusted by the ratio of the year 2000 EPZ population to the

projected year 2050 EPZ population. NextEra performed sensitivity analyses in which the evacuation speed, the delayed start time or preparation time for evacuation of the EPZ, and the emergency declaration time were each individually decreased by 50 percent and also doubled relative to the base case. In response to an NRC staff RAI, NextEra reported that the decrease in evacuation speed increased the population dose risk by 3 percent, and the increase in evacuation speed decreased the population dose risk by 4 percent. Additionally, the decrease in delay time decreased the population dose risk by 9 percent, the increase in delay time decreased the population dose risk by 2 percent, the decrease in emergency declaration time decreased the population dose risk by 6 percent, and the increase in emergency declaration time decreased the population dose risk by 3 percent (NextEra, 2011a). For all three parameters, both the increase and decrease in the base values resulted in no change to the offsite economic cost risk. In the ER, NextEra explained that an increase in delay time or emergency declaration time could decrease population dose risk if the evacuation and plume release are simultaneous. NextEra also performed a sensitivity analysis assuming that the population does not evacuate for a severe accident resulting in a small, early containment penetration failure with no source term scrubbing, representative of a seismically-induced severe accident event. In response to an NRC staff RAI, NextEra reported that this resulted in increasing the population dose risk by 4 percent with no change in offsite economic cost risk. The NRC staff concludes that the evacuation assumptions and analysis are reasonable and acceptable for the purposes of the SAMA evaluation.

In an NRC staff RAI, NextEra clarified that sea-breeze circulation was included in the SAMA evaluation only to the extent that this is included in the onsite meteorological data (NextEra, 2011a). NextEra further explained that there are two major mechanisms associated with sea-breezes, a mixing front and thermal internal boundary layer (TIBL). A mixing front results in increased plume mixing and dispersion, resulting in a potential decrease in population dose. This was conservatively ignored in the SAMA evaluation. However, TIBL could decrease dispersion and increase population dose. Given this, NextEra performed a sensitivity study assuming 25 percent of the year with TIBL formation (data for year 2005 identified a TIBL was present 7 percent of the year). The increase in TIBL formation increased the population dose risk and offsite economic cost risk by 4 percent and 7 percent, respectively. In addition, sensitivity of the TIBL lid height was investigated by changing the lid height from 110 meters (m) to 100 m. The decrease in TIBL lid height resulted in an increase in population dose risk and offsite economic cost of less than 1 percent each. The NRC staff concludes that sea-breeze affects have a minor impact on the SAMA analysis results.

Much of the site-specific economic and agricultural data were provided from SECPOP2000 (NRC, 2003) by specifying the data for each of the 13 counties surrounding Seabrook, to a distance of 80 km (50 mi). SECPOP2000 uses county economic and agriculture data from the 2000 National Census of Agriculture. This included the fraction of land devoted to farming, annual farm sales, the fraction of farm sales resulting from dairy production, and the value of non-farm land. In response to an NRC staff RAI, NextEra identified that the recent, three known errors in SECPOP2000 were corrected for the SAMA evaluation (NextEra, 2011a).

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.

F.3 Potential Plant Improvements

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

F.3.1 Process for Identifying 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
- 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 SAMAs, referred to as Phase I SAMAs, was identified. In Phase I of the evaluation, NextEra performed a qualitative screening of the initial list of SAMAs and eliminated SAMAs 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 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 further evaluation. The remaining SAMAs, referred to as Phase II SAMAs, are listed in Table F.7-1 of the ER (NextEra, 2010). In Phase II, NextEra performed an additional qualitative screening of the Phase II SAMAs and eliminated 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 remaining 61 SAMA candidates, as discussed in Sections F.4 and F.6 below. The estimated benefits for these SAMAs included the risk reduction from both internal and external events.

As previously discussed, 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. In response to NRC staff RAIs, NextEra performed a sensitivity analysis to account for the potential additional risk reduction benefits associated with the additional risk from seismic events. NextEra multiplied the estimated benefits for internal and external events by a factor of 2.6 for those Phase II SAMAs that were qualitatively screened on high implementation costs and by a factor of 2.1 for all other Phase II SAMAs for which a detailed evaluation was performed (NextEra, 2011a; NextEra, 2011b).

F.3.2 Review of NextEra's Process

NextEra's efforts to identify potential SAMAs focused primarily on areas associated with internal initiating events but also included explicit consideration of potential SAMAs for fire and seismic events. The initial list of SAMAs generally addressed the accident sequences considered to be important to CDF from functional, initiating event, and risk reduction worth (RRW) perspectives at Seabrook.

NextEra's SAMA identification process began with a review of the list of potential PWR enhancements in Table 14 of NEI 05-01 (NEI, 2005). As a result of this review, 153 SAMAs were identified. In response to an NRC staff RAI, NextEra clarified that as a result of a general solicitation of Seabrook staff for possible SAMA candidates and a review of both industry and plant-specific SAMA candidates by an expert panel, 13 additional SAMAs were identified (NextEra, 2011a).

NextEra provided tabular listings of both the Level 1 and LERF PRA internal, fire, and seismic basic events sorted according to their RRW (NextEra, 2010). SAMAs impacting these basic events would have the greatest potential for reducing risk. NextEra used an RRW cutoff of 1.005, which corresponds to about a 0.5 percent decrease in CDF given 100-percent reliability of the equipment or human actions associated with the SAMA. In response to an NRC staff RAI, NextEra determined that this equates to a benefit of approximately $2,500 based on eliminating the entire risk from basic event HH.RDGL2Q.FL, "operator fails to locally reset breakers and start pumps," which has an RRW of 1.0057 (NextEra, 2011a). Or, it equates to approximately $5,300 after the benefits have been multiplied by a factor of 2.1 to account for the additional risk from seismic events (NextEra, 2011b). NextEra correlated all 70 Level 1 and 48 LERF basic events in the listings with SAMA categories evaluated in Phase I or Phase II and showed that all of the basic events are either addressed by a SAMA category or a specific SAMA, or were operator actions for which no plant-specific procedure improvements were identified.

The NRC staff asked NextEra to clarify how the RRW importance analysis was used to develop plant-specific SAMAs (NRC, 2010a). NextEra responded that the SAMA identification process specifically included a review of the most risk-significant basic events, and all systems and components having an RRW greater than 1.005 were reviewed to ensure that each was covered by an existing generic or plant-specific SAMA candidate based on a functional category such as "feedwater and condensate" (NextEra, 2011a).

In a separate RAI, the NRC staff noted that it was not always clear which SAMA in a functional category addressed the specific basic events. The staff asked NextEra to identify the specific SAMAs that address each basic event in the importance list (NRC, 2010a). In response to the RAI, NextEra provided a listing of the top 15 Level 1 basic events, having an RRW down to 1.0223, and correlated at least 1 SAMA to each basic event (NextEra, 2011a). An RRW of 1.0223 was determined to equate to a benefit of approximately $32,000 based on eliminating the entire risk from basic event HH.ORWMZ1.FA, "operator minimizes emergency core cooling system (ECCS) flow with recirculation failure." Or, it equates to a benefit of approximately $67,000 after the benefits have been multiplied by a factor of 2.1 by the NRC staff to account for the additional risk from seismic events, which is less than the minimum implementation cost of $100,000 associated with a hardware change. As a result of this review the following, new SAMAs were identified and evaluated and are discussed further in Section F.6.2:

- SAMA "improve Bus E6 reliability, eliminate/reduce potential for bus fault"

- SAMA “improve Bus E5 reliability, eliminate/reduce potential for bus fault”
- SAMA “improve Supplemental Electrical Power System (SEPS) diesel generator (DG) reliability, eliminate potential for SEPS failure”
- SAMA “improve reliability of power operated relief valve (PORV) reseat function, eliminate PORV reseat failures”

NextEra states in the ER that no SAMAs were identified to address the operator actions in the Level 1 and LERF basic events importance lists because the current plant procedures and training meet current industry standards, and no plant-specific procedure improvements were identified that would affect the results of the HEP calculations. The NRC staff asked NextEra to consider the feasibility of non-procedural and training SAMAs for the human error basic events (NRC, 2011a). In response to this RAI and the previously discussed RAI, NextEra identified and evaluated the following SAMAs to automate the 3 operator actions included in the top 15 Level 1 basic events and to automate or install additional alarm indication for the operator action having the highest LERF-related RRW (NextEra, 2011a):

- SAMA “provide auto-start and load for SEPS DG”
- SAMA “provide hardware change for automatic ECCS flow control”

For each of these SAMAs, NextEra showed that the benefit from eliminating the risk of each of these basic events is less than the minimum implementation cost of $100,000 associated with a hardware change. This is discussed further in Section F.6.2. NextEra concluded that lower risk-significant operator actions on the Level 1 and 2 importance lists would correspondingly not be cost-beneficial since their potential benefit would be less than their minimum cost, as represented by a hardware change. Based on this result, no SAMAs were identified for operator actions having a lower RRW. Based on NextEra’s statement that procedure and training improvements have been considered but that no improvements were identified that would reduce plant risk, the NRC staff concludes that it is unlikely that additional cost-beneficial SAMAs would be found from a further review of operator actions having lower RRWs.

The NRC staff asked NextEra to provide a listing of the Level 2 non-LERF basic events that contribute 90 percent of the population dose-risk and to review these basic events for potential SAMAs (NRC, 2010a). In response to the RAI, NextEra provided a listing of the top 15 basic events each for release categories SE3, LL3, LEI, SEI, and LL4, which contribute approximately 91 percent of the population dose-risk, and correlated at least one SAMA to each basic event (NextEra, 2011a). The top 15 basic events correspond to a review of basic events down to release category-specific RRWs of 1.007 for SE3, 1.031 for LL3, 1.033 for LEI, 1.019 for SEI, and 1.030 for LL4. As a result of this review, the following additional SAMAs were identified and evaluated and are discussed further in Section F.6.2:

- SAMA “hardware or procedural change to eliminate or reduce likelihood of small pre-existing unidentified leakage”
- SAMA “hardware change for auto closure of SEPS breaker to eliminate operator action”
- SAMA “hardware change to eliminate motor operated valve (MOV) AC power dependencies”
- SAMA “provide a hardware modification (additional signals or remote capability) to automatically close containment isolation valve V-167”
- SAMA “provide hardware modification to improve lube oil pump reliability”

- SAMA “improve primary closed cooling (PCC) temperature element (TE) reliability, eliminate potential for temperature element failure”
- SAMA “provide a hardware modification for auto-control, eliminate operator action to align sump after core melt”
- SAMA “improve PCC heat exchanger reliability, eliminate potential for heat exchanger leakage”
- SAMA “improve service water secondary isolation MOV SWV-5 reliability, eliminate valve failure”
- SAMA “hardware for automatic feed flow, eliminate potential for operator failure to feed steam generator”
- SAMA “improve reliability of startup feed pump (SUFP), eliminate potential for SUFP failure”
- SAMA “hardware change to eliminate or reduce mechanical failures of motor-driven (MD) EFW pump”
- SAMA “implement hardware change to improve reliability of SGTR control, eliminate or reduce operator failure to terminate safety injection”
- SAMA “provide automatic control, eliminate or reduce operator failure to terminate safety injection”
- SAMA “hardware change to provide auto-makeup to reactor water storage tank (RWST), eliminate operator action”
- SAMA “hardware change for automatic control or eliminate operator action to maintain stable conditions”
- SAMA “improve hardware/procedures to reduce or eliminate basic event exposure probability, improve control rod insertion (CRI) availability”
- SAMA “provide auto-start of SUFP, eliminate potential for operator failure to start SUFP”
- SAMA “implement hardware change to improve reliability of SGTR control, eliminate operator action to depressurize”
- SAMA “hardware change to eliminate operator action to depressurize in SGTR events”
- SAMA “hardware change for automatic control or eliminate operator action to cooldown [reactor cooling system] RCS in SGTR events”
- SAMA “implement hardware change to improve reliability, eliminate operator action to cooldown/depressurize”
- SAMA “hardware change for automatic control or eliminate operator actions to cooldown the RCS for residual heat removal (RHR) shutdown cooling in SGTR events”
- SAMA “hardware change to improve valve reliability, eliminate Containment Building spray (CBS) discharge MOV failures”
- SAMA “hardware change for automatic venting control, eliminate need to perform late containment venting”
- SAMA “hardware change for automatic initiation of containment injection gravity drain, eliminate operator action”

The NRC staff estimated that a risk reduction of 3.3 percent, corresponding to the highest RRW review level of the five release categories reviewed, equates to a maximum benefit of approximately $27,000. Or, it equates to approximately $57,000 after the benefits have been multiplied by a factor of 2.1 by the NRC staff to account for the additional risk from seismic events, which is less than the minimum implementation cost of $100,000 associated with a hardware change. Based on this, and NextEra's statement discussed previously that procedure and training improvements have been considered but that no improvements were identified that would reduce plant risk, the NRC staff concludes that it is unlikely that additional cost-beneficial SAMAs would be found from a further review of release category basic events having lower RRWs.

In response to this same RAI, NextEra stated that all of the top ranked basic events related to LERF, as identified in Table F.3.2.1-2 of the ER, were addressed by the Level 1 and Level 2 basic events reviews described above. The NRC staff reviewed the LERF basic events and determined that all but 17 basic events were addressed by at least 1 SAMA. All but one of these events had an RRW of less than 1.031, which was estimated by the NRC staff to have a maximum benefit less than the minimum implementation cost of $100,000 associated with a hardware change. Basic event FWP161.FS, "startup pre-lube oil pump FY-P-161 fails to start on demand," has a LERF RRW of 1.0886. The NRC staff asked NextEra to provide an evaluation of a SAMA to address this basic event (NRC, 2011b). In response to the followup RAI, NextEra identified and evaluated SAMA "improve the reliability of the pre-lube pump via installation of a redundant pump" to address basic event FWP161.FS (NextEra, 2011b). This is discussed further in Section F.6.2. Based on the results of the NRC staff's review of the LERF basic events, NextEra's evaluation of a SAMA for basic event FWP161.FS, and NextEra's statement discussed previously that procedure and training improvements have been considered but that no improvements were identified that would reduce plant risk, the NRC staff concludes that it is unlikely that additional cost-beneficial SAMAs would be found from a further review of release category basic events having lower RRWs.

The NRC staff noted that neither the Level 1 nor LERF importance analyses specifically identified any initiating events and asked NextEra to clarify why this is the case (NRC, 2010a). In response to the RAI, NextEra stated that the importance analyses did include consideration of initiating events because failure of the support system relied upon to mitigate the initiating event is included in the importance analysis (NextEra, 2011a). NextEra further noted that several SAMA candidates were evaluated assuming complete elimination of certain initiating events. In response to a followup RAI, NextEra identified the SAMA candidates that address each of the top 10 most risk-significant initiating events, which correspond to all initiating events that contribute at least 2.6 percent to the total CDF (NextEra, 2011b). As a result of this review, the following additional SAMAs were identified and evaluated and are discussed further in Section F.6.2:

- SAMA "improve overall Seabrook reliability; reduce potential for plant trip initiating event frequency or reliability of mitigation systems to plant trip"
- SAMA "reduce/elimination impact of 0.7 g seismic event"
- SAMA "protect relay room from potential impact from high energy line break (HELB)"
- SAMA "improve/reduce the core damage frequency contribution of Switchgear Room B fire events"

The NRC staff estimated that a risk reduction of 2.6 percent, corresponding to the least risk significant of the initiating events reviewed by NextEra, equates to a maximum benefit of

approximately $21,000. Or, it equates to approximately $44,000 after the benefits have been multiplied by a factor of 2.1 by the NRC staff to account for the additional risk from seismic events, which is less than the minimum implementation cost of $100,000 associated with a hardware change. Based on this, and NextEra's statement discussed previously that procedure and training improvements have been considered but that no improvements were identified that would reduce plant risk, the NRC staff concludes that it is unlikely that additional cost-beneficial SAMAs would be found from a further review of initiating events having lower contribution to CDF.

In response to an NRC staff RAI, NextEra reviewed the cost-beneficial SAMAs from prior SAMA analyses for five Westinghouse four-loop PWR sites (NextEra, 2011a). NextEra's review determined that all but two of these cost-beneficial SAMAs were already represented by a SAMA, have intent that was already met at Seabrook, have low potential for risk reduction at Seabrook (e.g., do not address risk-important basic events), or were not applicable to Seabrook. Two SAMAs were identified and evaluated further as a result of this review and are further discussed in Section F.6.2. The two SAMAs are "procedure change to ensure that the RCS cold leg water seals are not cleared" and "installation of redundant parallel service water valves to the emergency diesel generators (EDGs)."

The NRC staff noted that both SAMA 173, identified from the IPEEE review, and SAMA 185 are described as "improve procedural guidance for directing depressurization of RCS," and requested NextEra to clarify the difference between these two SAMAs (NRC, 2010a). In response to the RAI, NextEra clarified that SAMA 173 was to improve procedural guidance directing operators to depressurize the RCS before core damage, while SAMA 185 was to improve procedural guidance directing operators to depressurize the RCS after core damage. The NRC staff considers NextEra's clarification reasonable.

Although the IPE did not identify any fundamental vulnerabilities or weaknesses related to internal events, 14 potential plant improvements were identified. NextEra reviewed these potential improvements for consideration as plant-specific candidate SAMAs. In response to an NRC staff RAI, NextEra clarified that the following 13 SAMAs were identified from the review of the potential plant improvements identified in the IPE (NextEra, 2011a):

- Phase II SAMA 167, "install independent seal injection pump (low volume pump) with automatic start"
- Phase II SAMA 168, "install independent seal injection pump (low volume pump) with manual start"
- Phase II SAMA 169, "install independent charging pump (low volume pump) with manual start"
- Phase I SAMA 155, "install alternate emergency AC power source (e.g., swing diesel)"
- Phase II SAMA 156, "install alternate off-site power source that bypasses switchyard, for example, use campus power source to energize Bus E5 or E6"
- Phase II SAMA 174, "provide alternate scram button to remove power from MG sets to CR drives"
- Phase II SAMA 157, "provide independent AC source for battery chargers, for example, provide portable generator to charge station battery"

- Phase I SAMA 158, “provide enhanced procedural direction for cross-tie of batteries within each train”
- Phase II SAMA 159, “install additional batteries”
- Phase II SAMA 184, “control/reduce time that the containment purge valves are in open position”
- Phase I SAMA 185, “improve procedural guidance to directing depressurization of RCS”
- Phase II SAMA 186, “install containment leakage monitoring system”
- Phase II SAMA 187, “install RHR isolation valve leakage monitoring system”

In addition, the improvement identified in the IPE for “alternate, independent EFW pump (e.g., diesel firewater pump hard piped to discharge of startup feed pump),” is already addressed by Phase I SAMA 29, “provide capability for alternate injection via diesel-driven fire pump,” and Phase II SAMA 163, “install third EFW pump (steam-driven).” Phase I SAMA 29 and Phase II SAMA 163 were previously identified from the review of the list of potential PWR enhancements in Table 14 of NEI 05-01 (NEI, 2005). Phase I SAMAs 29, 155, 158, and 185 were screened in the Phase I evaluation as having already been implemented.

Based on this information, the NRC staff concludes that the set of SAMAs evaluated in the ER, together with those identified in response to NRC staff RAIs, addresses the major contributors to internal event CDF.

As described previously, NextEra’s importance analysis considered both fire and seismic basic events from the internal and external event integrated Level 1 and Level 2 PRA model. The NRC staff noted that since the importance analyses did not separately consider the importance of internal, fire, and seismic events, SAMAs identified to address the important basic events may not address the more important initiator (e.g., fire) and requested NextEra to explain how the identified SAMAs address this issue (NRC, 2010a). In response to the RAI, NextEra explained that the importance analysis considers the contribution from all hazards, and the contribution from the individual hazards will be a subset of the total risk contribution. Additionally, based on evaluations provided in response to the NRC staff RAIs discussed above in which SAMAs were identified to address each of the important Level 1 and 2 basic events, hardware changes to address the individual hazard contributors would not, in NextEra’s judgement, be cost-beneficial based on a conservative minimum cost for a hardware change of $100,000 (NextEra, 2011a). Based on the NRC staff conclusions above regarding NextEra’s systematic process for identifying SAMAs for each important Level 1 and 2 basic event and NextEra’s statement that procedure/training improvements have been considered but that no improvements were identified that would reduce plant risk, the NRC staff agrees that it is unlikely that additional cost-beneficial SAMAs would be found from a further review of basic events.

Although the IPEEE did not identify any fundamental vulnerabilities or weaknesses related to external events, two potential plant improvements were identified to improve seismic CDF, and five potential plant improvements were identified to improve fire CDF. Additionally, five potential plant improvements were identified that were being evaluated to improve internal event risk but which may also reduce external event risk because they address functional failures. In response to an NRC staff RAI, NextEra clarified that the following 12 SAMAs were identified from the review of the potential plant improvements identified in the IPEEE (NextEra, 2011a):

- SAMAs to improve seismic CDF

- Phase II SAMA 181, “improve relay chatter fragility”
- Phase II SAMA 182, “improve seismic capacity of EDGs and steam-driven EFW pump”

- SAMAs to improve fire CDF
  - Phase II SAMA 175, “install fire detection in turbine building relay room”
  - Phase I SAMA 176, “install additional suppression at west wall of turbine building”
  - Phase I SAMA 177, “improve fire response procedure to indicate that [primary component cooling water] PCCW can be impacted by [primary auxiliary building] PAB fire event”
  - Phase I SAMA 178, “improve the response procedure to indicate important fire areas including control room, PCCW pump area, and cable spreading room”
  - Phase I SAMA 180, “modify SW pump house roof to allow scuppers to function properly”
- Other SAMAs identified from the IPEEE review
  - Phase I SAMA 160, “enhancements to address loss of SF6-type sequences”
  - Phase I SAMA 171, “install high temperature O-rings in RCPs”
  - Phase I SAMA 173, “improve procedural guidance for directing depressurization of RCS”
  - Phase II SAMA 179, “fire-induced LOCA response procedure from Alternate Shutdown Panel”
  - Phase I SAMA 183, “Turbine Building internal flooding improvements”

Phase I SAMAs 160, 171, 173, 176, 177, 178, 180, and 183 were screened in the Phase I evaluation as having already been implemented.

The NRC staff questioned whether SAMA 162, “increase the capacity margin of the condensate storage tank (CST)” addressed basic event COTK25.RT, “condensate storage tank CO-TK-25 ruptures/excessive leakage” (NRC, 2010a). In response to the RAI, NextEra explained that the CST has a median seismic fragility of 1.65 g and a HCLPF of 0.65, without crediting the concrete shield structure surrounding the CST (NextEra, 2011a). Therefore, NextEra identified and evaluated a SAMA to make “seismic upgrades to the CST.” This is discussed further in Section F.6.2.

The NRC staff asked NextEra to clarify how additional fire barriers for fire areas were considered since SAMA 143, “upgrade fire compartment barriers,” was screened in the Phase I evaluation based on the Seabrook plant design including 3-hour rated fire barriers (NRC, 2010a). NextEra responded with a review of the fire risk by plant location and explained that it is not physically possible to install additional fire barriers in the control room, which contribute 52 percent of the fire CDF, and that additional fire barriers in the essential switchgear rooms, which contribute 41 percent of the fire CDF, would have no impact on the fire risk since these rooms are already separated (NextEra, 2011a). Other lower risk fire areas were also similarly evaluated with similar conclusions. In a response to a followup NRC staff RAI, NextEra further clarified that additional fire barriers were not considered for the essential switchgear rooms because a review of fire scenarios in these rooms did not identify impacts to any

redundant safety train cables (NextEra, 2011b). The NRC staff concludes that the applicant's rationale for eliminating fire barrier enhancements from further consideration is reasonable.

Based on the licensee's IPEEE, the review of the results of the Seabrook PRA, which includes seismic and fire events, and the expected cost associated with further risk analysis and potential plant modifications, the NRC staff concludes that the opportunity for seismic and fire-related SAMAs has been adequately explored and that it is unlikely that there are any additional cost-beneficial seismic or fire-related SAMA candidates.

As stated earlier, other external hazards (i.e., high winds, external floods, transportation and nearby facility accidents, and chemical releases) are below the IPEEE threshold screening frequency, or met the 1975 SRP design criteria, and are not expected to represent opportunities for cost-beneficial SAMA candidates. Nevertheless, NextEra reviewed the IPEEE results and identified no additional Phase I SAMAs to reduce HFO risk (NextEra, 2010).

For many of the Phase II SAMAs listed in the ER, the information provided did not sufficiently describe the proposed modification. Therefore, the NRC staff asked the applicant to provide more detailed descriptions of the modifications for several of the Phase II SAMA candidates (NRC, 2010a). In response to the RAI, NextEra provided the requested information on the modifications for SAMAs 44, 59, 94, 112, 114, 163, 186, and 187 (NextEra, 2011a).

The NRC staff questioned NextEra about lower cost alternatives to some of the SAMAs evaluated (NRC, 2010a), including the following:

- use a portable generator to extend the coping time in loss of AC power events (to power selected instrumentation and DC power to the turbine-driven auxiliary feedwater pump provide alternate DC feeds (using a portable generator) to panels supplied only by DC bus
- purchase or manufacture of a "gagging device" that could be used to close a stuck-open steam generator safety valve for a SGTR event prior to core damage

In response to the RAIs, NextEra addressed the suggested lower cost alternatives (NextEra, 20011). This is discussed further in Section F.6.2.

The NRC staff requested NextEra to clarify the Phase I screening criteria, which was described in the ER as including the following two criteria that appear to not have been used: (1) excessive implementation cost and (2) very low benefit (NRC, 2010a). NextEra responded that these criterion, while they could have been used in the Phase I evaluation, were not used in the Phase I screening evaluation in order to force evaluation of more SAMA candidates into the Phase II evaluation so that the merit of each could be judged based on associated costs and benefits (NextEra, 2011a).

The NRC staff asked NextEra to provide justification for the screening of SAMA 29, "provide capability for alternate injection via diesel-driven fire pump," in the Phase I evaluation on the basis that it has already been implemented through an existing alternate mitigation strategy (NRC, 2010a). In response to the RAI, NextEra responded that Seabrook has the capability to use its diesel-driven fire pump to provide injection to the steam generators through implementation of existing SAMGs (NextEra, 2011a). NextEra also stated that two portable diesel-driven pumps are also available to provide injection using suction from the fire protection system, the cooling tower basin, and the Browns River. Based on this clarification, the NRC staff considers NextEra's basis for screening SAMA 29 reasonable.

The NRC staff noted that SAMA 64, “implement procedure and hardware modification for a component cooling water header cross-tie,” was screened in the Phase I evaluation because a cross-tie already exists to support a maintenance activity. The staff asked NextEra to clarify if the cross-tie between divisions A and B of the PCCW system is already provided for in existing plant procedures (NRC, 2010a). In response to the RAI, NextEra clarified that the Seabrook operating procedures do provide explicit instructions for alignment of the PCCW division A and B cross-tie. Additionally, while the cross-tie is primarily used during maintenance activities, it could be used during an off-normal event involving a failure of heat sink in one division with failure of frontline components in the opposite division, provided that adequate time is available (NextEra, 2011a).

The NRC staff questioned why SAMA 79, “install bigger pilot operated relief valve so only one is required,” was screened in the Phase I evaluation based on the intent of the SAMA having already been implemented when the success criterion is 2-of-2 PORVs needed for intermediate head SI (NRC, 2010a). NextEra responded that the context of SAMA 79 was to increase the capacity of the pressurizer PORVs such that opening of only one PORV would satisfy the feed and bleed success criteria for all loss of feedwater-type sequences, which is all that is needed at Seabrook if feed and bleed is provided by one of two high head charging pumps (NextEra, 2010). However, since opening of two PORVs is needed if feed is provided by one of two SI pumps, NextEra provided a Phase II evaluation of this SAMA, the results of which are further discussed in Section F.6.2.

The NRC staff asked NextEra to provide justification for the screening of SAMA 82, “stage backup fans in switchgear rooms,” and SAMA 84, “switch for emergency feedwater room fan power supply to station batteries,” in the Phase I evaluation on the basis that they are not applicable to Seabrook (NRC, 2010a). In response to the RAI, NextEra explained that the context of SAMA 82 was to enhance the availability and reliability of ventilation to the essential switchgear rooms in the event of a loss of switchgear room ventilation. Additionally, this SAMA is more accurately screened as its intent having been already implemented at Seabrook since procedures already exist for maintaining acceptable switchgear room temperatures when ventilation becomes unavailable, which includes opening doors and setting up portable fans (NextEra, 2011a). The NRC staff considers NextEra’s clarification for SAMA 82 reasonable.

Regarding SAMA 84, NextEra explained that the context of this SAMA was to enhance the availability and reliability of ventilation to the EFW pump house, in the event of a loss of pump house ventilation, by switching the pump house ventilation fan(s) power supply to station batteries. NextEra further stated that the initial screening of “not applicable” is incorrect (NextEra, 2011a). NextEra further explained that since procedures already exist for maintaining acceptable EFW pump house room temperatures when ventilation becomes unavailable, failure of the already reliable ventilation system is not a significant contributor to CDF. Nevertheless, NextEra provided a Phase II evaluation of this SAMA, the results of which are further discussed in Section F.6.2.

The NRC staff noted that SAMA 92, “use a fire water system as a backup source for the containment spray system,” was screened in the Phase I evaluation because the containment spray function is not important early, yet basic events RCPCV456A.FC and RCPCV456B.FC, “spray valves fail to open on demand,” appear on the LERF importance list (NRC, 2010a). In response to the RAI, NextEra explained that these two basic events refer to modeling of the PORVs and not the containment spray valves, that descriptions of these two events in the ER inadvertently referred to the PORVs as PORV spray valves, that the PORV function is unrelated

to the containment spray function, and that, therefore, no SAMA is necessary. The NRC staff considers NextEra's clarification reasonable.

The NRC staff also asked NextEra to provide justification for the screening of SAMA 105, "delay containment spray actuation after a large LOCA," and SAMA 191, "remove the 135°F temperature trip of the PCCW pumps," in the Phase I evaluation on the basis that they would violate the current licensing basis (CLB) for Seabrook (NRC, 2010a). In response to the RAI, NextEra provided a Phase II evaluation of these SAMAs, the results of which are further discussed in Section F.6.2 (NextEra, 2011a).

The NRC staff requested that NextEra clarify the basis for screening SAMA 127, "revise emergency operating procedures (EOPs) to direct isolation of a faulted steam generator," in the Phase I evaluation on the basis that it is already implemented (NRC, 2010a). NextEra responded that the context of SAMA 127 was to have specific EOPs for isolation of the steam generator for the purpose of reducing the consequences of a SGTR, and existing EOPs direct specific operator actions to diagnose a SGTR and to perform its isolation. Additionally, existing plant EOPs also specifically provide actions for the identification and isolation of a faulted steam generator (NextEra, 2011a). The NRC staff considers NextEra's clarification reasonable.

The NRC staff asked NextEra to clarify the screening of SAMA 188, "containment flooding – modify the containment integrated leak rate test (ILRT) 10-inch test flange to include a 5-inch adapter with isolation valve" based on the statement that "flange and procedures exist" (NRC, 2010a). NextEra responded that the 10-inch flange with fire hose adapter has been pre-fabricated, is stored in a designated and controlled area, and is available for attaching to the 10-inch ILRT flange to provide containment flooding via Severe Accident Guideline instructions (NextEra, 2011a). NextEra further explained that pre-installation of the flange adapter will provide no significant time savings in light of the containment flooding scenario evolution via the fire hose connection which takes several days. The NRC staff considers NextEra's clarification reasonable.

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

The 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. This search 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.

F.4 Risk Reduction Potential of Plant Improvements

NextEra evaluated the risk-reduction potential of the 61 SAMAs retained for the Phase II evaluation in the ER and not screened for excessive cost. 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.

NextEra used model re-quantification to determine the potential benefits. The CDF, population dose, and offsite economic cost reductions were estimated using the SSPSS-2006 PRA model with a truncation level of 1×10^{-14} per year. The changes made to the model to quantify the impact of SAMAs are detailed in Appendix F.A and Table F.7-1 of Attachment F to the ER (NextEra, 2010). Tables F-6 and F-7 list the assumptions considered to estimate the risk reduction for each of the evaluated analysis cases, the estimated risk reduction in terms of percent reduction in CDF and population dose, the estimated total benefit (present value) of the averted risk, and the Phase II SAMAs evaluated for each analysis case. The estimated benefits reported in Tables F-6 and F-7 reflect the combined benefit in both internal and external events. The Phase II SAMAs included in Tables F-6 and F-7 are the 61 Phase II SAMAs evaluated in the ER and the additional SAMAs determined to be cost-beneficial in response to NRC staff RAIs. The determination of the benefits for the various SAMAs is further discussed in Section F.6.

The NRC staff questioned the assumptions used in evaluating the benefits or risk reduction estimates of certain SAMAs provided in the ER (NRC, 2010a). For example, several SAMAs (i.e., SAMA 179, SAMAs involving model case NOSGTR, and SAMAs involving model case LOCA06) were reported to have a reduction in CDF used in the benefit calculation that was somewhat different from the contribution to CDF reported in Table F.3.1.1.1-1 of the ER, and the NRC asked NextEra to clarify these discrepancies. In response to the NRC staff RAI, NextEra stated that each of the differences identified in the RAI were reviewed, and it was determined that in each case the difference was due to rounding (NextEra, 2011a). NextEra also clarified that the CDF contribution reported in Table F.3.1.1.1-1 was developed from PRA documentation and that the CDF reduction used in the calculation of SAMA benefits is judged to be more precise. The NRC staff considers NextEra's explanation reasonable.

As discussed in Section F.2.2, NextEra provided the results of a sensitivity analysis that applied a multiplier of 2.1 to account for the additional risk reduction from seismic events (NextEra, 2011b). In this analysis, NextEra revised the modeling assumptions for several SAMAs that were determined to have been modeled incorrectly (i.e., assigned to the wrong analysis case) or were determined to be overly conservative. The revised modeling assumptions are provided in Tables F-6 and F-7. The determination of the benefits in the sensitivity analysis for the various SAMAs is discussed further in Section F.6.

The NRC staff has reviewed NextEra's bases for calculating the risk reduction for the various plant improvements and concludes that the rationale and assumptions for estimating risk reduction are reasonable and generally conservative (i.e., the estimated risk reduction is higher than what would actually be realized). Accordingly, the NRC staff based its estimates of averted risk for the various SAMAs on NextEra's risk reduction estimates.

Table F-6. SAMA cost and benefit screening analysis for Seabrook[a]

Analysis case & applicable SAMAs	Modeling assumptions	% Risk reduction		Total benefit ($)[j]		Cost ($)
		CDF	Population dose	Baseline (internal + external)	Baseline with uncertainty	
NOSBO 2—Replace lead-acid batteries with fuel cells	Eliminate failure of the EDGs	27	12	160K (330K)	300K (620K)	>1M
14[m]—Install a gas turbine generator						>1M
16[m]—Improve uninterruptable power supplies						>1M
20—Add a new backup source of diesel cooling						>1M
161—Modify EDG jacket heat exchanger SW supply & return to allow timely alignment of alternate cooling water source (supply & drain) from firewater, reactor makeup water (RMW), dewatering (DW), etc.						>1M[l]
190—Add synchronization on capability to SEPS diesel						>1M
NOLOSP 13—Install an additional buried offsite power source	Eliminate LOOP events	42	36	340K (700K)	640K (1.3M)	>2.4M[l]
24—Bury offsite power lines						>3M[l]
156—Install alternate offsite power source that bypasses the switchyard; for example, use campus power source to energize Bus E5 or E6						>7M[l]
BREAKER 21—Develop procedures to repair or replace failed 4 kV breakers	Eliminate failure of the 4 KV bus infeed breakers	1	<1	8K (17K)	15K (32K)	Screened[n]
LOCA02 25—Install an independent active or passive high pressure injection system	Eliminate failure of the high pressure injection system	68	52	470K (980K)	890K (1.9M)	>5M[l]

Analysis case & applicable SAMAs	Modeling assumptions	% Risk reduction		Total benefit ($)[j]		Cost ($)
		CDF	Population dose	Baseline (internal + external)	Baseline with uncertainty	
26—Provide an additional high pressure injection pump with independent diesel						>5M[l]
39—Replace two of the four electric SI pumps with diesel-powered pumps						>5M[l]
LOCA03 28—Add a diverse low pressure injection system	Eliminate failure of the low pressure injection system	11	29	160K (340K)	300K (640K)	>1M
LOCA04 35—Throttle low pressure injection pumps either in medium or large-break LOCAs to maintain RWST inventory	Eliminate RWST running out of water	28	12	160K (330K)	300K (630K)	>1M[l]
106—Install automatic containment spray pump header throttle valves						>1M[l]
LOCA01 41—Create a reactor coolant depressurization system	Eliminate all small LOCA events	7	2	33K (70K)	63K (130K)	>1M
SW01 43—Add redundant DC control power for SW pumps	Eliminate the dependency of the SW pumps on DC power	1	1	10K (21K)	19K (40K)	>100K
CCW01 44—Replace ECCS pump motors with air-cooled motors	Eliminate failure of the component cooling water (CCW) pumps	25	23	180K (380K)	350K (730K)	>4M[l]
59—Install a digital feed water upgrade						>1M[l]
RCPLOCA 55—Install an independent RCP seal injection system with dedicated diesel	Eliminate all RCP seal LOCA events	11	12	92K (170K)	180K (370K)	>1M
56[b]—Install an independent RCP seal injection system without dedicated diesel						>3M

Analysis case & applicable SAMAs	Modeling assumptions	% Risk reduction		Total benefit ($)[j]		Cost ($)
		CDF	Population dose	Baseline (internal + external)	Baseline with uncertainty	
167—Install independent seal injection pump (low volume pump) with automatic start						>1M
168—Install independent seal injection pump (low volume pump) with manual start						>1M
169—Install independent charging pump (high volume pump) with manual start						>500K
170—Replace the positive displacement pump (PDP) with a 3rd centrifugal pump; consider low volume and cooling water independence						>500K
172—Evaluate installation of a "shutdown seal" in the RCPs being developed by Westinghouse						>1M
FW01 79[d]—Install bigger pilot operated relief valve so only one is required	Eliminate all loss of feedwater events	12	7	73K (150K)	140K (290K)	>1M[l]
HVAC2 80—Provide a redundant train or means of ventilation	Eliminate the dependency of the CS, SI, RHR, and CBS pumps on heating, ventilation, and air conditioning (HVAC)	8	1	32K (67K)	61K (130K)	>500K
OEFWVS 84[e]—Switch for EFW room fan power supply to station batteries	Eliminate loss of EFW ventilation	<1	<1	<1K (<1K)	<1K (<2K)	>250K
CONT01 91[b]—Install a passive containment spray system	Eliminate all containment failures due to overpressurization	0	36	160K (340K)	310K (650K)	>3–6M
93[b]—Install an unfiltered hardened containment vent						>3M

Analysis case & applicable SAMAs	Modeling assumptions	% Risk reduction		Total benefit ($)[j]		Cost ($)
		CDF	Population dose	Baseline (internal + external)	Baseline with uncertainty	
94—Install a filtered containment vent to remove decay heat; Option 1: Gravel Bed Filter; Option 2: Multiple Venturi Scrubber						>5M[l]
99[b]—Strengthen primary & secondary containment (e.g., add ribbing to containment shell)						>10M
102[b]—Construct a building to be connected to primary & secondary containment & maintained at a vacuum						>10M
107[b]—Install a redundant containment spray system						>3–4M
H2Burn 96—Provide post-accident containment inerting capability	Eliminate all hydrogen ignition & burns	0	0[g]	<1K (<1K)	<1K (<1K)	>100K
108—Install an independent power supply to the hydrogen control system using either new batteries, a nonsafety grade portable generator, existing station batteries, or existing AC/DC independent power supplies, such as the security system diesel						>100K
109—Install a passive hydrogen control system						>100K
OLRPS 105[f]—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

Analysis case & applicable SAMAs	Modeling assumptions	% Risk reduction		Total benefit ($)[j]		Cost ($)
		CDF	Population dose	Baseline (internal + external)	Baseline with uncertainty	
CONT02p 112—Add redundant and diverse limit switches to each CIV	Contributes 50 percent of the risk reduction from eliminating failure of all CIVs	0	19	100K (220K)	200K (420K)	>500K
114—Install self-actuating CIVs						>500K
LOCA06[p] 113—Increase leak testing of valves in ISLOCA paths	Contributes 50 percent of the risk reduction from eliminating all ISLOCA events	1	3	14K (30K)	27K (60K)	>100K
LOCA06 115—Locate RHR inside containment	Eliminate all ISLOCA events	2	7	28K (60K)	53K (110K)	>1M
187—Install RHR isolation valve leakage monitoring system						>190K
NOSGTR 119—Institute a maintenance practice to perform a 100% inspection of steam generator tubes during each refueling outage	Eliminate all SGTR events	3	17	86K (180K)	160K (345K)	>500K
121—Increase the pressure capacity of the secondary side so that a SGTR would not cause the relief valves to lift						>500K
125—Route the discharge from the main steam safety valves through a structure where a water spray would condense the steam & remove most of the fission products						>500K
126—Install a highly reliable (closed loop) steam generator shell-side heat removal system that relies on natural circulation & stored water sources						>500K
129—Vent main steam safety valves in containment						>500K

Analysis case & applicable SAMAs	Modeling assumptions	% Risk reduction		Total benefit ($)[j]		Cost ($)
		CDF	Population dose	Baseline (internal + external)	Baseline with uncertainty	
NOATWS 130—Add an independent boron injection system	Eliminate all ATWS events	3	11	70K (150K)	130K (280K)	>500K
131—Add a system of relief valves to prevent equipment damage from pressure spikes during an ATWS						>500K
133—Install an ATWS sized filtered containment vent to remove decay heat						>500K
174—Provide alternate scram button to remove power from motor generator (MG) sets to control rod (CR) drives						>500K
LOCA05 147—Install digital large break LOCA protection system	Eliminate all piping failure LOCAs	10	12	100K (220K)	200K (410K)	>500K
NOSLB 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
OSEPALL 154[k]—Modify SEPS design to accommodate automatic bus loading & automatic bus alignment	Eliminate failure of all operator actions to align & load the SEPS DGs	Not Provided	Not Provided	33K (68K)	62K (130K)	>750K
Case INDEPAC **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. Also, eliminate failure to recover offsite power for plant-related, grid-related, and weather-related LOOP events.[h]**	**4**	**2**	**23K (48K)**	**45K (95K)**	**30K**
159—Install additional batteries						>1M

Analysis case & applicable SAMAs	Modeling assumptions	% Risk reduction		Total benefit ($)[j]		Cost ($)
		CDF	Population dose	Baseline (internal + external)	Baseline with uncertainty	
CST01 162—Increase the capacity margin of the CST	Eliminate CST running out of water	1	1	9K (18K)	16K (34K)	>100K
164—Modify 10" condensate filter flange to have a 2½-inch female fire hose adapter with isolation valve						>40K
Turbine-driven auxiliary feedwater (TDAFW) 163—Install third EFW pump (steam-driven)	Eliminate failure of the TDAFW train	19	9	100K (210K)	190K (400K)	>2M[l]
NORMW **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**
FIRE2 175—Improve fire detection in turbine building relay room	This SAMA has been implemented (NextEra, 2011b).					
FIRE1 179—Fire induced LOCA response procedure from alternate shutdown panel	Eliminate control room fire causing opening of the PORV and a LOCA	1	<1	4K (8K)	7K (15K)	>20K[l]
SEISMIC01 181—Improve relay chatter fragility	Eliminate all seismic relay chatter failures	9	12	100K (210K)	200K (410K)	>600K[l]
SEISMIC02 182—Improve seismic capacity of EDGs and steam-driven EFW pump	Eliminate all seismic failures of EDGs or turbine-driven EFW	0	0	<1K (<1K)	<1K (<1K)	>500K
PURGE 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

Analysis case & applicable SAMAs	Modeling assumptions	% Risk reduction		Total benefit ($)[j]		Cost ($)
		CDF	Population dose	Baseline (internal + external)	Baseline with uncertainty	
CISPRE 186[o]—Install containment leakage monitoring system	Eliminate all CDF contribution from pre-existing containment leakage	Not Provided	Not Provided	11K (23K)	20K (43K)	>500K
IOF2SEPS 189—Modify or analyze SEPS capability; 1 of 2 SEPS for LOOP non-SI loads, 2 of 2 for LOOP 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
PCTES 191[f]—Remove the 135°F temperature trip of the PCCW pumps	Eliminate inadvertent failure of the redundant TE/logic of the associated PCC division for both loss of PCCW initiating events & loss of PCCW mitigative function	<1	<1	<1K (<1K)	<1K (<1K)	>100K
NOCBFLD **192(i)—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**
V167AC **193(c)—Hardware change to eliminate MOV AC power dependency**	**Eliminate MOV AC power dependency by replacing the MOV with a fail-closed AOV**	**0**	**35**	**190K (400K)**	**365K (770K)**	**300K**

[a] SAMAs in bold are potentially cost-beneficial.

[b] This is retained as a quantitatively-evaluated Phase II SAMA in response to NRC staff RAI 3.g (NextEra, 20011).

[c] This is a new SAMA identified in response to NRC staff RAI 2.f (NextEra, 2011a) and conference call clarification #7 (NRC, 2011a).

[d] Evaluation of this SAMA is provided in response to NRC staff RAIs 5.g (NextEra, 2011a) and conference call clarification #14 (NRC, 2011a).

[e] Evaluation of this SAMA is provided in response to NRC staff RAI 5.j (NextEra, 2011a).

[f] Evaluation of these SAMAs is provided in response to NRC staff RAI 5.n (NextEra, 2011a) and conference call clarification #15 (NRC, 2011a).

[g] Reduction in population dose is provided in response to NRC staff RAI 6.g (NextEra, 2011a).

[h] Information is provided in response to NRC staff RAI 6.h (NextEra, 2011a).

[i] This is a new SAMA identified and evaluated in response to NRC staff RAI 1.a (NextEra, 2011a) and conference call clarification #1 (NRC, 2011a).

[j] Values in parenthesis are the results of the sensitivity analysis applying a multiplier of 2.1 to account for the additional risk of seismic events (NextEra, 2011b).

Analysis case & applicable SAMAs	Modeling assumptions	% Risk reduction		Total benefit ($)[j]		Cost ($)
		CDF	Population dose	Baseline (internal + external)	Baseline with uncertainty	

[k] The analysis case for SAMA 154 changed from NOSBO to OSEPALL in response to followup NRC staff RAI 4 (NextEra 2011b).

[l] Cost updated in supplement to response to followup NRC staff RAI 4 (NextEra 2011c).

[m] The analysis case for SAMAs 14 and 16 changed from NOLOSP to NOSBO in response to followup NRC staff RAI 4 (NextEra, 2011b).

[n] In response to followup NRC staff RAI 4, NextEra determined that detailed procedures already exist for inspection and repair of the Seabrook 4 kV breakers, and this SAMA was, therefore, screened from further consideration (NextEra, 2011b).

[o] The analysis case for SAMA 186 changed from CONT01 to CISPRE in response to followup NRC staff RAI 4 (NextEra, 2011b).

[p] Modeling assumptions, risk reduction, and benefit results changed in response to followup NRC staff RAI 4 (NextEra, 2011b). The revised risk reduction and benefits were estimated by the NRC staff based on the benefits estimated by NextEra for the sensitivity analysis.

F.5 Cost Impacts of Candidate Plant Improvements

NextEra developed plant-specific costs of implementing the 61 Phase II candidate SAMAs. An expert panel—composed of senior plant staff from the PRA group, the design group, operations, and license renewal—developed the cost estimates based on their experience with developing and implementing modifications at Seabrook. The NRC staff requested that NextEra describe the level of detail used to develop the cost estimates (NRC, 2010a). In response to the RAI, NextEra explained that the cost estimates were based on the experience and judgment of the plant staff serving on the expert panel and that, 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 (RPC).

The NRC staff reviewed the bases for the applicant's cost estimates (presented in Section F.7.2 and Table F.7-1 of Attachment F to the ER). For certain improvements, the NRC staff also compared the cost estimates to estimates developed elsewhere for similar improvements, including estimates developed as part of other licensees' analyses of SAMAs for operating reactors and advanced light-water reactors. In response to an RAI requesting a more detailed description of the changes associated with Phase II SAMAs 44, 59, 94, 112, 114, 163, 186, and 187, NextEra provided additional information detailing the analysis and plant modifications included in the cost estimate of each improvement (NextEra, 2011a). The staff reviewed the costs and found them to be reasonable and generally consistent with estimates provided in support of other plants' analyses.

The NRC staff requested additional clarification on the estimated cost of more than $100,000 for implementation of Phase II SAMA 113, "increase leak testing of valves in ISLOCA paths," which is high for what does not appear to be a hardware modification (NRC, 2010a). In response to the RAI, NextEra explained that most of the ISLOCA valves that are candidates for this enhancement are located inside containment, and leak testing of these ISLOCA valves is typically done during plant refueling outages or cold shutdown when the valves are accessible. Additionally, increased leak testing on a more frequent basis would require a costly plant shutdown (NextEra, 2011a). Based on this additional information, the NRC staff considers this estimated cost to be reasonable and acceptable for purposes of the SAMA evaluation.

The NRC staff noted that Phase I SAMA 65, “install a digital feed water upgrade,” has an estimated implementation cost of $30 million, which is much larger than the estimated implementation cost of more than $500,000 for Phase II SAMA 147, “install digital large break LOCA protection system.” The NRC staff asked NextEra to explain the reason for this difference between what appear to be similar modifications (NRC, 2010a). NextEra responded that the estimated implementation cost of $30 million for Phase I SAMA 65 was based on a detailed assessment of the costs associated with the Seabrook long-range plan for a digital upgrade of the feedwater control system, while the estimated cost of more than $500,000 for SAMA 147 was based on the judgment of the expert panel (NextEra, 2011a). NextEra also noted that since the conservatively estimated benefit for SAMA 147 was much less than the estimated implementation cost, developing a more detailed cost estimate for this SAMA was not necessary. The NRC staff considers NextEra’s clarification reasonable.

The NRC staff requested additional clarification on the estimated cost of $30,000 for implementation of Phase II SAMA 157, “provide independent AC power source for battery chargers,” which seems low for what is described as a hardware change (NRC, 2010a). In response to the RAI, NextEra explained that the cost estimate is based on expert panel judgment and includes procurement of a small portable, nonsafety-related 480V generator and associated connection cables, operation guideline development, and storage onsite in a convenient location for ease in moving into position/connected if ever needed during an extended SBO event (NextEra, 2011a). The NRC staff considers NextEra’s clarification reasonable.

As discussed in Section F.2.2, NextEra provided the results of a sensitivity analysis that applied a multiplier of 2.1 to account for the additional risk reduction from seismic events (NextEra, 2011b). In this analysis, NextEra revised the implementation costs for several SAMAs in which the estimated costs were determined to be overly conservative. The revised implementation costs are provided in Tables F-6 and F-7. The staff reviewed the basis for each of the revised costs and found them to be reasonable and, generally, consistent with estimates provided in support of other plants’ analyses.

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

F.6 Cost-Benefit Comparison

NextEra’s cost-benefit analysis and the NRC staff’s review are described in the following sections.

F.6.1 NextEra’s Evaluation

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. NextEra's derivation of each of the associated costs is summarized below.

NUREG/BR-0058 has recently been revised to reflect the NRC's policy on discount rates. Revision 4 of NUREG/BR-0058 states that two sets of estimates should be developed, one at 3 percent and one at 7 percent (NRC, 2004). NextEra provided a base set of results using the 7 percent discount rate and a sensitivity study using the 3 percent discount rate (NextEra, 2010).

Averted Public Exposure (APE) Costs

The APE costs were calculated using the following formula:

APE = Annual reduction in public exposure (Δperson-rem/year)

x monetary equivalent of unit dose ($2,000 per person-rem)

x present value conversion factor (10.76 based on a 20-year period with a 7 percent discount rate)

As stated in NUREG/BR-0184 (NRC, 1997a), the monetary value of the public health risk after discounting does not represent the expected reduction in public health risk due to a single accident. Rather, it is the present value of a stream of potential losses extending over the remaining lifetime (in this case, the renewal period) of the facility. Thus, it reflects the expected annual loss due to a single accident, the possibility that such an accident could occur at any time over the renewal period, and the effect of discounting these potential future losses to present value. For the purposes of initial screening, which assumes elimination of all severe accidents caused by internal and external events, NextEra calculated an APE of approximately $230,400 for the 20-year license renewal period (NextEra, 2010).

Averted Offsite Property Damage Costs (AOC)

The AOCs were calculated using the following formula:

AOC = Annual CDF reduction

x offsite economic costs associated with a severe accident (on a per-event basis)

x present value conversion factor

This term represents the sum of the frequency-weighted offsite economic costs for each release category, as obtained for the Level 3 risk analysis. For the purposes of initial screening, which assumes elimination of all severe accidents caused by internal events, NextEra calculated an annual offsite economic cost of about $23,500 based on the Level 3 risk analysis (NextEra, 2011a). This results in a 7 percent-discounted value of approximately $253,300 for the 20-year license renewal period.

Averted Occupational Exposure (AOE) Costs

The AOE costs were calculated using the following formula:

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

NextEra derived the values for AOE from information provided in Section 5.7.3 of the *Regulatory Analysis Technical Evaluation Handbook* (NRC, 1997a). Best estimate values provided for immediate occupational dose (3,300 person-rem) and long-term occupational dose (20,000 person-rem over a 10-year cleanup period) were used. The present value of these doses was calculated using the equations provided in the handbook in conjunction with a monetary equivalent of unit dose of $2,000 per person-rem, a real discount rate of 7 percent, and a time period of 20 years to represent the license renewal period. For the purposes of initial screening, which assumes elimination of all severe accidents caused by internal events, NextEra calculated an AOE of approximately $5,500 for the 20-year license renewal period (NextEra, 2010).

Averted Onsite Costs

AOSC include averted cleanup and decontamination costs (ACC) and averted power replacement costs. Repair and refurbishment costs are considered for recoverable accidents only and not for severe accidents. NextEra derived the values for AOSC based on information provided in Section 5.7.6 of NUREG/BR-0184, the *Regulatory Analysis Technical Evaluation Handbook* (NRC, 1997a).

NextEra divided this cost element into two parts—the onsite cleanup and decontamination cost, also commonly referred to as ACC, and the RPC.

ACC were calculated using the following formula:

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

The total cost of cleanup and decontamination subsequent to a severe accident is estimated in NUREG/BR-0184 to be $\$1.5 \times 10^9$ (undiscounted). This value was converted to present costs over a 10-year cleanup period and integrated over the term of the proposed license extension. For the purposes of initial screening, which assumes elimination of all severe accidents caused by internal events, NextEra calculated an ACC of approximately $167,200 for the 20-year license renewal period.

Long-term RPC were calculated using the following formula:

RPC = Annual CDF reduction
x present value of replacement power for a single event

x factor to account for remaining service years for which replacement power is required

x reactor power scaling factor

NextEra based its calculations on the rated Seabrook gross electric output of 1,290 megawatt electric (MWe) and scaled up from the 910 MWe reference plant in NUREG/BR-0184 (NRC, 1997a). Therefore, NextEra applied a power scaling factor of 1,290/910 to determine the RPC. For the purposes of initial screening, which assumes elimination of all severe accidents caused by internal events, NextEra calculated an RPC of approximately $162,300 and an AOSC of approximately $329,500 (sum of ACC of $167,200 and RPC of $162,300) for the 20-year license renewal period.

Using the above equations, 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 (sum of APE of $230,400, AOC of $253,300, AOE of $5,500, and AOSC of $329,500), also referred to as the maximum averted cost risk (MACR). Use of a multiplier of 2.1 to account for the additional risk from seismic events in the sensitivity analysis increases the MACR, as estimated by the NRC staff, to $1.7 million.

NextEra's Results

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 contained in the ER (using a 7 percent discount rate), NextEra identified one potentially cost-beneficial SAMA (SAMA 165). Based on the consideration of analysis uncertainties, NextEra identified one additional potentially cost-beneficial SAMA (SAMA 157). 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). In addition, in response to NRC staff RAIs, NextEra provided the results of sensitivity analysis applying a multiplier of 2.1 to account for additional SAMA benefits in external events due to a potentially larger seismic CDF (NextEra, 2011; NextEra, 2011b). No additional potentially cost-beneficial SAMAs were identified from this sensitivity analysis, which was performed for both the baseline and uncertainty analyses.

The potentially cost-beneficial SAMAs for Seabrook are listed below:

- SAMA 157—Provide independent AC power source for battery chargers
- SAMA 165—RWST fill from firewater during containment injection—Modify 6 inch RWST flush flange to have a 2½-inch female fire hose adapter with isolation valve
- SAMA 192—Install a globe valve or flow limiting orifice upstream in the fire protection system
- SAMA 193—Hardware change to eliminate MOV AC power dependency

The potentially cost-beneficial SAMAs, and NextEra's plans for further evaluation of these SAMAs, are discussed in more detail in Section F.6.2.

F.6.2 Review of NextEra's Cost-Benefit Evaluation

The cost-benefit analysis performed by NextEra was based primarily on NUREG/BR-0184 (NRC, 1997a) and discount rate guidelines in NUREG/BR-0058 (NRC, 2004), and it was

executed consistent with this guidance. One SAMA was determined to be cost-beneficial in NextEra's baseline analysis in the ER (SAMA 165, as described above). NextEra stated that this SAMA would be entered into the Seabrook long-range plan development process for further implementation consideration (NextEra, 2010).

NextEra considered the impact that possible increases in benefits from analysis uncertainties would have on the results of the SAMA assessment. In the ER, NextEra presents the results of an uncertainty analysis of the internal and external events CDF for Seabrook, which indicates that the 95th percentile value is a factor of 1.9 greater than the point estimate CDF for Seabrook. Since none of the Phase I SAMAs were screened based on excessive cost or very low benefit, a re-examination of the Phase I SAMAs based on the upper bound benefits was not necessary. NextEra reexamined the Phase II SAMAs to determine if any would be potentially cost-beneficial if the baseline benefits were increased by a factor of 1.9. One SAMA became cost-beneficial in NextEra's analysis (SAMA 157, as described above). Although not cost-beneficial in the baseline analysis, NextEra stated that this SAMA would be entered into the Seabrook long-range plan development process for further implementation consideration (NextEra, 2010).

The NRC staff asked NextEra to describe how the uncertainty distribution was developed to derive the 95th percentile CDF value and how the distribution is different for internal, fire, and seismic CDF (NRC, 2010a). In response to the RAI, NextEra explained that the uncertainty distribution was developed using a Monte Carlo sample size of 10,000 and a sequence bin cutoff of 1×10^{-9}, that the distribution included the integrated contribution from both internal and external events, and that individual contributions for internal, fire, and seismic events were not developed (NextEra, 2011a). In response to a followup RAI, NextEra further clarified that the uncertainty analysis included uncertainty distributions for fire-initiating events, seismic-initiating events, component seismic fragilities, operator actions, and component random failures (NRC, 2011b). NextEra also noted that, while uncertainty distributions were not specifically considered for hot short probabilities and non-suppression probabilities, numerous sensitivity studies were performed to support the fire events and seismic events models to ensure the reasonableness of key input parameters. The results of these sensitivity studies indicate that the baseline fire and seismic results are relatively insensitive to reasonable variations in key input parameters. Based on the results of these studies and the level of uncertainty applied in the fire and seismic events analyses, NextEra concluded that the uncertainty distribution used for the SAMA evaluation adequately reflects the uncertainty for both internal and external events.

NextEra provided the results of additional sensitivity analyses in the ER, including the use of 3 percent and 8.5 percent discount rates, variations in MACCS2 input parameters (as discussed in Section F.2.2), and a 41-year analysis period representing the remaining operating life of the plant accounting for the expected 20-year period of extended operation. These analyses did not identify any additional potentially cost-beneficial SAMAs.

SAMAs identified primarily on the basis of the internal events analysis could provide benefits in certain external events, in addition to their benefits in internal events. Since the SSPSS-2006 PRA model is an integrated internal and external events model, NextEra's evaluation accounted for the potential risk reduction benefits associated with both internal and external events. The NRC staff asked NextEra to assess the impact of updated 2008 seismic hazard curves by the USGS on the Seabrook SAMA analysis (NRC, 2010a). As indicated in Section F.2.2, NextEra responded with a sensitivity analysis in which a multiplier was applied to the estimated benefits for internal events to account for the higher seismic CDF developed from the 2008 USGS

seismic hazard curves (NextEra, 2011a). Since no SAMAs were screened in the Phase I analysis on very low benefit or excessive implementation cost, NextEra did not reexamine the Phase I SAMAs. NextEra did reexamine the Phase II SAMAs that were qualitatively screened on high cost or very low benefit to determine if any of these SAMAs would be retained for further analysis if the benefits (or MMACR) were increased by a factor of 2.1. As a result of this analysis, the following SAMAs were further evaluated in the quantitative Phase II evaluation:

- SAMA 56—Install an independent RCP seal injection system, without dedicated diesel
- SAMA 91—Install a passive containment spray system
- SAMA 93—Install an unfiltered, hardened containment vent

NextEra also provided a sensitivity analysis that reexamined the Phase II SAMAs to determine if any would be potentially cost-beneficial if the baseline and uncertainty benefits were increased by a factor of 2.1 (NextEra, 2011b). The baseline sensitivity analysis of the Phase II SAMAs (using a multiplier of 2.1 and a 7 percent real discount rate) did not identify any additional potentially cost-beneficial SAMAs. NextEra also reexamined the Phase II SAMAs to determine if any would be potentially cost-beneficial if the baseline sensitivity analysis benefits were increased by an additional factor of 1.9 (in addition to the multiplier of 2.1 for external events) to account for uncertainties. The uncertainty sensitivity analysis did not identify any additional potentially cost-beneficial SAMAs. The results of the sensitivity analysis for the baseline and uncertainty evaluations are provided in Table F-6.

As indicated in Section F.2.2, in response to an NRC staff RAI, NextEra identified and evaluated SAMA 192, “install a globe valve or flow limiting orifice upstream in the fire protection system,” based on insights from the upgraded internal flooding PRA model (NextEra, 2011a). The results of the evaluation of this SAMA are provided in Table F-6. This SAMA was determined not to be cost-beneficial in the baseline analysis, but it was determined to be potentially cost-beneficial in the uncertainty analysis. In response to a conference call clarification, NextEra stated that this SAMA would be entered into the Seabrook long-range plan development process for further implementation consideration (NRC, 2011a).

As indicated in Section F.3.2, in response to NRC staff RAIs and followup RAIs, NextEra identified several additional SAMAs based on its review of the Level 1 and Level 2 basic events importance lists, its review of initiating events, and its assessment of the feasibility of non-procedural and training SAMAs for human error basic events. The additional SAMAs and NextEra’s evaluation of each is summarized in Table F-7 (NextEra, 2011a; NextEra, 2011b). This table also provides the results of the sensitivity analysis applying the multiplier of 2.1 to account for the additional risk of seismic events (NextEra, 2011b). None of the SAMAs identified in Table F-7 were determined to be cost-beneficial in either the baseline or uncertainty analysis or in the sensitivity analysis.

Table F-7. Non-cost-beneficial SAMAs identified and evaluated in response to NRC staff RAIs

Analysis case & applicable SAMAs	Modeling assumptions	Total benefit ($)[i]		Cost ($)
		Baseline (internal + external)	Baseline with uncertainty	
E6S Improve Bus E6 reliability, eliminate/reduce potential for bus fault	Eliminate all risk associated with Bus fault	39K (82K)	74K (160K)	>500K[f]
Improve Bus E5 reliability, eliminate/reduce potential for bus fault				>500K[f]
Improve Bus E11B reliability, eliminate bus failure				>500K[f]
Improve Bus E11A reliability, eliminate bus failure				>500K[f]
SEPES Eliminate potential for SEPS failure; improve SEPS DG reliability	Eliminate all SEPS hardware failures (NextEra, 2011b)	40K (84K)	76K (159K)	>300K[f]
PORVRS Improve reliability of PORV reseat function, eliminate PORV reseat failures	Eliminate all PORV reclosure failures	23K (48K)	43K (91K)	>100K
ORWS Provide hardware change for automatic ECCS flow control	Eliminate failure of the human action to provide RWST makeup	32K (67K)	61K (130K)	>300K[f]
Hardware change to provide auto-makeup to RWST, eliminate operator action				>300K[f]
Hardware change for automatic control or eliminate operator action to maintain stable conditions				>300K[f]
CISPRE Hardware or procedural change to eliminate or reduce likelihood of small pre-existing unidentified leakage	Eliminate all CDF contribution from pre-existing containment leakage	11K (23K)	20K (43K)	>50–100K
OSEPALL Hardware change for auto closure of SEPS breaker to eliminate operator action	Eliminate failure of all operator actions to align & load the SEPS DGs	33K (68K)	62K (130K)	>750K[f]
Provide auto-start & load for SEPS DG[e]				>750K[f]
OC12S Provide a hardware modification (additional signals or remote capability) to automatically close CIV V-167	Eliminate failure of the operator action to close valve V-167	3K (6K)	5K (11K)	SAMA 193[g]

Analysis case & applicable SAMAs	Modeling assumptions	Total benefit ($)[i]		Cost ($)
		Baseline (internal + external)	Baseline with uncertainty	
DGP115A/B Provide hardware modification to improve lube oil pump reliability	Eliminate the risk contribution from release categories SE3, LL3, SE1, & LL4 due to failure of the DG-1A engine driven lube oil pump to run on demand	9K (19K)	17K (36K)	>100K
PCCTS Improve PCC TE reliability, eliminate potential for TE failure	Eliminate all failures of temperature elements (TEs) TE-2171 & TE-2172	29K (61K)	55K (120K)	>250K[f]
XOSMPS Provide a hardware modification for auto-control, eliminate operator action to align sump after core melt	Eliminate failure of the human action to align containment sump recirculation after core melt	21K (44K)	40K (83K)	>100K
PCCLS Improve PCC heat exchanger reliability, eliminate potential for heat exchanger leakage	Eliminate all risk associated with heat exchanger E17A & E17B leakage	22K (46K)	42K (87K)	>100K
SWV5 Improve SW secondary isolation MOV SWV-5 reliability, eliminate valve failure	Eliminate the risk contribution from release categories LL3, LL4, & SE1 due to failure of SWV-5	8K (17K)	16K (34K)	>100K
XOEFW Hardware for automatic feed flow, eliminate potential for operator failure to feed steam generator	Eliminate failure of the operator action to provide feed to the faulted steam generator	4K (9K)	8K (16K)	>100K
SUFPS Improve reliability of SUFP, eliminate potential for SUFP failures[h]	Two cases evaluated: Eliminate failure of MOV FW-V-163 to open on demand, which contributes approximately 23% of the risk associated with failure of the entire startup feedwater system (Analysis Case SUFPS)	10K (21K)	19K (39K)	>100K
	Eliminate failure of MOV FW-V-156 to open on demand, which contributes approximately 23% of the risk associated with failure of the entire startup feedwater system (Analysis Case SUFPS)	10K (21K)	19K (39K)	>100K

Analysis case & applicable SAMAs	Modeling assumptions	Total benefit ($)[i]		Cost ($)
		Baseline (internal + external)	Baseline with uncertainty	
Improve reliability of SUFP, eliminate potential for SUFP mechanical failures[h]	Eliminate all risk associated with the startup feedwater pump FWP-113, which contributes approximately 15% of the risk associated with Analysis Case SUFPS	6K (13K)	12K (26K)	>100K
Hardware change to improve SUFP reliability, eliminate potential for SUFP/valve failure[h]	Eliminate failure of recirculation valve FW-PCV-4326 to open, which contributes approximately 9% of the risk associated with Analysis Case SUFPS	4K (8K)	7K (15K)	>100K
Improve the reliability of the pre-lube pump via installation of a redundant pump[c]	Eliminate failure of the pre-lube oil pump, which contributes approximately 17.5% of the risk associated with Analysis Case SUFPS	7K (16K)	14K (30K)	>100K
MEFWS Hardware change to eliminate or reduce mechanical failures of MD EFW pump (installation of additional MD pump)	Eliminate all risk associated with MD EFW pump failures	39K (81K)	73K (150K)	>200K[f]
Hardware change to improve reliability, eliminate or reduce mechanical failures of MD EFW pump/valves[h]	Eliminate failure of MOV FW-V-347 to open, which contributes approximately 8.5% of the risk associated with Analysis Case MEFWS	4K (8K)	7K (15K)	>200K[f]
OTSIS Implement hardware change to improve reliability of SGTR control, eliminate or reduce operator failure to terminate SI	Eliminate failure of the human action to terminate SI following successful cooldown & depressurization of the SGTR	28K (59K)	54K (110K)	>300K[f]
Provide automatic control, eliminate or reduce operator failure to terminate SI				>300K[f]
UET Improve hardware/procedures to reduce or eliminate basic event exposure probability, improve CRI availability	Eliminate the risk contribution from release categories LE1 & LL4 due to basic event ZZ.2PORV.NOCRI, “ATWS—unfavorable exposure time (UET) probability given 2 PORVs & 3 safety valves (SVs) available, without CRI”	3K (6K)	6K (13K)	>100K

Analysis case & applicable SAMAs	Modeling assumptions	Total benefit ($)[i]		Cost ($)
		Baseline (internal + external)	Baseline with uncertainty	
OSUFPS Provide auto-start of SUFP, eliminate potential for operator failure to start SUFP	Eliminate failure of the human action to start the SUFP	7K (14K)	13K (27K)	>100K
OSGRDS Implement hardware change to improve reliability of SGTR control, eliminate operator action to depressurize	Eliminate failure of the human action to depressurize the RCS & terminate flow to the ruptured steam generator	5K (10K)	9K (18K)	>100K
Hardware change to eliminate operator action to depressurize in SGTR events				>300K[f]
Hardware change for automatic control or eliminate operator action to cooldown RCS in SGTR events				>300K[f]
ORWCDS Implement hardware change to improve reliability, eliminate operator action to cooldown/depressurize	Eliminate failure of the human action to cooldown & depressurize the RCS to minimize leakage with recirculation failure	4K (9K)	8K (18K)	>100K
ORHCDS Hardware change for automatic control or eliminate operator action to cooldown the RCS for RHR shutdown cooling in SGTR events	Eliminate failure of all human actions related to cooldown/depressurization of the RCS to support RHR shutdown cooling during SGTR events	12K (26K)	24K (49K)	>100K
CBSDVS Hardware change to improve valve reliability, eliminate CBS discharge MOV failures	Eliminate failure of MOVs CBS-V-11 & CBS-V-17	<1K (<2K)	<1K (<2K)	>100K
XOVNTS Hardware change for automatic venting control, eliminate need to perform late containment venting	Eliminate failure of the human action to vent containment	30K (64K)	58K (120K)	>300K[f]
XOINES Hardware change for automatic initiation of containment injection gravity drain, eliminate operator action	Eliminate all operator actions to initiate containment injection	4K (9K)	8K (16K)	>100K
RXT1[b] Improve overall Seabrook reliability; reduce potential for plant trip initiating event frequency or reliability of mitigation systems to plant trip	Eliminate all reactor trip events with the condenser available	41K (86K)	77K (160K)	>250K
E7T[b] Reduce/eliminate impact of 0.7 g seismic event	Eliminate all failures due to 0.7 g seismic events	31K (66K)	59K (125K)	>500K

Analysis case & applicable SAMAs	Modeling assumptions	Total benefit ($)[i]		Cost ($)
		Baseline (internal + external)	Baseline with uncertainty	
F4TREL[b] Protect relay room from potential impact from HELB	Eliminate all failures due to a flood in the turbine building resulting in a LOOP	22K (46K)	42K (88K)	>100K
FSGBE6[b] Improve/reduce the CDF contribution of switchgear room B fire events	Eliminate failure of electrical Bus E6 due to a fire in switchgear room B	14 (30K)	28K (60K)	>500K
LOCA04 Provide hardware change for automatic alignment of recirculation, eliminate operator action[d]	Eliminate RWST running out of water	160K (330K)	300K (630K)	>1M

[a] Information in this table is generally from the RAI responses dated January 13, 2011 (NextEra, 2011a). Information that is supplemented or updated by the April 18, 2011, responses to NRC staff followup RAIs (NextEra, 2011b) is specifically noted.

[b] Information on Analysis Cases RXT1, E7T, F4TREL, and FSGBE6 and associated SAMA candidates was provided in response to followup NRC staff RAI 1 (NextEra, 2011b). The results for the sensitivity analysis were estimated by the NRC staff using the multiplier of 2.1.

[c] Information on this SAMA was provided in response to followup NRC staff RAI 5 (NextEra, 2011b). The results for the sensitivity analysis were estimated by the NRC staff using the multiplier of 2.1.

[d] Information on this SAMA was provided in response to followup NRC staff RAI 4 and 6 (NextEra, 2011b). This SAMA was modeled using Analysis Case LOCA04, the benefits for which are taken from Table F-6 of this appendix.

[e] The analysis case for this SAMA changed from OSPE1 to OSEPALL in response to followup NRC staff RAI 4 (NextEra, 2011b).

[f] Cost was updated in response to followup NRC staff RAI 4 (NextEra, 2011b).

[g] This SAMA is supplanted by SAMA 193, which replaces the MOV with a fail-closed AOV, and which has been determined to be cost-beneficial (NextEra, 2011b).

[h] Modeling assumptions, risk reduction, and benefit results changed in response to followup NRC staff RAI 4 (NextEra, 2011b). The revised risk reduction and benefits were estimated by the NRC staff based on the benefits estimated by NextEra for the sensitivity analysis.

[i] Values in parenthesis are the results of the sensitivity analysis applying a multiplier of 2.1 to account for the additional risk of seismic events (NextEra, 2011b).

In addition to the SAMAs identified in Table F-7, NextEra identified and evaluated SAMA 193, "hardware change to eliminate MOV AC power dependencies." The results of the evaluation of this SAMA are provided in Table F-6. This SAMA was determined to not be cost-beneficial in the baseline analysis, but it was determined to be potentially cost-beneficial in the uncertainty analysis. In response to a conference call clarification, NextEra stated that this SAMA would be entered into the Seabrook long-range plan development process for further implementation consideration (NRC, 2011a).

As indicated in Section F.3.2, in response to an NRC staff RAI, NextEra identified and evaluated a SAMA to make "seismic upgrades to the CST" (NextEra, 2011a). This SAMA was estimated to have an implementation cost of more than $100,000. NextEra performed a bounding analysis of the benefit of this SAMA by assuming that it eliminated structural failures of the CST during all seismic-initiating events. The total baseline benefit (using a 7 percent real discount rate) was estimated to be $1,000 and, after accounting for uncertainties, to be $2,000. Based on this result, NextEra concluded that this SAMA was not cost-beneficial in either the baseline or the uncertainty analysis. The NRC staff also concludes that this SAMA would not be

cost-beneficial after applying the multiplier of 2.1 to account for the additional risk from seismic events.

As indicated in Section F.3.2, in response to an NRC staff RAI, NextEra provided a Phase II evaluation of the following SAMAs, which were originally screened in the Phase I evaluation (NextEra, 2011a; NextEra, 2011b):

- SAMA 79—Install bigger pilot operated relief valve so only one is required
- SAMA 84—Switch for EFW room fan power supply to station batteries
- SAMA 105—Delay containment spray actuation after a large LOCA
- SAMA 191—Remove the 135°F temperature trip of the PCCW pumps

The results of the cost-benefit evaluation for these SAMAs are provided in Table F-6, which was determined by NextEra to not be cost-beneficial in either the baseline or uncertainty analysis or in the sensitivity analysis applying the 2.1 multiplier.

As indicated in Section F.3.2, in response to an NRC staff RAI, NextEra provided an evaluation of the following two SAMAs identified as a result of its review of the cost-beneficial SAMAs from prior SAMA analyses for five Westinghouse four-loop PWR sites (NextEra, 2011a):

- SAMA "procedure change to ensure that the RCS cold leg water seals are not cleared" has an estimated implementation cost of $15–20,000. NextEra performed a bounding analysis of the benefit of this SAMA by assuming that it eliminated all thermally-induced SGTR events (Analysis Case XSGTIS). The total baseline benefit (using a 7 percent real discount rate) was estimated to be less than $1,000 and, after accounting for uncertainties, to be less than $1,000. Based on this result, NextEra concluded that this SAMA was not cost-beneficial in either the baseline or the uncertainty analysis. NextEra also concluded that this SAMA would not be cost-beneficial after applying the multiplier of 2.1 to account for the additional risk from seismic events (NextEra, 2011b).
- SAMA "installation of redundant parallel service water valves to the EDGs" has an estimated implementation cost of greater than $1 million (NextEra, 2011b). NextEra performed a bounding analysis of the benefit of this SAMA by assuming that it eliminated all SBO events. The total baseline benefit (using a 7 percent real discount rate) was estimated to be $160,000 and, after accounting for uncertainties, to be $300,000. Based on this result, NextEra concluded that this SAMA was not cost-beneficial in either the baseline or the uncertainty analysis. NextEra also concluded that this SAMA would not be cost-beneficial after applying the multiplier of 2.1 to account for the additional risk from seismic events (NextEra, 2011b).

As indicated in Section F.3.2, for certain SAMAs considered in the ER, there may be alternatives that could achieve much of the risk reduction at a lower cost (NRC, 2010a). The NRC staff asked the applicant to evaluate additional lower cost alternatives to the SAMAs considered in the ER, as summarized below:

- Use a portable generator to extend the coping time in loss of AC power events (to power selected instrumentation and DC power to the turbine-driven AFW pump and provide alternate DC feeds (using a portable generator) to panels supplied only by DC bus—In response to the NRC staff RAI, NextEra stated that these two alternatives are already represented by SAMA 157, "provide independent AC power source for battery chargers; for example, provide portable generator to charge station battery," which was

determined to be cost-beneficial (NextEra, 2011a). The NRC staff agrees with this conclusion.

- Purchase or manufacture of a "gagging device" that could be used to close a stuck-open steam generator safety valve for a SGTR event prior to core damage—In response to the NRC staff RAI, NextEra provided a Phase II evaluation of this proposed alternative (NextEra, 2011a). NextEra performed a bounding analysis of the benefit of this alternative by assuming that it eliminated failure of the main steam safety valve to re-close during a SGTR event, provided that operators were successful at controlling EFW flow, SI, and RCS depressurization. The total baseline benefit (using a 7 percent real discount rate) was estimated to be less than $1,000 and, after accounting for uncertainties, to be less than $1,000. Based on this result, NextEra concluded that this SAMA was not cost-beneficial in either the baseline or the uncertainty analysis for either hardware or procedure changes. The NRC staff concludes that this alternative has been adequately addressed. NextEra also concluded that this SAMA would not be cost-beneficial after applying the multiplier of 2.1 to account for the additional risk from seismic events (NextEra, 2011b).

The NRC staff noted that the evaluation of SAMA 80, "provide a redundant train or means of ventilation," assumes removal of HVAC dependence for CS, SI, RHR, and CBS pumps and asked NextEra to provide an evaluation of a SAMA to remove the HVAC dependency for just the highest risk system (NRC, 2010a). In response to the RAI, NextEra explained that, while the estimated implementation cost to install a redundant HVAC train to all of these ECCS pumps and systems was assumed to be greater than $500,000, installation of a redundant HVAC train to any single ECCS pump or system is judged to be greater than $500,000 as well (NextEra, 2011a). NextEra concluded the proposed SAMA would not be cost-beneficial given that the maximum benefit of SAMA 80 was conservatively estimated to be $32,000 (using a 7 percent real discount rate) and to be $61,000 after accounting for uncertainties and that this benefit would only decrease with an evaluation of fewer ECCS pumps and systems.

The NRC staff notes that all of the potentially cost-beneficial SAMAs (SAMAs 157, 165, 192, and 193) identified in NextEra's original or revised baseline and uncertainty analyses, and in response to NRC staff RAIs, 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 potentially cost-beneficial SAMAs discussed above, the costs of the other SAMAs evaluated would be higher than the associated benefits.

F.7 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. A qualitative screening removed SAMA candidates that had modified features not applicable to Seabrook due to design differences, that were determined to have already been implemented at Seabrook or Seabrook meets the intent of the SAMA, or that could be combined with another similar SAMA under consideration. Based on this screening, 117 SAMAs were eliminated, 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. For the remaining SAMA candidates, a more

detailed design and cost estimate were developed, as shown in Table F-6. The cost-benefit analyses showed that two of the SAMA candidates were potentially cost-beneficial in the baseline analysis (SAMAs 157 and 165). NextEra performed additional analyses to evaluate the impact of parameter choices and uncertainties on the results of the SAMA assessment. As a result, no additional SAMAs were identified as potentially cost-beneficial in the ER. 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 would 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 sound. 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. Although the treatment of SAMAs for external events was somewhat limited, 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.

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, and components during the period of extended operation. Therefore, they need not be implemented as part of license renewal pursuant to Title 10 of the *Code of Federal regulations* (CFR), Part 54.

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11. ABSTRACT *(200 words or less)*

This draft supplemental impact statement (SEIS) has been prepared in response to an application submitted by NextEra Energy Seabrook, LLC 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, 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.

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