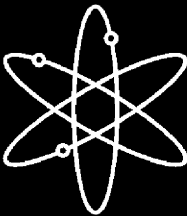


Generic Environmental Impact Statement for License Renewal of Nuclear Plants



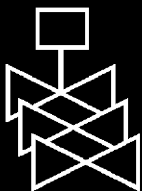
Supplement 29



**Regarding
Pilgrim Nuclear Power Station**



Draft Report for Comment



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



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**Generic Environmental
Impact Statement for
License Renewal of
Nuclear Plants**

Supplement 29

**Regarding
Pilgrim Nuclear Power Station**

Draft Report

Draft Completed : December 2006

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



COMMENTS ON DRAFT REPORT

Any interested party may submit comments on this report for consideration by the NRC staff. Comments may be accompanied by additional relevant information or supporting data. Please specify the report number NUREG-1437, Supplement 29, draft, in your comments, and send them by February 28, 2007 to the following address:

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Mail Stop T6-D59
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Electronic comments may be submitted to the NRC by the Internet at PilgrimEIS@nrc.gov.

For any questions about the material in this report, please contact:

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Abstract

1
2
3
4 The U.S. Nuclear Regulatory Commission (NRC) considered the environmental impacts of
5 renewing nuclear power plant operating licenses (OLs) for a 20-year period in its *Generic*
6 *Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), NUREG-1437,
7 Volumes 1 and 2, and codified the results in 10 CFR Part 51. In the GEIS (and its
8 Addendum 1), the staff identified 92 environmental issues and reached generic conclusions
9 related to environmental impacts for 69 of these issues that apply to all plants or to plants with
10 specific design or site characteristics. Additional plant-specific review is required for the
11 remaining 23 issues. These plant-specific reviews are to be included in a supplement to the
12 GEIS.

13
14 This draft supplemental environmental impact statement (SEIS) has been prepared in response
15 to an application submitted by Entergy Nuclear Operations, Inc. (Entergy), a subsidiary of
16 Entergy Corporation, to the NRC to renew the OL for Pilgrim Nuclear Power Station (PNPS) for
17 an additional 20 years under 10 CFR Part 54. This draft SEIS includes the NRC staff's analysis
18 that considers and weighs the environmental impacts of the proposed action, the environmental
19 impacts of alternatives to the proposed action, and mitigation measures available for reducing
20 or avoiding adverse impacts. It also includes the staff's preliminary recommendation regarding
21 the proposed action.

22
23 Regarding the 69 issues for which the GEIS reached generic conclusions, neither Entergy nor
24 the staff has identified information that is both new and significant for any issue that applies to
25 PNPS. In addition, the staff determined that information provided during the scoping process
26 was not new and significant with respect to the conclusions in the GEIS. Therefore, the staff
27 concludes that the impacts of renewing the OL for PNPS would not be greater than impacts
28 identified for these issues in the GEIS. For each of these issues, the staff's conclusion in the
29 GEIS is that the impact is of SMALL^(a) significance (except for collective off-site radiological
30 impacts from the fuel cycle and high-level waste and spent fuel, which were not assigned a
31 single significance level).

32
33 Regarding the remaining 23 issues, those that apply to PNPS are addressed in this draft SEIS.
34 For each applicable issue, the staff concludes that the significance of the potential
35 environmental impacts of renewal of the OL would be SMALL, with the exception of some
36 marine aquatic resources. Due to entrainment and impingement, the continued operation of the
37 cooling water system would have MODERATE^(b) impacts on the local winter flounder
38 (*Pseudopleuronectes americanus*) population, and the Jones River population of rainbow smelt

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

(b) Environmental effects are sufficient to alter noticeably but not to destabilize important attributes of the resource.

Abstract

1 (*Osmerus mordax*). Continued operation of the cooling water system would have SMALL to
2 MODERATE impingement and entrainment impacts on other marine aquatic species as well.
3 Therefore, cumulative impacts on the local winter flounder population and Jones River
4 population of rainbow smelt would be MODERATE, and cumulative impacts on other marine
5 aquatic species would be SMALL to MODERATE.
6

7 The NRC staff's preliminary recommendation is that the Commission determine that the
8 adverse environmental impacts of license renewal for PNPS are not so great that preserving
9 the option of license renewal for energy-planning decisionmakers would be unreasonable. This
10 recommendation is based on (1) the analysis and findings in the GEIS; (2) the Environmental
11 Report submitted by Entergy; (3) consultations with Federal, State, and local agencies; (4) the
12 staff's own independent review; and (5) the staff's consideration of public comments received
13 during the scoping process.
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27
28
29
30
31
32
33
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35
36
37
38
39
40
41

Contents

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44

Abstract.....	iii
Executive Summary.	xvii
Abbreviations/Acronyms.	xxiii
1.0 Introduction	1-1
1.1 Report Contents.	1-1
1.2 Background.....	1-3
1.2.1 Generic Environmental Impact Statement.	1-3
1.2.2 License Renewal Evaluation Process.	1-5
1.3 The Proposed Federal Action.	1-8
1.4 The Purpose and Need for the Proposed Action.....	1-8
1.5 Compliance and Consultations.	1-9
1.6 References.	1-9
2.0 Description of Nuclear Power Plant and Site and Plant Interaction with the Environment.	2-1
2.1 Plant and Site Description and Proposed Plant Operation During the Renewal Term.....	2-1
2.1.1 External Appearance and Setting.	2-4
2.1.2 Reactor Systems.....	2-4
2.1.3 Cooling and Auxiliary Water Systems.	2-7
2.1.4 Radioactive Waste Management Systems and Effluent Control Systems.	2-12
2.1.4.1 Liquid Waste Processing Systems and Effluent Controls. .	2-13
2.1.4.2 Gaseous Waste Processing Systems and Effluent Controls.	2-15
2.1.4.3 Solid Waste Processing.	2-16
2.1.5 Nonradioactive Waste Systems.....	2-17
2.1.6 Plant Operation and Maintenance.....	2-17
2.1.7 Power Transmission System.....	2-18

Contents

1	2.2	Plant Interaction with the Environment.	2-20
2			
3	2.2.1	Land Use.	2-20
4	2.2.2	Water Use.	2-21
5	2.2.3	Water Quality.	2-22
6			
7	2.2.3.1	Surface Water.	2-22
8	2.2.3.2	Groundwater.	2-24
9			
10	2.2.4	Air Quality.	2-26
11	2.2.5	Marine Aquatic Resources.	2-27
12			
13	2.2.5.1	Water Body Characteristics.	2-27
14	2.2.5.2	Chemical Contaminants near PNPS.	2-29
15	2.2.5.3	Biological Communities.	2-31
16			
17	2.2.5.3.1	Fish	2-31
18	2.2.5.3.2	Pelagic Invertebrates.	2-74
19	2.2.5.3.3	Plankton.	2-75
20	2.2.5.3.4	Benthic Invertebrate.	2-76
21	2.2.5.3.5	Marine Aquatic Plants.	2-81
22	2.2.5.3.6	Marine Mammals	2-83
23	2.2.5.3.7	Federally Listed Marine Species.	2-84
24			
25	2.2.6	Terrestrial and Freshwater Aquatic Resources.	2-87
26			
27	2.2.6.1	Description of Site Terrestrial and Freshwater Aquatic Environments.	2-88
28			
29	2.2.6.2	Rare Terrestrial and Freshwater Aquatic Species.	2-93
30			
31	2.2.7	Radiological Impacts	2-99
32	2.2.8	Socioeconomic Factors.	2-101
33			
34	2.2.8.1	Housing.	2-101
35	2.2.8.2	Public Services.	2-104
36			
37	2.2.8.2.1	Water Supply.	2-104
38	2.2.8.2.2	Education.	2-105
39	2.2.8.2.3	Transportation.	2-106
40			
41	2.2.8.3	Off-site Land Use.	2-107

1 2.2.8.3.1 Plymouth County.. 2-109

2 2.2.8.3.2 Barnstable County. 2-111

3

4 2.2.8.4 Visual Aesthetics and Noise. 2-112

5 2.2.8.5 Demography 2-113

6

7 2.2.8.5.1 Regional Population. 2-113

8 2.2.8.5.2 Transient Population. 2-114

9 2.2.8.5.3 Minority and Low-Income Populations. 2-115

10 2.2.8.5.4 Minority Populations. 2-116

11 2.2.8.5.5 Low-Income Populations. 2-120

12

13 2.2.8.6 Economy 2-122

14

15 2.2.8.6.1 Employment. 2-122

16 2.2.8.6.2 Migrant Farm Labor. 2-123

17 2.2.8.6.3 Taxes. 2-124

18

19 2.2.9 Historic and Archaeological Resources. 2-125

20

21 2.2.9.1 Cultural Background. 2-125

22 2.2.9.2 Historic and Archaeological Resources at the PNPS

23 Site 2-126

24

25 2.2.9.2.1 Previously Identified Resources. 2-126

26 2.2.9.2.2 Results of Walkover Survey. 2-128

27 2.2.9.2.3 Potential Archaeological Resources. 2-129

28

29 2.2.10 Related Federal Project Activities and Consultations. 2-129

30

31 2.3 References 2-130

32

33 3.0 Environmental Impacts of Refurbishment. 3-1

34

35 3.1 References 3-4

36

37 4.0 Environmental Impacts of Operation. 4-1

38

39 4.1 Cooling System. 4-2

40

41 4.1.1 Entrainment of Fish and Shellfish in Early Life Stages. 4-10

Contents

1	4.1.1.1	Environmental Monitoring.....	4-11
2	4.1.1.2	Entrainment Monitoring.	4-13
3	4.1.1.3	Assessment of Entrainment Impact.	4-16
4	4.1.1.4	Summary of Entrainment Impacts.	4-23
5			
6	4.1.2	Impingement of Fish and Shellfish.....	4-24
7			
8	4.1.2.1	Impingement Monitoring.....	4-24
9	4.1.2.2	Assessment of Impingement Impact.	4-26
10	4.1.2.3	Summary of Impingement Impacts.....	4-27
11			
12	4.1.3	Heat Shock.	4-29
13	4.1.4	Potential Mitigation Measures.	4-34
14			
15	4.2	Transmission Lines.....	4-38
16			
17	4.2.1	Electromagnetic Fields-Acute Effects.	4-42
18	4.2.2	Electromagnetic Fields-Chronic Effects.....	4-43
19			
20	4.3	Radiological Impacts of Normal Operations.	4-44
21	4.4	Socioeconomic Impacts of Plant Operations During the License Renewal Period	4-45
22			
23			
24	4.4.1	Housing Impacts During Operations.	4-48
25	4.4.2	Public Services: Public Utility Impacts During Operations.....	4-48
26	4.4.3	Off-site Land Use During Operations.....	4-49
27	4.4.4	Public Services: Transportation Impacts During Operations.....	4-51
28	4.4.5	Historic and Archaeological Resources.....	4-52
29			
30	4.4.5.1	Site Specific Cultural Resources Information.....	4-52
31	4.4.5.2	Conclusions.....	4-53
32			
33	4.4.6	Environmental Justice.....	4-53
34			
35	4.4.6.1	Minority Populations.....	4-54
36	4.4.6.2	Low-Income Populations.....	4-55
37			
38	4.5	Ground-Water Use and Quality.....	4-56
39	4.6	Threatened or Endangered Species.....	4-57
40			
41	4.6.1	Marine Aquatic Species.....	4-58

1 4.6.2 Terrestrial and Freshwater Aquatic Species. 4-59

2

3 4.7 Evaluation of New and Potentially Significant Information on Impacts of

4 Operations During the Renewal Term. 4-61

5 4.8 Cumulative Impacts. 4-68

6

7 4.8.1 Cumulative Impacts on Marine Aquatic Resources. 4-68

8 4.8.2 Cumulative Impacts on Terrestrial and Freshwater Aquatic

9 Resources. 4-71

10 4.8.3 Cumulative Impacts on Human Health. 4-71

11 4.8.4 Cumulative Socioeconomic Impacts 4-72

12 4.8.5 Cumulative Impacts on Groundwater Use and Quality. 4-73

13 4.8.6 Cumulative Impacts on Threatened and Endangered Species. . . . 4-73

14 4.8.7 Conclusions Regarding Cumulative Impacts. 4-74

15

16 4.9 Summary of Impacts of Operations During the Renewal Term. 4-74

17 4.10 References. 4-75

18

19 5.0 Environmental Impacts of Postulated Accidents. 5-1

20

21 5.1 Postulated Plant Accidents. 5-1

22

23 5.1.1 Design-Basis Accidents. 5-2

24 5.1.2 Severe Accidents. 5-3

25

26 5.2 Severe Accident Mitigation Alternatives. 5-4

27

28 5.2.1 Introduction. 5-5

29 5.2.2 Estimate of Risk. 5-5

30 5.2.3 Potential Plant Improvements. 5-7

31 5.2.4 Evaluation of Risk Reduction and Costs of Improvements. 5-7

32 5.2.5 Cost-Benefit Comparison. 5-8

33 5.2.6 Conclusions. 5-9

34

35 5.3 References. 5-10

36

37 6.0 Environmental Impacts of the Uranium Fuel Cycle and Solid Waste

38 Management. 6-1

39

40 6.1 The Uranium Fuel Cycle. 6-2

41 6.2 References. 6-9

Contents

1	7.0 Environmental Impacts of Decommissioning.	7-1
2		
3	7.1 Decommissioning.	7-2
4	7.2 References.	7-4
5		
6	8.0 Environmental Impacts of Alternatives to License Renewal.	8-1
7		
8	8.1 No-Action Alternative.	8-1
9		
10	8.1.1 Land Use.	8-2
11	8.1.2 Ecology	8-3
12	8.1.3 Water Use and Quality - Surface Water.	8-3
13	8.1.4 Water Use and Quality - Groundwater.	8-3
14	8.1.5 Air Quality.	8-3
15	8.1.6 Waste.	8-4
16	8.1.7 Human Health.	8-4
17	8.1.8 Socioeconomics.	8-4
18	8.1.9 Socioeconomics (Transportation).	8-4
19	8.1.10 Aesthetics.	8-5
20	8.1.11 Historic and Archeological Resources.	8-5
21	8.1.12 Environmental Justice.	8-5
22		
23	8.2 Alternative Energy Sources.	8-7
24		
25	8.2.1 Coal-Fired Generation.	8-9
26		
27	8.2.1.1 Closed-Cycle Cooling System.	8-10
28	8.2.1.2 Once-Through Cooling System.	8-20
29		
30	8.2.2 Natural Gas-Fired Generation.	8-21
31		
32	8.2.2.1 Closed-Cycle Cooling System.	8-22
33	8.2.2.2 Once-Through Cooling System.	8-31
34		
35	8.2.3 Nuclear Power Generation.	8-31
36		
37	8.2.3.1 Closed-Cycle Cooling System.	8-33
38	8.2.3.2 Once-Through Cooling System.	8-38
39		
40	8.2.4 Purchased Electrical Power.	8-39
41		

1 8.2.5 Other Alternatives. 8-39

2

3 8.2.5.1 Oil-Fired Generation. 8-39

4 8.2.5.2 Wind Power. 8-40

5 8.2.5.3 Solar Power. 8-41

6 8.2.5.4 Hydropower. 8-41

7 8.2.5.5 Geothermal Energy. 8-42

8 8.2.5.6 Wood Waste. 8-42

9 8.2.5.7 Municipal Solid Waste. 8-43

10 8.2.5.8 Other Biomass-Derived Fuels. 8-44

11 8.2.5.9 Fuel Cells. 8-44

12 8.2.5.10 Delayed Retirement. 8-45

13 8.2.5.11 Conservation. 8-45

14

15 8.2.6 Combination of Alternatives. 8-45

16

17 8.3 Summary of Alternatives Considered. 8-46

18 8.4 References. 8-49

19

20 9.0 Summary and Conclusions. 9-1

21

22 9.1 Environmental Impacts of the Proposed Action—License Renewal. 9-4

23

24 9.1.1 Unavoidable Adverse Impacts. 9-6

25 9.1.2 Irreversible or Irrecoverable Resource Commitments. 9-6

26 9.1.3 Short-Term Use Versus Long-Term Productivity. 9-7

27

28 9.2 Relative Significance of the Environmental Impacts of License Renewal

29 and Alternatives. 9-7

30 9.3 Staff Conclusions and Recommendations. 9-8

31 9.4 References. 9-8

32

Contents

1	Appendix A	Comments Received on the Environmental Review.....	A-1
2	Appendix B	Contributors to the Supplement.....	B-1
3	Appendix C	Chronology of NRC Staff Environmental Review Correspondence Related to Entergy Nuclear Corporation's Application for License Renewal of Pilgrim Nuclear Power Station.....	C-1
4			
5			
6	Appendix D	Organizations Contacted.....	D-1
7	Appendix E	Pilgrim Nuclear Power Station's Compliance Status and Consultation Correspondence.....	E-1
8			
9	Appendix F	GEIS Environmental Issues Not Applicable to Pilgrim Nuclear Power Station.....	F-1
10			
11	Appendix G	Severe Accident Mitigation Alternatives.....	G-1
12			

Figures

1			
2			
3			
4	2-1	Location of PNPS, 50-mi Radius.	2-2
5	2-2	Location of PNPS, 6-mi Radius.	2-3
6	2-3	Aerial Photograph Showing PNPS Property Boundaries and	
7		Environs.	2-5
8	2-4	Facility Layout	2-6
9	2-5	PNPS Intake Structure.	2-8
10	2-6	PNPS Transmission Lines.	2-19
11	2-7	Gulf of Maine Winter Flounder.. . . .	2-69
12	2-8	Winter Flounder Abundance Estimates in Northwest Cape Cod Bay.. . . .	2-69
13	2-9	NMFS Winter Flounder Abundance in the Gulf of Maine.	2-70
14	2-10	MDMF Winter Flounder Abundance in the Gulf of Maine.. . . .	2-70
15	2-11	Aggregate of Minority Races Population Map.	2-119
16	2-12	Low-Income Population Map.	2-121
17	2-13	Expanded Facility Layout.. . . .	2-127
18			
19	4-1	Equivalent Adult Summary of Entrained and Impinged Winter Flounder	
20		from PNPS.	4-22
21			

Tables

1			
2			
3			
4	2-1	PNPS Transmission Line ROWs.	2-18
5	2-2	Effluent Limitations - NPDES Permit for PNPS.	2-23
6	2-3	Effluent Limitations - MDEP Groundwater Discharge Permit for PNPS	
7		Wastewater Treatment Facility.	2-24
8	2-4	Marine Threatened or Endangered Species.	2-85
9	2-5	Protected Terrestrial Species Potentially Occurring in the Vicinity of PNPS	
10		and the Associated Transmission Line ROW.	2-94
11	2-6	Pilgrim Nuclear Power Station Permanent Employee Residence Information	
12		by County and Town/City.	2-102
13	2-7	Housing Units and Housing Units Vacant (Available) by County During	
14		1990 and 2000.	2-103
15	2-8	Selected Plymouth County Public Water Supply Systems and Capacities	
16		in 2003.	2-104
17	2-9	Barnstable County Public Water Supply Systems and Capacities in 2003. . .	2-105
18	2-10	Traffic Counts for Roads in the Vicinity of PNPS.	2-107
19	2-11	Land Use in Plymouth County, 1999.	2-110
20	2-12	Land Use in Barnstable County, 1999.	2-111
21	2-13	Population Growth in Plymouth and Barnstable Counties - 1980 to 2020. . .	2-114
22	2-14	Percentage of Minority and Low-income Individuals in the 50-mile Radius	
23		Study Area and Threshold Criteria for Identifying Minority and Low-income	
24		Populations at the Block Group Level.	2-117
25	2-15	Block Groups Exceeding Thresholds for Minority and Low-income	
26		Populations in Counties Within a 50-mile Radius of PNPS.	2-118
27	2-16	Employment Trends: Number of Employees by Industry Section 1990	
28		and 2000.	2-122
29	2-17	PNPS Contributions to Town of Plymouth Property Tax Revenues.	2-125
30			
31	3-1	Category 1 Issues for Refurbishment Evaluation.	3-2
32	3-2	Category 2 Issues for Refurbishment Evaluation.	3-3
33			
34	4-1	Category 1 Issues Applicable to the Operation of the PNPS Cooling System	
35		During the Renewal Term.	4-2
36	4-2	Category 2 Issues Applicable to the Operation of the PNPS Cooling System	
37		During the Renewal Term.	4-10
38	4-3	Number of Eggs and Larvae Entrained for Six Species of Fish at PNPS from	
39		1980 to 2005.	4-17
40	4-4	Equivalent Adult Losses of Winter Flounder.	4-22
41	4-5	Annual Extrapolated Totals for Typical Dominants Found on the PNPS Intake	
42		Screens, 1980 - 2005.	4-28
43	4-6	Category 1 Issues Applicable to the PNPS Transmission Lines During the	
44		Renewal Term.	4-39

1 4-7 Category 2 and Uncategorized Issues Applicable to the PNPS Transmission
 2 Lines During the Renewal Term. 4-42
 3 4-8 Category 1 Issues Applicable to Radiological Impacts of Normal Operations
 4 During the Renewal Term. 4-44
 5 4-9 Category 1 Issues Applicable to Socioeconomics During the Renewal Term. 4-46
 6 4-10 Environmental Justice and GEIS Category 2 Issues Applicable to
 7 Socioeconomics During the Renewal Term. 4-47
 8 4-11 Category 1 Issues Applicable to Groundwater Use and Quality During the
 9 Renewal Term. 4-56
 10 4-12 Category 2 Issues Applicable to the Threatened or Endangered Species
 11 During the Renewal Term. 4-57
 12
 13 5-1 Category 1 Issue Applicable to Postulated Accidents During the Renewal
 14 Term. 5-3
 15 5-2 Category 2 Issue Applicable to Postulated Accidents During the Renewal
 16 Term. 5-4
 17 5-3 Pilgrim Core Damage Frequency. 5-6
 18 5-4 Breakdown of Population Dose by Containment Release Mode. 5-7
 19
 20 6-1 Category 1 Issues Applicable to the Uranium Fuel Cycle and Solid Waste
 21 Management During the Renewal Term. 6-2
 22
 23 7-1 Category 1 Issues Applicable to the Decommissioning of PNPS Following the
 24 Renewal Term. 7-2
 25
 26 8-1 Summary of Environmental Impacts of the No-Action Alternative. 8-6
 27 8-2 Summary of Environmental Impacts of Coal-Fired Generation at an
 28 Alternate Greenfield Site Using Closed-Cycle Cooling. 8-19
 29 8-3 Summary of Environmental Impacts of Coal-Fired Generation at the
 30 PNPS Site with Once-Through Cooling System. 8-21
 31 8-4 Summary of Environmental Impacts of Natural Gas-Fired Generation at the
 32 PNPS Site and an Alternate Greenfield Site Using Closed-Cycle Cooling. . . . 8-29
 33 8-5 Summary of Environmental Impacts of Natural Gas-Fired Generation at the
 34 PNPS Site with Once-Through Cooling. 8-32
 35 8-6 Summary of Environmental Impacts of New Nuclear Power Generation at
 36 an Alternate Greenfield Site Using Closed-Cycle Cooling. 8-37
 37 8-7 Summary of Environmental Impacts of a New Nuclear Power Plant Sited
 38 at an Alternate Greenfield Site with Once-Through Cooling. 8-38
 39 8-8 Summary of Environmental Impacts of 350 MW(e) of Natural Gas-Fired
 40 Generation, 250 MW(e) from Wind Generation, and 115 MW(e)
 41 from DSM Measures. 8-47

Contents

Tables

1 9-1 Summary of Environmental Significance of Licence Renewal, the No Action
2 Alternative, and Alternative Methods of Generation Using Once-Through
3 Cooling. 9-10
4
5 G-1 PNPS Core Damage Frequency. G-3
6 G-2 Breakdown of Population Dose by Containment Release Mode. G-4
7 G-3 PNPS PSA History. G-6
8 G-4 SAMA Cost/Benefit Screening Analysis for PNPS. ... G-20
9
10

Executive Summary

By letter dated January 25, 2006, Entergy Nuclear Operations, Inc. (Entergy) submitted an application to the U.S. Nuclear Regulatory Commission (NRC) to renew the operating license (OL) for Pilgrim Nuclear Power Station (PNPS) for an additional 20-year period. If the OL is renewed, State regulatory agencies and PNPS will ultimately decide whether the plant will continue to operate based on factors such as the need for power or other matters within the State's jurisdiction or the purview of the owners. If the OL is not renewed, then the plant must be shut down at or before the expiration date of the current OL, which is June 8, 2012.

The NRC has implemented Section 102 of the National Environmental Policy Act of 1969, as amended (NEPA) (42 USC 4321), in Title 10 of the Code of Federal Regulations (CFR), Part 51 (10 CFR Part 51). In 10 CFR 51.20(b)(2), the Commission requires preparation of an environmental impact statement (EIS) or a supplement to an EIS for renewal of a reactor OL. In addition, 10 CFR 51.95(c) states that the EIS prepared at the OL renewal stage will be a supplement to the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), NUREG-1437, Volumes 1 and 2.^(a)

Upon acceptance of the PNPS application, the NRC began the environmental review process described in 10 CFR Part 51 by publishing a notice of intent to prepare an EIS and conduct scoping. The staff visited the PNPS site in May 2006 and held public scoping meetings on May 17, 2006. In the preparation of this draft supplemental environmental impact statement (SEIS) for PNPS, the staff reviewed the PNPS Environmental Report (ER) and compared it to the GEIS, consulted with other agencies, conducted an independent review of the issues following the guidance set forth in NUREG-1555, Supplement 1, the *Standard Review Plans for Environmental Reviews for Nuclear Power Plants, Supplement 1: Operating License Renewal*, and considered the public comments received during the scoping process. The public comments received during the scoping process that were considered to be within the scope of the environmental review are provided in Appendix A, Part 1, of this draft SEIS.

The staff will hold two public meetings in Plymouth, Massachusetts in January 2007, to describe the preliminary results of the NRC environmental review, to answer questions, and to provide members of the public with information to assist them in formulating comments on this draft SEIS. When the comment period ends, the staff will consider and address all of the comments received that are within the scope of the environmental review. These comments will be addressed in Appendix A, Part 2 of the final SEIS.

This draft SEIS includes the NRC staff's preliminary analysis that considers and weighs the environmental effects of the proposed action, the environmental impacts of alternatives to the

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

Executive Summary

1 proposed action, and mitigation measures for reducing or avoiding adverse effects. It also
2 includes the staff's preliminary recommendation regarding the proposed action.

3
4 The Commission has adopted the following statement of purpose and need for license renewal
5 from the GEIS:

6
7 The purpose and need for the proposed action (renewal of an operating license) is to provide
8 an option that allows for power generation capability beyond the term of a current nuclear
9 power plant operating license to meet future system generating needs, as such needs may
10 be determined by state, utility, and, where authorized, Federal (other than NRC)
11 decisionmakers.

12
13 The evaluation criterion for the staff's environmental review, as defined in 10 CFR 51.95(c)(4)
14 and the GEIS, is to determine:

15
16 . . . whether or not the adverse environmental impacts of license renewal are so great that
17 preserving the option of license renewal for energy planning decisionmakers would be
18 unreasonable.

19
20 Both the statement of purpose and need and the evaluation criterion implicitly acknowledge that
21 there are factors, in addition to license renewal, that will ultimately determine whether an existing
22 nuclear power plant continues to operate beyond the period of the current OL.

23
24 NRC regulations [10 CFR 51.95(c)(2)] contain the following statement regarding the content of
25 SEISs prepared at the license renewal stage:

26
27 The supplemental environmental impact statement for license renewal is not required to
28 include discussion of need for power or the economic costs and economic benefits of the
29 proposed action or of alternatives to the proposed action except insofar as such benefits and
30 costs are either essential for a determination regarding the inclusion of an alternative in the
31 range of alternatives considered or relevant to mitigation. In addition, the supplemental
32 environmental impact statement prepared at the license renewal stage need not discuss
33 other issues not related to the environmental effects of the proposed action and the
34 alternatives, or any aspect of the storage of spent fuel for the facility within the scope of the
35 generic determination in § 51.23(a) ["Temporary storage of spent fuel after cessation of
36 reactor operation—generic determination of no significant environmental impact"] and in
37 accordance with § 51.23(b).

38
39 The GEIS contains the results of a systematic evaluation of the consequences of renewing an
40 OL and operating a nuclear power plant for an additional 20 years. It evaluates

1 92 environmental issues using the NRC's three-level standard of significance—SMALL,
2 MODERATE, or LARGE—developed using the Council on Environmental Quality guidelines.

3
4 The following definitions of the three significance levels are set forth in footnotes to Table B-1 of
5 10 CFR Part 51, Subpart A, Appendix B:

6
7 SMALL - Environmental effects are not detectable or are so minor that they will neither
8 destabilize nor noticeably alter any important attribute of the resource.

9
10 MODERATE - Environmental effects are sufficient to alter noticeably, but not to
11 destabilize, important attributes of the resource.

12
13 LARGE - Environmental effects are clearly noticeable and are sufficient to destabilize
14 important attributes of the resource.

15
16 For 69 of the 92 issues considered in the GEIS, the analysis in the GEIS reached the following
17 conclusions:

- 18
19 (1) The environmental impacts associated with the issue have been determined to apply
20 either to all plants or, for some issues, to plants having a specific type of cooling system
21 or other specified plant or site characteristics.
22
23 (2) A single significance level (i.e., SMALL, MODERATE, or LARGE) has been assigned to
24 the impacts (except for collective offsite radiological impacts from the fuel cycle and from
25 high-level waste and spent fuel disposal).
26
27 (3) Mitigation of adverse impacts associated with the issue has been considered in the
28 analysis, and it has been determined that additional plant-specific mitigation measures
29 are not likely to be sufficiently beneficial to warrant implementation.
30

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

35
36 Of the 23 issues that do not meet the criteria set forth above, 21 are classified as Category 2
37 issues requiring analysis in a plant-specific supplement to the GEIS. The remaining two issues,
38 environmental justice and chronic effects of electromagnetic fields, were not categorized.
39 Environmental justice was not evaluated on a generic basis and must be addressed in a plant-
40 specific supplement to the GEIS. Information on the chronic effects of electromagnetic fields
41 was not conclusive at the time the GEIS was prepared.

Executive Summary

1 This draft SEIS documents the staff's consideration of all 92 environmental issues identified in
2 the GEIS. The staff considered the environmental impacts associated with alternatives to
3 license renewal and compared the environmental impacts of license renewal and the
4 alternatives. The alternatives to license renewal that were considered include the no-action
5 alternative (not renewing the OL for PNPS) and alternative methods of power generation. Based
6 on projections made by the U.S. Department of Energy's Energy Information Administration
7 (DOE/EIA), coal and gas-fired generation appear to be the most likely power-generation
8 alternatives if the power from PNPS is replaced. These alternatives are evaluated assuming
9 that the replacement power generation plant is located at either the PNPS site or some other
10 unspecified alternate location.

11
12 Entergy and the staff have established independent processes for identifying and evaluating the
13 significance of any new information on the environmental impacts of license renewal. Neither
14 Entergy nor the staff has identified information that is both new and significant related to
15 Category 1 issues that would call into question the conclusions in the GEIS. Therefore, the staff
16 relies upon the conclusions of the GEIS for all of the Category 1 issues that are applicable to
17 PNPS. However, the staff has identified the need for an essential fish habitat (EFH)
18 consultation, therefore, an EFH assessment is included in Appendix E of this SEIS.

19
20 PNPS's license renewal application presents an analysis of the Category 2 issues plus
21 environmental justice and chronic effects from electromagnetic fields. The staff has reviewed
22 the PNPS analysis for each issue and has conducted an independent review of each issue. Six
23 Category 2 issues are not applicable, because they are related to plant design features or site
24 characteristics not found at PNPS. Four Category 2 issues are not discussed in this draft SEIS,
25 because they are specifically related to refurbishment. PNPS has stated that its evaluation of
26 structures and components, as required by 10 CFR 54.21, did not identify any major plant
27 refurbishment activities or modifications as necessary to support the continued operation of
28 PNPS for the license renewal period. In addition, any replacement of components or additional
29 inspection activities are within the bounds of normal plant operation, and are not expected to
30 affect the environment outside of the bounds of the plant operations evaluated in the U.S.
31 Atomic Energy Commission's 1972 *Final Environmental Statement Related to Operation of*
32 *PNPS*.

33
34 Eleven Category 2 issues related to operational impacts and postulated accidents during the
35 renewal term, as well as environmental justice and chronic effects of electromagnetic fields, are
36 discussed in detail in this draft SEIS. Five of the Category 2 issues and environmental justice
37 apply to both refurbishment and to operation during the renewal term and are only discussed in
38 this draft SEIS in relation to operation during the renewal term. For the 11 Category 2 issues
39 and environmental justice, the staff concludes that the potential environmental effects are of
40 SMALL and SMALL to MODERATE significance in the context of the standards set forth in the
41 GEIS. A MODERATE impact was determined based on entrainment of the local population of

1 winter flounder (*Pseudopleuronectes americanus*) and MODERATE impact was determined
2 based on impingement of the Jones River population of rainbow smelt (*Osmerus mordax*). The
3 staff also determined that appropriate Federal health agencies have not reached a consensus
4 on the existence of chronic adverse effects from electromagnetic fields. Therefore, no further
5 evaluation of this issue is required. For severe accident mitigation alternatives (SAMAs), the
6 staff concludes that a reasonable, comprehensive effort was made to identify and evaluate
7 SAMAs. Based on its review of the SAMAs for PNPS and the plant improvements already
8 made, the staff concludes that Entergy identified five potentially cost-beneficial SAMAs. The
9 staff concludes that two additional SAMAs are potentially cost-beneficial. However, these
10 SAMAs do not relate to adequate managing of the effects of aging during the period of extended
11 operation. Therefore, they do not need to be implemented as part of the license renewal
12 pursuant to 10 CFR Part 54.

13
14 The staff concluded that the potential site-specific impacts of the cooling intake system due to
15 entrainment (local winter flounder population) and impingement (Jones River rainbow smelt)
16 would be MODERATE. For all other marine aquatic species, the staff concluded that potential
17 impacts due to entrainment and impingement would be SMALL to MODERATE. Additional
18 mitigation to minimize the impacts of entrainment and impingement may be justified. EPA
19 Region I is currently in the process of reviewing the National Pollutant Discharge Elimination
20 System permit renewal application for PNPS. It is expected that this evaluation in conjunction
21 with the 316(b) comprehensive demonstration study currently being conducted by Entergy will
22 evaluate the need for and feasibility of any additional mitigation measures.

23
24 Cumulative impacts of past, present, and reasonably foreseeable future actions were
25 considered, regardless of what agency (Federal or non-Federal) or person undertakes such
26 other actions. For purposes of this analysis, the staff concluded that the cumulative impacts
27 resulting from the incremental contribution of PNPS operation and maintenance of the
28 transmission line right-of-way would be SMALL for all resources with the exception of marine
29 aquatic resources, which would experience SMALL to MODERATE cumulative impacts.

30
31 If the PNPS operating licenses are not renewed and the units cease operation on or before the
32 expiration of their current operating licenses, then the adverse impacts of likely alternatives
33 would not be smaller than those associated with continued operation of PNPS. The impacts
34 may, in fact, be greater in some areas.

35
36 The preliminary recommendation of the NRC staff is that the Commission determine that the
37 adverse environmental impacts of license renewal for PNPS are not so great that preserving the
38 option of license renewal for energy planning decisionmakers would be unreasonable. This
39 recommendation is based on (1) the analysis and findings in the GEIS; (2) the ER submitted by
40 Entergy; (3) consultations with other Federal, State, and local agencies; (4) the staff's own

Executive Summary

- 1 independent review; and (5) the staff's consideration of public comments received during the
- 2 scoping process.

Abbreviations/Acronyms

1		
2		
3		
4	°	degree(s)
5	µm	micron(s)
6		
7	ac	acre(s)
8	AC	alternating current
9	ACC	averted cleanup and decontamination costs
10	ADS	automatic depressurization system
11	AEC	U.S. Atomic Energy Commission
12	ALARA	as low as reasonably achievable
13	AOC	averted offsite property damage costs
14	AOE	averted occupational exposure
15	AOG	augmented offgas
16	AOSC	averted onsite cost
17	APE	averted public exposure
18	ASME	American Society of Mechanical Engineers
19	ASMFC	Atlantic States Marine Fisheries Commission
20	ATWS	anticipated transient without scram
21		
22	BA	biological assessment
23	BTU	British thermal unit(s)
24	BWROG	boiling water reactor owners group
25		
26	C	Celsius
27	CAA	Clean Air Act
28	CAIR	Clean Air Interstate Rule
29	CAPB	collapsed accident progression bins
30	CCCP	conditional core damage probabilities
31	CDF	core damage frequency
32	CDS	Comprehensive Demonstration Study
33	CET	containment event tree
34	CEQ	Council on Environmental Quality
35	CFR	<i>Code of Federal Regulations</i>
36	cfs	cubic foot (feet) per second
37	Ci	curie(s)
38	cm	centimeter(s)
39	CO	carbon monoxide
40	CO ₂	carbon dioxide
41	COE	cost of enhancement
42	CST	condensate storage tanks
43	CWA	Clean Water Act

Abbreviations/Acronyms

1	DC	direct current
2	DCH	direct containment heating
3	delta T	change in temperature
4	DFO	Department of Fisheries and Oceans
5	DMR	discharge monitoring report
6	DO	dissolved oxygen
7	DOE	U.S. Department of Energy
8	DTV	direct torus vent
9		
10	EA	environmental assessment
11	ECCS	emergency core cooling system
12	EDG	emergency diesel generator
13	EEZ	exclusive economic zone
14	EFH	essential fish habitat
15	EIA	Energy Information Administration (of DOE)
16	EIS	environmental impact statement
17	ELF-EMF	extremely low frequency-electromagnetic field
18	EN-EV	environmental review and evaluation procedure
19	Entergy	Entergy Nuclear Operations, Inc.
20	EOP	emergency operating procedure
21	EPA	U.S. Environmental Protection Agency
22	EPH	extractable petroleum hydrocarbons
23	EPRI	Electrical Power Research Institute
24	ER	Environmental Report
25	ESA	Endangered Species Act of 1976, as amended
26	ETE	evacuation time estimate
27		
28	F	Fahrenheit
29	FIVE	fire-induced vulnerability evaluation
30	FMP	fishery management plan
31	FR	<i>Federal Register</i>
32	fps	foot (feet) per second
33	ft	foot (feet)
34	FWS	U.S. Fish and Wildlife Service
35	fy	fiscal year
36		
37	GL	generic letter
38	GARM	Groundfish Assessment Review Meeting
39	GEIS	<i>Generic Environmental Impact Statement for License Renewal of Nuclear Plants,</i>
40		<i>NUREG-1437</i>
41	gpm	gallon(s) per minute

Abbreviations/Acronyms

1	HAPC	habitat area of particular concern
2	HCLPF	high confidence low probability of failure
3	HLW	high-level waste
4	HPCI	high pressure coolant injection
5		
6	ICRP	International Commission on Radiological Protection
7	in.	inch(es)
8	IPE	individual plant examination
9	IPEEE	individual plant examination external events
10	ISLOCA	interfacing sysyem LOCA
11		
12	km	kilometer(s)
13	kV	kilovolt(s)
14	kW	kilowatt(s)
15	kWh	kilowatt hour(s)
16		
17	L	liter(s)
18	LLRWSF	low level radwaste storage facility
19	LOCA	loss of coolant accident
20	LOOP	loss of offsite power
21	LPCI	low pressure coolant injection
22		
23	m	meter(s)
24	m/s	meter(s) per second
25	mA	milliampere(s)
26	MA DEM	Massachusetts Department of Environmental Management
27	MAAP	modular accident analysis program
28	MACCS2	MELCOR Accident Consequence Code System 2
29	MAFMC	Mid-Atlantic Fishery Management Council
30	MassGIS	Massachusetts Geographic Information System
31	MBDS	Massachusetts Bay Disposal Site
32	MCC	motor control centers
33	MDEP	Massachusetts Department of Environmental Protection
34	MDFW	Massachusetts Division of Fisheries and Wildlife
35	MDMF	Massachusetts Division of Marine Fisheries
36	MDPH	Massachusetts Department of Public Health
37	MEOEA	Massachusetts Executive Office for Environmental Affairs
38	mg/L	milligram(s) per liter
39	MHC	Massachusetts Historical Commission
40	mi	mile(s)
41	MISER	Massachusetts Institute for Social and Environmental Research

Abbreviations/Acronyms

1	mL	milliliter(s)
2	MLW	mean low water
3	mm	millimeter(s)
4	mrem	millirem(s)
5	MRI	Marine Research, Inc.
6	MSIV	main steam isolation valve
7	MSL	mean sea level
8	MW(e)	megawatt(s) electric
9	MW(h)	megawatt hour(s)
10	MWRA	Massachusetts Water Resource Authority
11	MW(t)	megawatt(s) thermal
12		
13	NAFO	Northwest Atlantic Fisheries Organization
14	NAS	National Academy of Sciences
15	NEFMC	New England Fishery Management Council
16	NEFSC	Northeast Fisheries Science Center
17	NEPA	National Environmental Policy Act of 1969, as amended
18	NESC	National Electric Safety Code
19	NHESP	Massachusetts Natural Heritage and Endangered Species Program
20	NHPA	National Historic Preservation Act
21	NIEHS	National Institute of Environmental Health Sciences
22	NMFS	National Marine Fisheries Service
23	NO ₂	nitrogen dioxide
24	NO _x	nitrogen oxide(s)
25	NOAA	National Oceanic and Atmospheric Administration
26	NOV	notice of violation
27	NPDES	National Pollutant Discharge Elimination System
28	NPSH	net positive suction head
29	NRC	U.S. Nuclear Regulatory Commission
30		
31	OCPC	Old Colony Planning Council
32	ODCM	Offsite Dose Calculation Manual
33	OL	operating license
34		
35	PAH	polycyclic aromatic hydrocarbon
36	PCB	polychlorinated biphenyl
37	PDS	plant damage state
38	PGA	peak ground acceleration
39	PILOT	payments in lieu of taxes
40	PM _{2.5}	particulate matter, 2.5 microns or less in diameter
41	PM ₁₀	particulate matter, 10 microns or less in diameter

Abbreviations/Acronyms

1	PNPS	Pilgrim Nuclear Power Station
2	ppm	parts per million
3	ppt	parts per thousand
4	PSA	probabilistic safety assessment
5	psi	pound(s) per square inch
6		
7	RAMAS	risk analysis management alternative system
8	RBCCW	reactor building closed cooling water
9	RCIC	reactor coolant injection cooling
10	REMP	radiological environmental monitoring program
11	REWD	Radioactive Effluent and Waste Disposal Report
12	RHR	residual heat removal
13	ROW	right-of-way
14	RPC	replacement power costs
15	RPV	reactor pressure valve
16	RRW	risk reduction worth
17		
18	s	second(s)
19	SAFE	Stock Assessment and Fishery Evaluation
20	SAMA	severe accident mitigation alternative
21	SARC	Stock Assessment Review Committee
22	SBO	station blackout
23	SCR	selective catalytic reduction
24	SEIS	supplemental environmental impact statement
25	SGTS	standby gas treatment system
26	SLC	standby liquid control
27	SMHS	Southeastern Massachusetts Health Study
28	SO ₂	sulfur dioxide
29	SO _x	sulfur oxide(s)
30	SPRA	seismic probabilistic risk assessment
31	SRV	steam release valve
32	SSB	spawning stock biomass
33	SSW	salt service water
34	Sv	sievert(s)
35		
36	TBCCW	turbine building closed cooling water
37	TDS	total dissolved solids
38	TPH	total petroleum hydrocarbons
39	TRC	total residual chlorine

Abbreviations/Acronyms

1	U.S.	United States
2	USACE	U.S. Army Corp of Engineers
3	USC	United States Code
4	USCB	U.S. Census Bureau
5	USF	unresolved safety issue
6		
7	V	volt(s)
8	VDC	volts direct current
9	VIMS	Virginia Institute of Marine Science
10		
11	yr	year(s)

1.0 Introduction

Under the U.S. Nuclear Regulatory Commission's (NRC's) environmental protection regulations in Title 10 of the *Code of Federal Regulations* (CFR) Part 51, which implement the National Environmental Policy Act of 1969, as amended (NEPA), renewal of a nuclear power plant operating license (OL) requires the preparation of an environmental impact statement (EIS). In preparing the EIS, the NRC staff is required first to issue the statement in draft form for public comment, and then issue a final statement after considering public comments on the draft. To support the preparation of the EIS, the staff prepared a *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), NUREG-1437, Volumes 1 and 2 (NRC 1996; 1999).^(a) The GEIS is intended to (1) provide an understanding of the types and severity of environmental impacts that may occur as a result of license renewal of nuclear power plants under 10 CFR Part 54, (2) identify and assess the impacts that are expected to be generic to license renewal, and (3) support 10 CFR Part 51 to define the number and scope of issues that need to be addressed by the applicants in plant-by-plant renewal proceedings. Use of the GEIS guides the preparation of complete plant-specific information in support of the OL renewal process.

Entergy Nuclear Operations, Inc. (Entergy), a subsidiary of Entergy Corporation, operates Pilgrim Nuclear Power Station (PNPS) in Plymouth, Massachusetts under OL DPR-35, which was issued by the NRC. This OL will expire on June 8, 2012. On January 25, 2006, Entergy submitted an application to the NRC to renew the PNPS OL for an additional 20 years under 10 CFR Part 54 (Entergy 2006a). Entergy is a licensee for the purposes of its current OL and an applicant for the renewal of the OL. Pursuant to 10 CFR 54.23 and 51.53(c), Entergy submitted an Environmental Report (ER) (Entergy 2006b) in which Entergy analyzed the environmental impacts associated with the proposed license renewal action, considered alternatives to the proposed action, and evaluated mitigation measures for reducing adverse environmental effects.

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

1.1 Report Contents

The following sections of this introduction (1) describe the background for the preparation of this draft SEIS, including the development of the GEIS and the process used by the staff to assess the environmental impacts associated with license renewal, (2) describe the proposed

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

Introduction

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

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

19
20 Additional information is included in appendices. Appendix A contains public comments related
21 to the environmental review for license renewal and staff responses to those comments.
22 Appendices B through G, respectively, include the following:

- 23
24 • the preparers of the supplement (Appendix B),
- 25
26 • the chronology of the NRC staff's environmental review correspondence related to this
27 draft SEIS (Appendix C),
- 28
29 • the organizations contacted during the development of this draft SEIS (Appendix D),
- 30
31 • Entergy's compliance status in Table E-1 (this appendix also contains copies of
32 consultation correspondence prepared and sent during the evaluation process)
33 (Appendix E),
- 34
35 • GEIS environmental issues that are not applicable to PNPS (Appendix F), and
- 36
37 • NRC staff evaluation of severe accident mitigation alternatives (SAMAs) (Appendix G).

1.2 Background

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

1.2.1 Generic Environmental Impact Statement

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

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

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

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

MODERATE – Environmental effects are sufficient to alter noticeably, but not to destabilize, important attributes of the resource.

LARGE – Environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

Introduction

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

3
4 The GEIS includes a determination of whether the analysis of the environmental issue could be
5 applied to all plants and whether additional mitigation measures would be warranted. Issues
6 are assigned a Category 1 or a Category 2 designation. As set forth in the GEIS, Category 1
7 issues are those that meet all of the following criteria:

- 8
- 10 (1) The environmental impacts associated with the issue have been determined to apply
11 either to all plants or, for some issues, to plants having a specific type of cooling system
12 or other specified plant or site characteristics.
 - 14 (2) A single significance level (i.e., SMALL, MODERATE, or LARGE) has been assigned to
15 the impacts (except for collective off-site radiological impacts from the fuel cycle and from
16 high-level waste and spent fuel disposal).
 - 18 (3) Mitigation of adverse impacts associated with the issue has been considered in the
19 analysis, and it has been determined that additional plant-specific mitigation measures
20 are likely not to be sufficiently beneficial to warrant implementation.

21
22 For issues that meet the three Category 1 criteria, no additional plant-specific analysis is
23 required in this draft SEIS unless new and significant information is identified.

24
25 Category 2 issues are those that do not meet one or more of the criteria of Category 1;
26 therefore, additional plant-specific review for these issues is required.

27
28 In the GEIS, the staff assessed 92 environmental issues and determined that 69 qualified as
29 Category 1 issues, 21 qualified as Category 2 issues, and 2 issues were not categorized. The
30 two issues not categorized are environmental justice and chronic effects of electromagnetic
31 fields. Environmental justice was not evaluated on a generic basis and must be addressed in a
32 plant-specific supplement to the GEIS. Information on the chronic effects of electromagnetic
33 fields was not conclusive at the time the GEIS was prepared.

34
35 Of the 92 issues, 11 are related only to refurbishment, 6 are related only to decommissioning,
36 67 apply only to operation during the renewal term, and 8 apply to both refurbishment and
37 operation during the renewal term. A summary of the findings for all 92 issues in the GEIS is
38 codified in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B.

1 The NRC staff has identified a new issue that was not previously addressed in the GEIS related
2 to essential fish habitat (EFH). The consultation requirements of Section 305(b) of the
3 Magnuson-Stevens Fishery Conservation and Management Act, as amended by the National
4 Marine Fisheries Service Sustainable Fisheries Act of 1996, provide that Federal agencies
5 must consult with the Secretary of Commerce on all actions or proposed actions authorized,
6 funded, or undertaken by the agency that may adversely affect EFH. Therefore, concurrent
7 with issuance of this draft SEIS, the NRC staff has requested initiation of an EFH consultation
8 with the National Marine Fisheries Service. The EFH Assessment to support this consultation is
9 presented in Appendix E of this draft SEIS.

11 **1.2.2 License Renewal Evaluation Process**

12
13 An applicant seeking to renew its OL is required to submit an ER as part of its application. The
14 license renewal evaluation process involves careful review of the applicant's ER and assurance
15 that all new and potentially significant information not already addressed in or available during
16 the GEIS evaluation is identified, reviewed, and assessed to verify the environmental impacts of
17 the proposed license renewal.

18
19 In accordance with 10 CFR 51.53(c)(2) and (3), the ER submitted by the applicant must:

- 20
21
- 22 • provide an analysis of the Category 2 issues in Table B-1 of 10 CFR Part 51,
23 Subpart A, Appendix B in accordance with 10 CFR 51.53(c)(3)(ii) and
 - 24
 - 25 • discuss actions to mitigate any adverse impacts associated with the proposed action
26 and environmental impacts of alternatives to the proposed action.

27
28 In accordance with 10 CFR 51.53(c)(2), the ER does not need to:

- 29
- 30 • consider the economic benefits and costs of the proposed action and alternatives to the
31 proposed action except insofar as such benefits and costs are either (1) essential for
32 making a determination regarding the inclusion of an alternative in the range of
33 alternatives considered or (2) relevant to mitigation,
- 34
- 35 • consider the need for power and other issues not related to the environmental effects of
36 the proposed action and the alternatives,
- 37
- 38 • discuss any aspect of the storage of spent fuel within the scope of the generic
39 determination in 10 CFR 51.23(a) in accordance with 10 CFR 51.23(b), or
- 40

Introduction

- contain an analysis of any Category 1 issue unless there is significant new information on a specific issue — this is pursuant to 10 CFR 51.23(c)(3)(iii) and (iv).

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

In preparing to submit its application to renew the PNPS OL, Entergy developed a process to ensure that (1) information not addressed in or available during the GEIS evaluation regarding the environmental impacts of license renewal for PNPS would be properly reviewed before submitting the ER and (2) such new and potentially significant information related to renewal of the license for PNPS would be identified, reviewed, and assessed during the period of NRC review. Entergy reviewed the Category 1 issues that appear in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, to verify that the conclusions of the GEIS remained valid with respect to PNPS. This review was performed by personnel from Entergy and its support organization who were familiar with NEPA issues and the scientific disciplines involved in the preparation of a license renewal ER.

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

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

1 subparagraph of 10 CFR 51.53(c)(3)(ii) that describes the analysis required and the draft SEIS
2 sections where the analysis is presented. The draft SEIS sections that discuss the Category 2
3 issues are presented immediately following the table.
4

5 The NRC prepares an independent analysis of the environmental impacts of license renewal
6 and compares these impacts with the environmental impacts of alternatives. The evaluation of
7 the Entergy license renewal application began with the publication of a notice of acceptance for
8 docketing and notice of opportunity for a hearing in the *Federal Register* (FR) (71 FR 15222;
9 NRC 2006a) on March 27, 2006. The staff published a notice of intent to prepare an EIS and
10 conduct scoping (71 FR 19554; NRC 2006b) on April 14, 2006. Two public scoping meetings
11 were held on May 17, 2006, in Plymouth, Massachusetts. Comments received during the
12 scoping period were summarized in the *Environmental Impact Statement Scoping Process:
13 Summary Report - Pilgrim Nuclear Power Station* (NRC 2006c) dated September 26, 2006.
14 Comments that are applicable to this environmental review are presented in Part 1 of Appendix
15 A of this draft SEIS.
16

17 The staff followed the review guidance contained in NUREG-1555, Supplement 1 (NRC 2000).
18 The staff and contractor retained to assist the staff visited the PNPS Site on May 1 through May
19 5, 2006, to gather information and to become familiar with the site and its environs. The staff
20 also reviewed the comments received during scoping, and consulted with Federal, State,
21 regional, and local agencies. A list of the organizations consulted is provided in Appendix D.
22 Other documents related to PNPS were reviewed and are referenced within this draft SEIS.
23

24 This draft SEIS presents the staff's analysis that considers and weighs the environmental
25 effects of the proposed renewal of the OL for PNPS, the environmental impacts of alternatives
26 to license renewal, and mitigation measures available for avoiding adverse environmental
27 effects. Chapter 9, "Summary and Conclusions," provides the NRC staff's preliminary
28 recommendation to the Commission on whether or not the adverse environmental impacts of
29 license renewal are so great that preserving the option of license renewal for energy-planning
30 decisionmakers would be unreasonable.
31

32 A 75-day comment period will begin on the date of publication of the U.S. Environmental
33 Protection Agency Notice of Filing of the draft SEIS to allow members of the public to comment
34 on the preliminary results of the NRC staff's review. During this comment period, two public
35 meetings will be held in Plymouth, Massachusetts, in January 2007. During these meetings,
36 the staff will describe the preliminary results of the NRC environmental review and answer
37 questions related to it to provide members of the public with information to assist them in
38 formulating their comments.
39
40
41

1.3 The Proposed Federal Action

The proposed Federal action is renewal of the OL for PNPS. The PNPS facility is located in eastern Massachusetts on the western shore of Cape Cod Bay, approximately 38 miles (mi) southwest of Boston, Massachusetts, and 44 mi east of Providence, Rhode Island. The plant has one General Electric-designed boiling water reactor with a design power level of 1,998 megawatts thermal (MW[t]). In 2003, PNPS implemented a Thermal Power Optimization of 1.5 percent to achieve the current electrical rating of 715 megawatts electric (MW[e]). Plant cooling is provided by a once-through heat dissipation system that withdraws cooling water from and discharges it to Cape Cod Bay. PNPS produces electricity to supply the needs of more than 13,000 homes. The current OL for PNPS expires on June 8, 2012. By letter dated January 25, 2006, Entergy submitted an application to the NRC (Entergy 2006a) to renew this OL for an additional 20 years of operation (i.e., until June 8, 2032).

1.4 The Purpose and Need for the Proposed Action

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

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

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

This definition of purpose and need reflects the Commission's recognition that, unless there are findings in the safety review required by the Atomic Energy Act of 1954, as amended or findings in the NEPA environmental analysis that would lead the NRC to reject a license renewal application, the NRC does not have a role in the energy-planning decisions of state regulators and utility officials as to whether a particular nuclear power plant should continue to operate. From the perspective of the licensee and the state regulatory authority, the purpose of renewing

1 an OL is to maintain the availability of the nuclear plant to meet system energy requirements
2 beyond the current term of the plant's license.
3

4 **1.5 Compliance and Consultations**

5
6 Entergy is required to hold certain Federal, State, and local environmental permits, as well as
7 meet relevant Federal and State statutory requirements. In its ER, Entergy provided a list of the
8 authorizations from Federal, State, and local authorities for current operations as well as
9 environmental approvals and consultations associated with PNPS license renewal.
10 Authorizations and consultations relevant to the proposed OL renewal action are included in
11 Appendix E.
12

13 The staff has reviewed the list and consulted with the appropriate Federal, State, and local
14 agencies to identify any compliance or permit issues or significant environmental issues of
15 concern to the reviewing agencies. These agencies did not identify any new and significant
16 environmental issues. However, NRC is in consultations with the National Marine Fisheries
17 Service regarding threatened and endangered species and regarding EFH. The ER states that
18 Entergy is in compliance with applicable environmental standards and requirements for PNPS.
19 The staff has not identified any environmental issues that are both new and significant.
20

21 **1.6 References**

22
23 10 CFR Part 51. *Code of Federal Regulations*, Title 10, *Energy*, Part 51, "Environmental
24 Protection Regulations for Domestic Licensing and Related Regulatory Functions."

25
26 10 CFR Part 54. *Code of Federal Regulations*, Title 10, *Energy*, Part 54, "Requirements for
27 Renewal of Operating Licenses for Nuclear Power Plants."

28
29 40 CFR Part 1508. *Code of Federal Regulations*, Title 40, *Protection of Environment*, Part 1508,
30 "Terminology and Index."

31
32 Atomic Energy Act of 1954, as amended 42 USC 2011, et seq.
33

34 Entergy Nuclear Operations, Inc. (Entergy). 2006a *License Renewal Application, Pilgrim*
35 *Nuclear Power Station*, Docket No. 50-293, Facility Operating License No. DPR-35, Plymouth,
36 Massachusetts.
37

38 Entergy Nuclear Operations, Inc. (Entergy). 2006b. *Applicant's Environmental Report –*
39 *Operating License Renewal Stage, Pilgrim Nuclear Power Station*. Docket No. 50-293,
40 Plymouth, Massachusetts.

Introduction

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

2
3 Nuclear Regulatory Commission (NRC). 1996. *Generic Environmental Impact Statement for*
4 *License Renewal of Nuclear Plants*. NUREG-1437, Volumes 1 and 2, Washington, D.C.

5
6 Nuclear Regulatory Commission (NRC). 1999. *Generic Environmental Impact Statement for*
7 *License Renewal of Nuclear Plants Main Report*, “Section 6.3 – Transportation, Table 9.1,
8 Summary of findings on NEPA issues for license renewal of nuclear power plants,” Final Report.
9 NUREG-1437, Volume 1, Addendum 1, Washington, D.C.

10
11 Nuclear Regulatory Commission (NRC). 2000. *Standard Review Plans for Environmental*
12 *Reviews for Nuclear Power Plants, Supplement 1: Operating License Renewal*. NUREG-1555,
13 Supplement 1, Washington, D.C.

14
15 Nuclear Regulatory Commission (NRC). 2006a. “Notice of Acceptance for Docketing of the
16 Application and Notice of Opportunity for a Hearing Regarding Renewal of Facility Operating
17 License No. DPR-35 and for an Additional 20-Year Period.” *Federal Register*. Vol. 71, No. 58,
18 pp. 15222-15223. March 27, 2006.

19
20 Nuclear Regulatory Commission (NRC). 2006b. “Notice of Intent to Prepare an Environmental
21 Impact Statement and Conduct Scoping Process.” *Federal Register*. Vol. 71, No. 72, pp.
22 19554-19556. April 14, 2006.

23
24 Nuclear Regulatory Commission (NRC). 2006c. *Environmental Impact Statement Scoping*
25 *Process: Summary Report – Pilgrim Nuclear Power Station, Plymouth, Massachusetts*.
26 Washington, D.C. September 26, 2006.

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

Entergy's Pilgrim Nuclear Power Station (PNPS) is located on the rocky western shore of Cape Cod Bay in the Town of Plymouth, Plymouth County, Massachusetts. The nearest large cities are Boston, Massachusetts approximately 38 miles (mi) to the northwest and Providence, Rhode Island, approximately 44 mi to the west.

The facility consists of one boiling water reactor producing steam that turns a turbine to generate electricity. Facility cooling is provided by a once-through system using water from Cape Cod Bay. The plant and its environs are described in Section 2.1, and the plant's interaction with the environment is presented in Section 2.2.

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

Prior to development as a power facility, the site of PNPS was part of the Greenwood estate. The site was purchased in 1967 for the main purpose of constructing PNPS. The PNPS facility occupies approximately 140 acres (ac). Entergy also owns an additional 1500 ac adjacent to the plant site that is in a forest management trust (Entergy 2006a). The generating station is situated near the northeast end of Pine Hills, a ridge of low lying hills approximately 4 miles (mi) long. These hills reach a maximum height of 395 feet (ft) and form the major drainage divide in the area (Boston Edison Company 1974). Major plant structures are situated approximately 10 to 20 ft above mean sea level (MSL), but site elevation rises rapidly as distance from Cape Cod Bay increases. The maximum elevation within 3 mi of the site is 395 ft MSL at Manomet Hill. The terrain within 6 mi of the PNPS area is rolling forested hills, predominately hardwoods, interspersed with urban areas and a small number of agricultural areas, the majority of which are cranberry bogs.

More than 60 percent of the area within a 50-mi radius of the site is open water (Massachusetts Bay, Cape Cod Bay, Buzzards Bay, and Nantucket Sound) (Boston Edison Company 1974). The area within 6 mi of PNPS is located entirely within Plymouth County, primarily within the Town of Plymouth. The community of Plymouth is the nearest urbanized area. The area within 2 mi of PNPS includes Priscilla Beach, White Horse Beach, and part of the community of Plymouth, which supports both permanent and seasonal residences (Entergy 2006a). Figures 2-1 and 2-2, show the site location and features within 50-mi and 6-mi, respectively.

Plant and the Environment

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Figure 2-1. Location of PNPS, 50-mi Radius

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Figure 2-2. Location of PNPS, 6-mi Radius

1 **2.1.1 External Appearance and Setting**

2
3 As mentioned above, PNPS is located on the western shoreline of Cape Cod Bay and has 1 mi
4 of continuous shoreline frontage. The site can be accessed by land or from Cape Cod Bay.
5 Access by land is via Edison Access Road, which connects the site to Rocky Hill Road,
6 approximately 0.25 mi southwest of the site, and Route 3A, approximately 1.25 mi to the south.
7 A boat landing providing waterside access to the site is located immediately south of the
8 facility's cooling water intake canal (Entergy 2006a).

9
10 The major features of the PNPS site are the reactor and turbine buildings, the off-gas retention
11 building, the radwaste building, the diesel generator building, the intake structure, the
12 switchyard, the main stack, administration buildings, and recreational facilities. A nature area
13 consisting of hiking trails and an observation deck with a view of Cape Cod Bay are located
14 immediately northwest of the site. The nearest residence is over 2000 ft northwest of the
15 reactor building (Entergy 2006a). Single-family houses are also located approximately 2500 ft
16 southeast of the site. The transmission lines that connect PNPS to the New England power grid
17 are owned, operated and maintained by NSTAR Electric and Gas Corporation (NSTAR). The
18 transmission lines share a single right-of-way (ROW), which is bordered by forested swaths.
19 The transmission lines ROW extends southeast from the switchyard approximately 800 ft and
20 then south across Rocky Hill Road and Route 3A. The site boundary and general facility layout
21 are depicted on Figures 2-3 and 2-4, respectively.

22
23 **2.1.2 Reactor Systems**

24
25 PNPS has one boiling water reactor unit and a steam-driven turbine generator
26 manufactured by General Electric Company. Bechtel was the architect/engineer and
27 construction manager of the project. The unit was originally licensed for an output of 1998
28 megawatts-thermal (Mw[t]), and commercial operation began in December 1972. In 2003,
29 PNPS underwent a Thermal Power Optimization, which increased the electrical rating to the
30 current 715 gross megawatts-electric (Mw[e]). The PNPS fuel is a low-enriched uranium
31 dioxide with maximum enrichments of 4.6 percent by weight uranium-235 and fuel burnup levels
32 of 48,000 megawatt-days per metric ton uranium.

33
34 The primary containment for the reactor is a pressure suppression system, which includes a
35 drywell, pressure suppression chamber, vent system, isolation valves, containment cooling
36 system, and other service equipment, and is designed to withstand an internal pressure of 62
37 pounds per square inch (psi) above atmospheric pressure. The containment is also designed to
38 act as a radioactive materials barrier. A secondary containment completely encloses both the
39 primary containment and fuel storage areas and acts as a radioactive materials barrier, as well
40 (Entergy 2006a).

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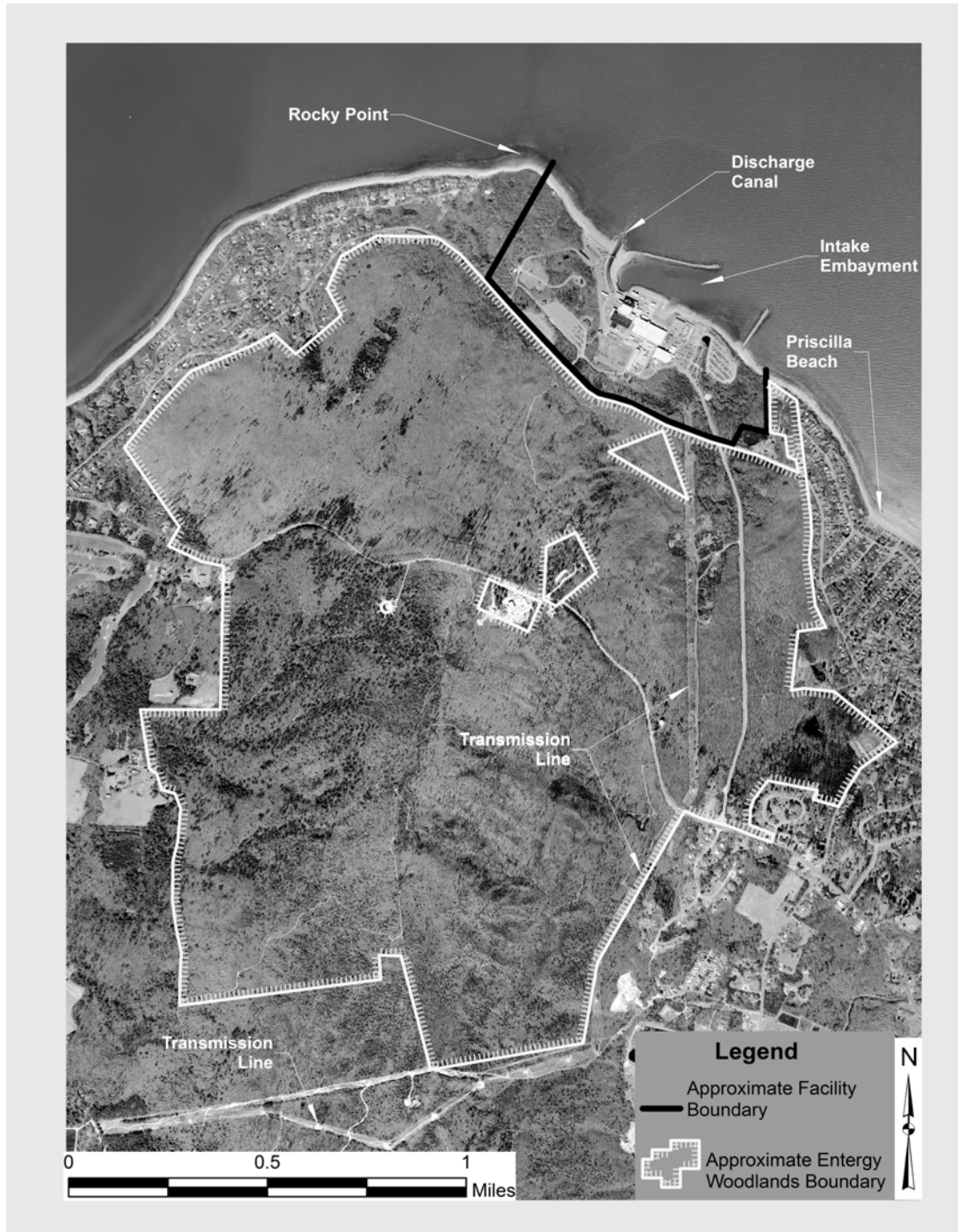


Figure 2-3. Aerial Photograph Showing PNPS Property Boundaries and Environs.

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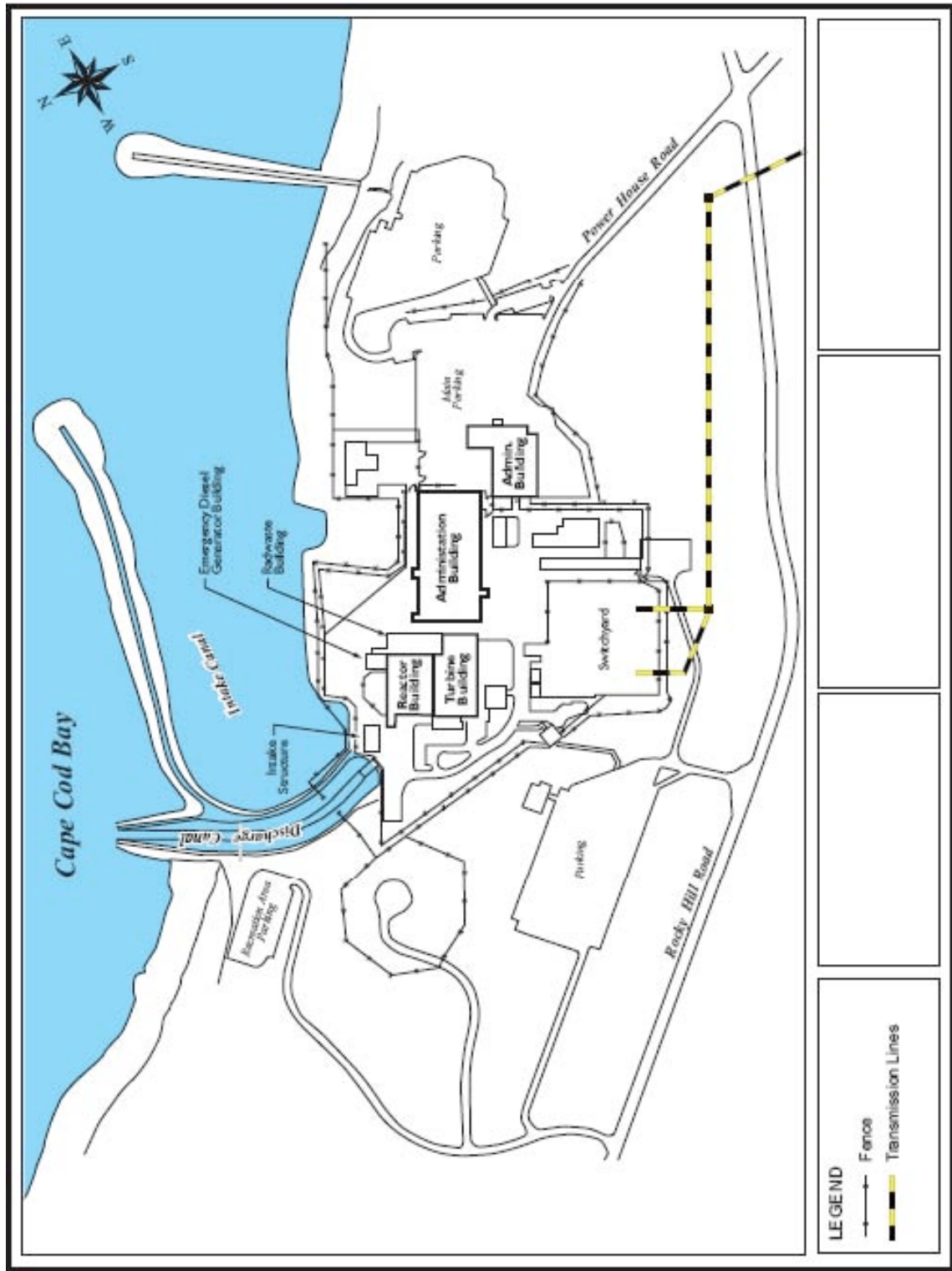


Figure 2-4. Facility Layout (Source: Entergy 2006a)

2.1.3 Cooling and Auxiliary Water Systems

The cooling and service water systems at PNPS operate as a once-through cooling system, with Cape Cod Bay being the water source. Seawater is withdrawn from the bay through an intake embayment formed by two breakwaters (Figure 2-4). The intake structure consists of wing walls, a skimmer wall that functions as a submerged baffle, slanted vertical bar racks that capture large debris, vertical traveling screens to prevent entrainment, fish return sluiceways, condenser cooling water pumps, and service water pumps (Figure 2- 5). The two wing walls are constructed of concrete, and guide flow into four separate intake bays. Each wing wall extends from the face of the intake structure at a 45 degree angle, one at a distance of 130 ft to the northwest and the other 63 ft to the northeast. The entrance of the intake measures 62 ft wide at the stop log guide, and extends to the floor of the intake structure at 24 ft below MSL . The skimmer wall at the front of the intake removes floating debris, with the bottom of the wall extending to 12 ft below MSL. Fish are able to escape the system by way of approximately 6 to 12 10-inch (in.) circular openings that are located in the skimmer walls and at each end of the intake structure. Divers have visually verified that the escape openings are effective. Bar racks behind the skimmer wall intercept large debris. The racks are constructed of 3 in. by 3/8 in. rectangular bars, with a 3 in. opening between each bar. Debris and large, impinged organisms are removed from the bar racks using a mechanical rake.

Located in the seawater pump wells of the intake structure, two vertical, mixed-flow, wet-type pumps provide a continuous supply of condenser cooling water. Each 1450 horsepower pump has a capacity of 155,500 gallons per minute (gpm) (346.5 cubic ft per second [cfs]). The water is pumped from the intake structure to the condensers via two buried concrete pipes measuring 7.5 ft in diameter. Measurements taken at the breakwaters during mid-tide level with both pumps running indicate that the average intake velocity is 0.05 ft per second (fps). At the intake, before the screens, the velocity is about 1 fps during all tidal conditions. Through the traveling screens, the velocity is about 2 fps. The velocity is approximately 0.15 fps near the east fish-return sluiceway, which is located in the intake embayment just east of the intake structure.

Located in the central wet well of the intake structure are five service water pumps that supply the service water system. Generally, four pumps run while one is kept on standby. Each pump has a capacity of 2500 gpm, providing a combined capacity at normal operation of approximately 10,000 gpm. The service water system is continuously chlorinated in order to control nuisance biological organisms in the service water discharge. Diffusers located downstream of the racks deliver a 12 percent sodium hypochlorite and seawater mixture to each intake bay. The mixture is used to ensure the total residual chlorine discharge concentration does not exceed a maximum daily concentration of 0.10 parts per million (ppm) and an average monthly concentration of 0.5 ppm in the service water discharge.

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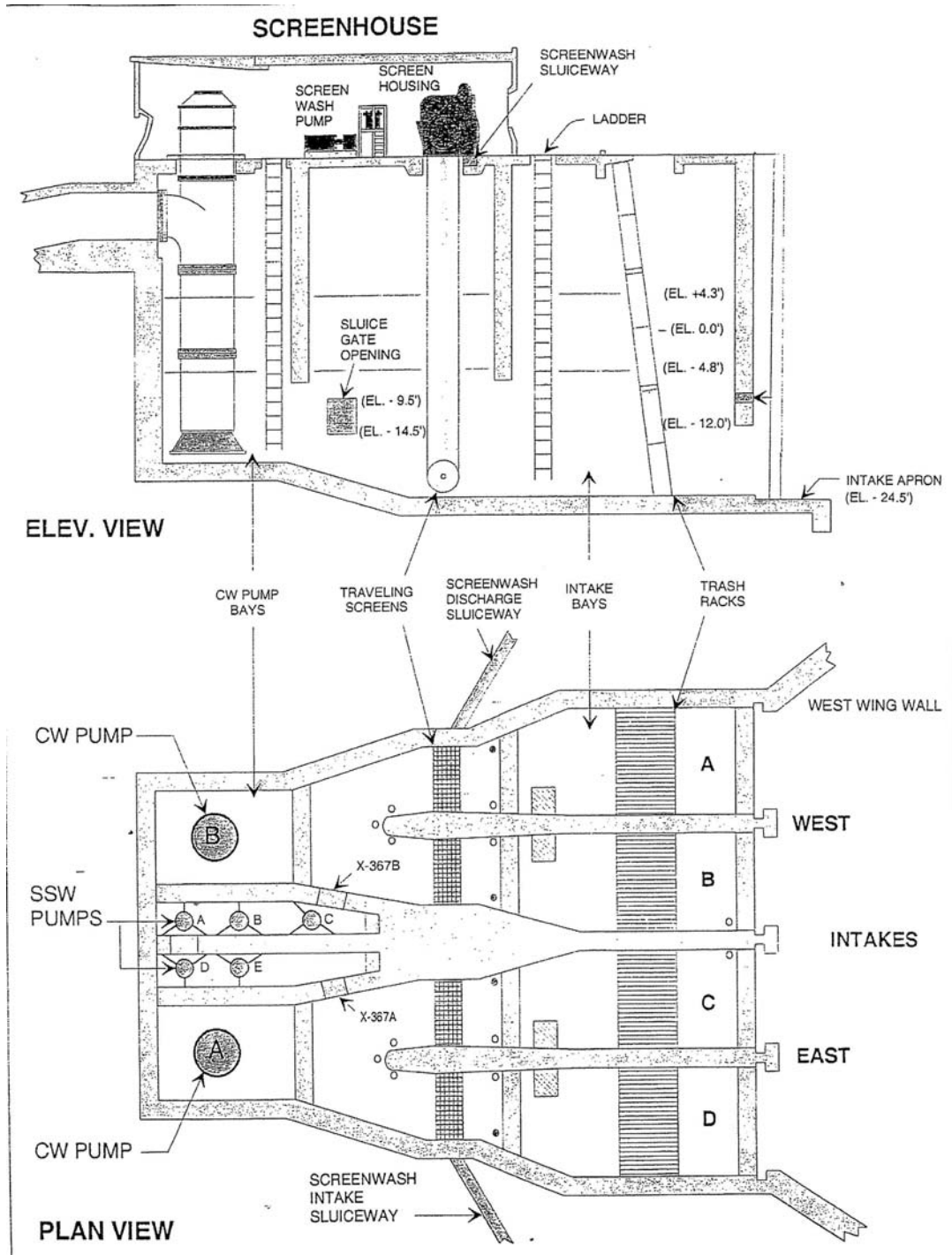


Figure 2-5. PNPS Intake Structure (Source: ENSR 2000)

1 Chlorination of the main cooling water system also takes place, but not on a continuous basis.
2 Hypochlorination events occur during spring, summer, and fall, when the circulating water
3 system is chlorinated for up to two hours per day (one hour for each pump). A chlorine solution
4 is added inboard of the bar rack to control fouling.

5
6 From intake to discharge, the travel time for water to move through the system varies from 5 to
7 10 minutes, depending upon whether one or two intake pumps are in service. The tidal stage
8 affects pump output, also causing changes in the transit time. In addition to dye dilution studies
9 conducted in the 1980s, the transit time has been estimated during chlorination events. During
10 these chlorination events, chlorine is added outboard of the intake screens and monitored
11 readings are taken in the discharge canal. Residual chlorine is typically detected approximately
12 5 minutes into the cycle. Since the chlorination events are usually conducted only when both
13 pumps are running, it has been estimated that the transit time would be twice as fast when
14 operating only one pump.

15
16 Prior to water flowing through either the cooling water pumps or the service water pumps, water
17 passes through one of four 10-ft-wide traveling screens. The screens work to prevent small
18 debris and small aquatic organisms from being entrained into the cooling water or service water
19 systems. Each screen is constructed of 53 segments with $\frac{1}{4}$ in. by $\frac{1}{2}$ in. stainless steel wire
20 mesh. Each segment has a stainless steel lip that is used to lift debris and organisms and
21 direct them into the fish-return sluiceway.

22
23 The traveling screens are not operated continuously but are operated during any of the
24 following scenarios:

- 25
- 26 • When the difference in water level on each side of the screen reaches a specified threshold
27 at an alarm set point. The threshold is typically set at 6 in. This level difference signifies that
28 too much debris has collected on the screen. Level differences are rare and usually the
29 result of a storm event.
 - 30
 - 31 • When there is an indication that fish are being impinged at a rate exceeding 20 fish per
32 hour, at which time the traveling screens are turned continuously until the impingement rate
33 drops below 20 fish per hour for two consecutive sampling events. Each impingement
34 sampling event is conducted for a minimum of 30 minutes, 3 times per week.
 - 35
 - 36 • During marine life monitoring. The screen wash, which occurs during screen rotations, is
37 scheduled for eight hours prior to each of the three weekly sampling events.
 - 38
 - 39 • During hypo-chlorination, which occurs each day for two hours when the main cooling water
40 system is chlorinated inboard of the trash rack to control fouling.

Plant and the Environment

- 1 • Whenever water temperatures are less than 30°Fahrenheit (F).
- 2
- 3 • At a minimum, once per each 12-hour shift. This usually occurs at the beginning and end of
- 4 each shift, and will usually last for a few hours.
- 5

6 On average, the traveling screens rotate 3 to 4 times each day. The screens normally operate at
7 5 fps, but can be accelerated to 20 fps during storm events that are causing extreme debris
8 loading.

9
10 The screens are washed when they are in operation, using a dual-level spray wash. Service
11 water is used as the source for the spray wash. Sodium thiosulfate is added to the wash water
12 to remove chlorine and protect organisms returned to the intake embayment. The screens are
13 washed from the side that faces the approaching flow at the splash housing, which is located
14 about 46 ft above the bottom of the intake structure. Low pressure spray, about 20 psi,
15 removes light fouling and organisms from the screen. Subsequently, a high pressure wash,
16 about 100 psi, is applied to remove heavy fouling. The low and high pressure washes are about
17 18 to 24 in. apart. The screen rotation rate is kept slow during high impingement events.

18
19 Impinged fish are washed into a seamless concrete fish-return sluiceway and usually returned
20 to the intake embayment approximately 300 ft east of the intake structure. The original west
21 sluiceway was installed in 1972 and was connected to the discharge canal. In 1979, the east
22 sluiceway was installed and connected to the intake embayment. During storms, the wash is
23 discharged via the original sluiceway to the discharge canal. An interchangeable baffle plate is
24 utilized to divert the flow to one sluiceway or the other from the screenhouse. The baffle plate
25 will direct organisms and debris; however, some water will flow over this structure and into the
26 alternate sluiceway. The new sluiceway was designed to maintain a minimum 6-in. depth and a
27 water velocity of less than 8 fps and is covered with galvanized wire screen. Though there are
28 several turns in the sluiceway, none appear to be greater than 23 degrees. The discharge point
29 of the east sluiceway is at the mean low water (MLW) level. On occasion, the end of the east
30 sluiceway has been seen above the water level, causing an actual "free fall" scenario. The west
31 sluiceway discharge is above the MLW level in the discharge canal.

32
33 Under normal operation, seawater is heated in the condensers to approximately 27 to 30°F
34 above the intake temperature. This is within the plant's National Pollutant Discharge Elimination
35 System (NPDES) permit which allows for as much as a 32°F temperature change. With the
36 cooling water flow being relatively constant at 311,040 gpm (693 cfs) throughout the year, the
37 discharge temperature is almost entirely a function of the intake water temperature. The
38 permitted change in temperature across the service water is 5 to 10°F. From the condensers,
39 water flows through buried concrete conveyance to the discharge canal. The conveyance
40 consists of 235 ft of 13 ft by 17 ft reinforced concrete box culvert, followed by 250 ft of a
41 concrete pipe that is 10.5 ft in diameter.

1 Three to five times each year, the plant is reduced to 50 percent power, and a thermal
2 backwash is conducted to control biological fouling. During the backwash, water is heated to
3 about 105° F, and two of the four traveling screens are rotated in reverse, allowing heated, non-
4 chlorinated seawater from the condensers to flow back over the screens and to the intake
5 embayment. The treatment is maintained for about 35 minutes. Scheduling of the thermal
6 backwash treatments is coordinated with the highest tide to achieve maximum coverage,
7 preventing mussels from growing in the upper elevations of the intake structure.
8

9 Upon exiting the concrete pipe, discharged water enters a 900-ft-long trapezoidal discharge
10 canal separated from the intake embayment by a breakwater. The discharge canal is created
11 by two breakwaters that are oriented perpendicular to the shoreline, one of which is shared with
12 the intake embayment. The channel sides are sloped at a 2:1 horizontal to vertical ratio. The
13 bottom is 30 ft wide at an elevation of 0 ft MLW, or 4.8 ft below MSL. The channel bottom
14 remains at this elevation until it converges with the shore, which has a slope of approximately
15 40:1 at the channel mouth. At low tide, the water in the discharge canal is several feet higher
16 than sea level, and the discharge is rapid and turbulent (estimated at 8.1 fps). At high tide, the
17 velocity is much lower (estimated at 1.4 fps) because the cross sectional area of flow in the
18 channel is greater. Discharge of the heated water creates a thermal plume in the nearshore
19 area of PNPS. A detailed discussion of the extent and characteristics of this plume is presented
20 in Section 4.1.3.
21

22 Dredging of the discharge canal has never been conducted. The intake embayment has been
23 dredged twice, once in 1982 and again in the late 1990s. The purpose of dredging in the
24 1990s, though unsuccessful, was to bring colder water into the cooling water system. Each
25 dredging event was individually permitted through the U.S. Army Corps of Engineers (USACE).
26 The potential dredge material was tested as part of the permit, undergoing chemical, biological,
27 and radiological analyses (see Section 2.2.5.2). The sediments were described as having
28 relatively low concentrations of the chemical parameters tested polychlorinated biphenyls
29 (PCBs), polycyclic aromatic hydrocarbons (PAHs), pesticides, petroleum hydrocarbons, heavy
30 metals, and thus considered to be Category One material under the Massachusetts Department
31 of Environmental Protection (MDEP) dredged material classification guidelines and being
32 suitable for disposal (BSC Group 1996). Of the three potential categories of dredged material, a
33 Category One classification has the lowest amount of contaminants. The dredged material was
34 disposed of in open water, at the Massachusetts Bay Disposal Site, north of Boston. There are
35 no current plans for future dredging of the discharge canal or the intake embayment at PNPS.
36
37

38 **2.1.4 Radioactive Waste Management Systems and Effluent Control Systems**

39

40 PNPS processing systems are designed and operated to meet the dose design objectives of
41 Title 10 of the Code of Federal Regulations (CFR) Part 20 and 10 CRF Part 50, Appendix I

Plant and the Environment

1 (“Numerical Guides for Design Objectives and Limiting Conditions for Operations to Meet the
2 Criterion ‘As Low As is Reasonably Achievable’ for Radiological Material in Light-Water-Cooled
3 Nuclear Power Reactor Effluents”). Radioactive wastes produced as a by-product of plant
4 operations are collected and treated within the liquid, gaseous and/or solid waste processing
5 systems before they are released to the environment or shipped to offsite disposal facilities.
6 Liquid and gaseous effluents containing radioactive materials are reduced to levels as low as
7 reasonably achievable (ALARA) prior to release. All liquid and gaseous releases are monitored
8 and controlled to ensure compliance with the authorized limits. The radionuclides removed from
9 the liquid and gaseous processing systems are converted to a solid waste form and disposed
10 with other generated solid radioactive wastes (Entergy 2006a).

11
12 Radioactive materials produced from the fission of uranium-235 and from neutron activation of
13 metals in the primary coolant system are the main source of liquid, gaseous and solid
14 radioactive waste. The radioactive fission products build up within the fuel and are contained
15 within the sealed fuel rods; however, small quantities of fission products are released from the
16 fuel rods into the reactor coolant under normal operating conditions. In addition, neutron
17 activation of trace concentrations of metals contained within the reactor coolant, such as
18 zirconium, iron, and cobalt, creates radioactive isotopes of these metals and these activation
19 products also enter the radioactive waste processing stream (Entergy 2006a).

20
21 Treating and separating these radionuclides from gases and liquids and removing contaminated
22 material from various reactor areas produces nonfuel solid wastes. Nonfuel solid radioactive
23 waste consists of contaminated tools and equipment, components removed from service,
24 solidified liquid waste, and spent filtration media. It also includes dry active waste such as
25 contaminated protective clothing, paper, rags and other trash generated from plant operations,
26 during design modification, and during routine maintenance activities. Some solid waste is
27 temporarily stored onsite prior to disposal offsite at a licensed disposal facility
28 (Entergy 2006a)

29
30 Spent fuel solid waste consists of reactor fuel assemblies that have exhausted a certain
31 percentage of their fissile fuel material. Spent fuel assemblies are removed from the reactor
32 core and replaced by fresh fuel during routine refueling outages, typically every 24 months.
33 These spent fuel assemblies are stored onsite in the spent fuel pool in the reactor building
34 (Entergy 2006a).

35
36 The site’s PNPS Off site Dose Calculations Manual (ODCM) specifies radioactive waste
37 sampling and analysis requirements and describes the methods used for calculating the
38 concentrations of radioactive material in effluents and the estimated offsite doses. The ODCM
39 also provides guidelines for operating radioactive waste treatment systems and instrumentation
40 in a manner so as to attain offsite doses that are ALARA (Entergy 2003c). Radioactive Effluent
41 and Waste Disposal (REWD) Reports for 2001 through 2005 were reviewed by the Staff

1 (Entergy 2002b, 2003b, 2004b, 2005b, 2006c). These data were used to develop information
2 for a representative year for capacity factors and operational events that impact the volume and
3 activity of liquid, gaseous, and solid waste.
4

5 **2.1.4.1 Liquid Waste Processing Systems and Effluent Controls**

6

7 The function of the liquid radioactive waste system is to collect, treat, store, and/or dispose of all
8 radioactive liquid wastes. Liquid waste is collected in sumps and drain tanks at various
9 locations throughout the plant and is then transferred to the appropriate receiving tank for
10 processing. The liquid radioactive waste control system is designed to segregate and then
11 process liquid radioactive waste from various sources separately. The liquid radioactive waste
12 is classified, collected, and processed as either clean (liquids having a varying amount of
13 radioactivity and low conductivity), chemical (liquids having low concentrations of radioactive
14 impurities and high conductivities), or miscellaneous radwastes (liquids having a high detergent
15 or contaminant level, but with a low radioactivity concentration) (Entergy 2006a).
16

17 Very low levels of radioactivity may be released in plant effluents if they meet the limits specified
18 in the U.S. Nuclear Regulatory Commission (NRC) regulations. These releases are closely
19 monitored and evaluated for compliance with NRC restrictions in accordance with the PNPS
20 ODCM (Entergy 2003c).
21

22 Clean liquid radioactive waste is collected from the equipment drain sumps located in the
23 drywell, the reactor building, the turbine building, the radioactive waste building, and the
24 retention building. The liquid wastes are then transferred to the clean waste receiver tank for
25 processing. The clean waste receiver tank also receives resin transfer water and ultrasonic
26 resin cleaner flush water. Flatbed filters and/or a mix of demineralizer, thermix, and/or radwaste
27 filter demineralizers are used to treat the clean liquid radioactive waste prior to its collection in
28 the treated water holding tanks. Liquid waste within the holding tanks is sampled and analyzed
29 and usually returned to the condensate storage tanks or the main condenser hot well for reuse
30 within the facility. If the analysis of the clean liquid waste indicates high contaminants or high
31 radioactivity, the clean liquid waste may be reprocessed. Clean liquid waste with abnormally
32 high conductivity may be reprocessed in the chemical waste system or evaluated for controlled
33 release into the circulating water discharge canal through the liquid radioactive waste header
34 (Entergy 2006a).
35

36 Chemical liquid radioactive wastes are collected from the floor drain sumps of the drywell,
37 reactor building, turbine building, radioactive waste building, and the retention building.
38 Collected liquid wastes are primarily from minor equipment leaks, tank overflows, equipment
39 drains, and floor drainage. The liquid wastes are automatically transferred to the chemical
40 waste receiver tanks when the sump is filled to a preset level. After decay and storage, the
41 chemical liquid wastes are evaluated for discharge or reprocessing (Entergy 2006a).

1 Miscellaneous liquid radioactive wastes are collected from floor drains within the turbine
2 washdown area, personnel decontamination areas, fuel cask decontamination area, reactor
3 head washdown area, truck decontamination area, machine shop wastes, and retube building
4 decontamination area. Miscellaneous liquid radioactive wastes primarily consists of water
5 collected from equipment washdown and decontamination solution wastes, radiochemistry
6 laboratory solution wastes, miscellaneous water waste, and personnel decontamination waste.
7 The wastes are sampled and analyzed for radioactivity to evaluate them for controlled release
8 or for transfer to the chemical waste receiver tank for reprocessing.

9
10 If it is determined that the liquid radioactive waste meets the ODCM criteria for controlled
11 release, it can be discharged on a controlled basis into the circulating water discharge canal
12 through the liquid radioactive waste discharge header. As the liquid waste passes through the
13 discharge header, the radioactivity level is continuously monitored. Accidental discharge is
14 protected against by instrumentation for detection and alarm of abnormal conditions and
15 administrative controls. The radioactivity level is monitored during the discharge; the discharge
16 is automatically terminated if the activity exceeds preset levels (Entergy 2006a)

17
18 A review of the liquid effluents reported in the annual PNPS REWD Reports for the years 2001
19 through 2005 (Entergy 2002b, 2003b, 2004b, 2005b, 2006c) was performed to estimate the
20 annual releases that would be expected during the license renewal period. No liquid releases
21 were made in 2004 or 2005; the largest liquid releases during this five-year period occurred in
22 2003. There were 11 batch discharges of liquid effluents in 2003 containing a total of 0.02 Ci of
23 fission and activation products and 38 Ci of tritium. All liquid discharges were well within the
24 NRC regulatory limits. No significant increases in liquid waste effluents are expected during the
25 license renewal term.

26
27 During this 5-year period, PNPS initiated an aggressive liquid radioactive waste management
28 program to reprocess and reuse water. The REWD Report for 2002 notes that liquid effluent
29 releases were significantly lower than in past years (Entergy 2003b). The REWD Reports for
30 2004 and 2005 recorded zero liquid releases (Entergy 2005b, 2006c).

31
32 See Section 2.2.7 for a discussion of the theoretical doses to the maximally exposed individual
33 as a result of liquid effluent releases.

34 35 36 37 38 **2.1.4.2 Gaseous Waste Processing Systems and Effluent Controls**

39
40 The sources of gaseous releases from PNPS are the 330-ft plant stack, the reactor building
41 vents, and the turbine building vents. The sources of releases to the stack are the main

1 condenser steam jet air ejectors, the gland seal off-gases, and the exhausts from the
2 augmented off-gas (AOG) charcoal absorber building, the radioactive waste building ventilation
3 system, and the mechanical vacuum pumps during startup. The releases from the reactor
4 building and turbine building vents are from steam leakage through valve stems, pump seals,
5 and flanged connections within these areas. The PNPS ventilation systems are designed to
6 maintain gaseous effluents to levels ALARA by a combination of holdups for decay of short-lived
7 radioactive material, filtration, and monitoring (Entergy 2006a).

8
9 Non-condensable gases from the main condenser air ejectors, the startup mechanical vacuum
10 pumps, and the gland condensers are processed through the air ejector and AOG system. The
11 AOG system also controls recombination of radiolytic hydrogen and oxygen that are
12 continuously removed from the reactor coolant to maintain turbine efficiency. After
13 recombination, the off-gas is routed to a condenser to remove moisture, and then through a 30-
14 minute delay pipe before entering the AOG charcoal absorber system. AOG charcoal
15 absorbers provide for holdup of krypton and xenon radioactivity. The holdup time allows decay
16 of the short-lived radioactive material which reduces the concentration of these materials such
17 that the site boundary concentration of gaseous effluent is maintained ALARA (Entergy 2006a).

18
19 The noncondensable exhaust from the main turbine gland seal condenser is collected and
20 processed by the gland seal holdup system. Saturated air-water vapor mixture with trace
21 amounts of hydrogen, oxygen, and radioactive gases are exhausted from the turbine generator
22 gland seal condenser. The exhaust enters into a 16-in. diameter holdup line and is delayed for
23 approximately 1.75 minutes. The effluent is routed to the main stack and mixed with the AOG
24 system effluent for discharge through the main stack (Entergy 2006a).

25
26 These streams are ultimately exhausted through the main stack. Two full capacity fans located
27 at the base of the main stack are designed to thoroughly mix all of the gas inlet streams and to
28 facilitate accurate radiation monitoring of the effluent (Entergy 2006a). This approach minimizes
29 release points to the environment, provides for continuous monitoring of the effluent, and takes
30 advantage of additional atmospheric dispersion (Entergy 2006a).

31
32 Ventilation from the administration building, machine shop, battery room and lube oil
33 compartments, recirculation pump motor-generator set area, diesel generator building, and
34 reactor auxiliary bay are listed as having negligible potential for the release of radioactive
35 effluents. Ventilation from the turbine building operating floor and switchgear area are classified
36 as having a low potential for release with airborne radiation concentration levels being
37 monitored by the turbine building effluent monitoring system (Entergy 2006a).

38
39 Primary containment venting, steam leakage outside the primary containment, hood vents, and
40 high pressure coolant injection testing are potential sources of low-level radioactive
41 contaminants at PNPS. Gaseous effluents from these areas are monitored and discharged
42 through either the main stack or the reactor building exhaust vent. The ventilation systems from

Plant and the Environment

1 these areas are designed to exhaust the air through process radiation monitoring equipment
2 (Entergy 2006a).

3
4 Gaseous effluents were reported in the PNPS REWD Reports for the years 2001 through 2005
5 (Entergy 2002b, 2003b, 2004b, 2005b, 2006c). During this 5-yr period, the average annual
6 releases of gaseous radioactive effluents were as follows:

- 7
8
- 9 • 90.0 Ci/yr of noble gases
 - 10 • 1.69×10^{-3} Ci/yr of radioiodines
 - 11 • 1.22×10^{-3} Ci/yr of beta and gamma emitters as particulates
 - 12 • 435 Ci/yr of tritium

13 All gaseous discharges were well within the NRC regulatory limits. No significant increases in
14 gaseous waste effluents are expected during the license renewal term.

15
16 See Section 2.2.7 for a discussion of the theoretical doses to the maximally exposed individual
17 as a result of gaseous releases.

18 19 **2.1.4.3 Solid Waste Processing**

20
21 The solid waste processing system processes both wet solid wastes (reactor cleanup sludge;
22 spent resins and charcoal from radwaste, spent fuel pool, and condensate demineralizers; and
23 thermex and radwaste filter/demineralizer) and dry solid waste (rags, paper, small equipment
24 parts, and solid laboratory wastes). Solid waste is processed at the radwaste building, the
25 radwaste trucklock, low level radwaste storage facility (LLRWSF) and/or the trash compaction
26 facility (Entergy 2006a).

27
28 Solid waste is segregated, separated, consolidated, and analyzed for disposal in the trash
29 compaction facility hazardous material area. The LLRWSF is utilized for interim storage for up
30 to 5 years of solid radioactive waste and for temporary storage of bulk dewatered waste for
31 shipment to a processing facility. Dewatered solid wastes are contained in high integrity
32 containers and are placed in cylindrical, concrete storage modules within the LLRWSF. Dry
33 radioactive waste are contained in steel containers and are stored in rectangular, concrete
34 storage modules within the LLRWSF (Entergy 2006a).

35
36 Disposal and transportation of radioactive waste at PNPS are performed in accordance with the
37 U.S. Nuclear Regulatory Commission (NRC) and U.S. Department of Transportation (DOT)
38 requirements. The amount and type of solid radioactive waste generated and shipped from
39 PNPS varies from year to year (Entergy 2006a). Based on a review of the PNPS REWD
40 Reports for the period 2001 through 2005, the annual average of solid radioactive waste
41 shipped from PNPS was 698 m³/yr containing 725 Ci/yr. (Entergy 2002b, 2003b, 2004b, 2005b,

1 2006c). No significant increases in radioactive waste shipments are expected during the
2 license renewal term.

3
4 Based on a review of the PNPS REWD Reports for the period 2001 through 2005, the annual
5 average of solid radioactive waste shipped from PNPS was 698 m³/yr containing 725 Ci/yr
6 (Entergy 2002b, 2003b, 2004b, 2005b, 2006c).

7 8 **2.1.5 Nonradioactive Waste Systems**

9
10 The principal nonradioactive waste streams from PNPS consist of heating boiler blowdown, filter
11 backwash, sludges and other wastes, floor and yard drains, and stormwater runoff.
12 Nonradioactive waste streams are produced from plant maintenance and cleaning activities.
13 Nonradioactive wastes, specifically chemical and biocide wastes, are also produced while
14 controlling the pH in the coolant, controlling scale and corrosion and while cleaning the main
15 condenser. Nonradioactive waste liquids are generally discharged with the cooling water
16 discharges. An onsite septic system collects the sanitary wastewater, which is transferred to an
17 onsite wastewater treatment facility and discharged to a leach field in accordance with the
18 Groundwater Discharge Permit # 2-389 issued by MDEP.

19
20 During operation of the oil-fired boilers, nonradioactive gases are discharged to the atmosphere.
21 By limiting fuel usage and hours of operation of the oil-fired boilers, emissions of regulated
22 pollutants is within the MDEP's air quality standards (Entergy 2006a).

23
24 Entergy has a corporate policy and a plan for waste minimization at its nuclear power plants,
25 including PNPS (Entergy 2006a). The plan provides a hierarchy of waste minimization options
26 that emphasize (1) source reduction, (2) reuse/recycling, (3) treatment to reduce volume
27 and/or toxicity, and (4) disposal, in that order. It is expected that Entergy would continue to
28 maintain and implement its waste minimization policy and plan during the license renewal period
29 at PNPS.

30 31 **2.1.6 Plant Operation and Maintenance**

32
33 PNPS utilizes various programs and activities to maintain, inspect, test and monitor the
34 performance of plant equipment and to manage aging effects. The programs and activities are
35 implemented to comply with the requirements of 10 CFR 50, Appendix B (Quality Assurance),
36 Appendix R (Fire Protection), and Appendices G and H, Reactor Vessel Materials; 10 CFR
37 50.55a, American Society of Mechanical Engineers (ASME) Code, Section XI, In-service
38 Inspection and Testing; 10 CFR 50.65, the maintenance rule, including the structures
39 monitoring; and to maintain water chemistry (Entergy 2006a).

1 Some programs and activities are performed during the operation of the nuclear unit, while
 2 others are performed during scheduled refueling outages. Additional programs are
 3 implemented in response to NRC generic communications and to meet technical specification
 4 surveillance requirements.
 5

6 **2.1.7 Power Transmission System**
 7

8 As presented in Table 2-1, the applicant identified two 345-kilovolt (kV) transmission lines that
 9 connect PNPS to the power grid, the 342 line and the 355 line. The two lines share a single
 10 300-ft-wide transmission line ROW that extends from the PNPS switchyard approximately 5.0
 11 mi to the Jordan Road Tap, and then the ROW extends an additional 2.2 mi to the Snake Hill
 12 Road substation (Entergy 2006a; AEC 1972) (Figure 2-6). Over its 7.2 mi length, the ROW
 13 covers approximately 260 ac. The transmission line ROW does not cross any State or Federal
 14 parks, wildlife refuges, or wildlife management areas (Entergy 2006a), nor does it cross any
 15 major lakes, ponds, or streams. However, the transmission line crosses a small stream near
 16 Old Sandwich Road.
 17

18 **Table 2-1.** PNPS Transmission Line ROWs
 19

Destination	Line	Number of lines	kV	Approximate Distance		ROW Width		ROW Area	
				km	(mi)	m	(ft)	hectares	acres
PNPS to Jordan Road Tap	342,355	2	345/ line	8.05	5	91.4	300	73.6	181.8
Jordan Road Tap to Snake Hill Road Substation	342,355	2	345/ line	3.5	2.2	91.4	300	32.3	80.0
Total				11.6	7.2			105.9	261.8

30
 31 Source: Entergy 2006a
 32
 33

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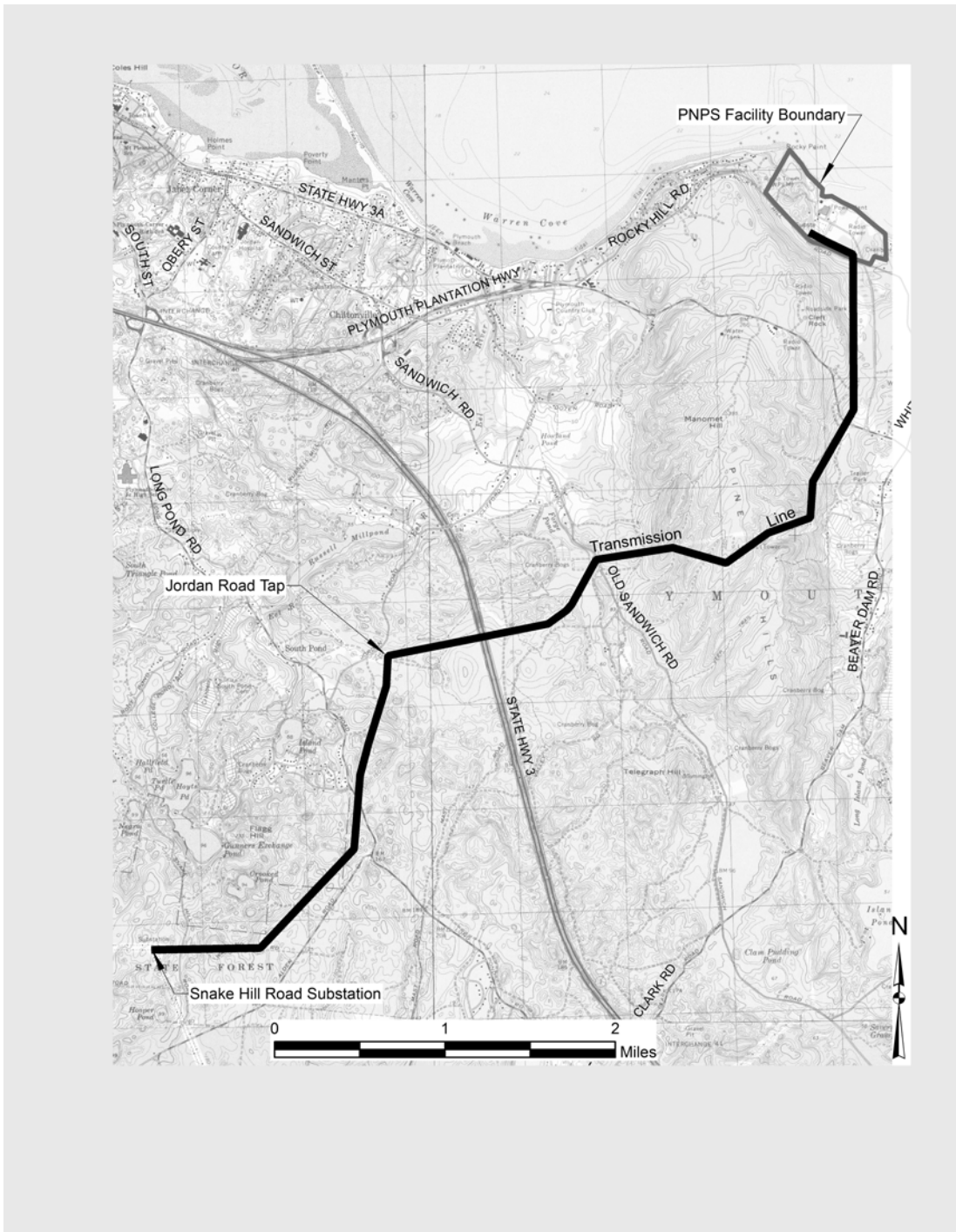


Figure 2-6. PNPS Transmission Lines

1 Entergy does not own, operate, or maintain the PNPS-to-Snake Hill Road transmission ROW or
2 transmission lines. The lines are owned and maintained by NSTAR, which provides electricity
3 and natural gas to businesses and residents in eastern Massachusetts (Entergy 2006a; NSTAR
4 2006). NSTAR maintains the transmission ROW in accordance with a Vegetation Management
5 Plan (NSTAR 2006) approved by the Massachusetts Department of Agricultural Resources and
6 the Natural Heritage and Endangered Species Program (NHESP). Under this plan, NSTAR
7 maintains the PNPS ROW from the station to the Snake Hill Road substation, as well as the rest
8 of their system, using an integrated vegetation management program. The ROWs are managed
9 by NSTAR to encourage the natural development of low-growing woody shrubs and herbaceous
10 plant communities while controlling tall growing trees and undesirable shrub species that may
11 interfere with the operation of the transmission lines.
12

13 **2.2 Plant Interaction with the Environment**

14
15 Sections 2.2.1 through 2.2.8 provide general descriptions of the environment near PNPS as
16 background information. They also provide detailed descriptions where needed to support the
17 analysis of potential environmental impacts of operation during the renewal term, as discussed
18 in Sections 3 and 4. Section 2.2.9 describes the historic and archaeological resources in the
19 area, and Section 2.2.10 describes possible impacts associated with other Federal project
20 activities.
21

22 **2.2.1 Land Use**

23
24 The PNPS facility occupies 140 ac, located northeast of Rocky Hill Road. The site includes a
25 central developed area surrounded by a security fence that contains the generating facilities,
26 switchyard, warehouses, office buildings, and parking lots. The remainder of the site,
27 surrounding the developed area to the north, west, and south, is primarily undeveloped and
28 wooded. The Cape Cod Bay shoreline borders the site to the east. The properties along the
29 shoreline north and south of the site, which also are situated between Rocky Hill Road and the
30 bay, are residential except for the parcel immediately north of the site, which is used for
31 nonprofit/conservation purposes. PNPS is located in and pays property taxes to the Town of
32 Plymouth. The site is zoned LI/Light Industrial by the town. The parcels immediately north and
33 south of the site are zoned RR/Rural Residential^(a).
34

35 Entergy also owns a large tract of undeveloped land, over 1530 ac, located predominantly
36 across Rocky Hill Road south and west of the 140-ac PNPS site. The majority of this property
37 has been placed in a forest land trust under Chapter 61 of the General Laws of Massachusetts,
38 Classification and Taxation of Forest Lands and Forest Products. The majority of this

(a) The RR zoning district has a minimum lot size of 120,000 ft² (Rural Residential). The R-25 district has a minimum lot size of 25,000 ft² (Medium Lot Residential) (Town of Plymouth 2004c).

1 woodlands property is zoned RR/Rural Residential; a small portion east of Power House Road
2 is zoned R-25/Residential^(a). The Entergy-owned property boundary, including the the PNPS
3 site and the woodlands tract, is shown in Figure 2-3.
4

5 A 300-ft-wide transmission ROW, containing two transmission lines built to connect PNPS to the
6 power grid, runs from the PNPS site to the Snake Hill Road substation approximately 7.2 mi to
7 the southwest (Entergy 2006a; AEC 1972). The corridor extends from the PNPS switchyard,
8 crosses Rocky Hill Road, and traverses almost 2 mi within the Entergy woodlands and along its
9 southeastern property boundary. The corridor then turns west, leaving the Entergy woodlands
10 property, and continues southwest approximately 5 mi to where it connects to a previously
11 existing corridor. Lands traversed by the transmission lines ROW are primarily undeveloped
12 woodland and are zoned RR/Rural Residential by the Town of Plymouth. At its southern end,
13 approximately 1.3 mi of the corridor are within Myles Standish State Forest.
14

15 Section 307(c)(3)(A) of the Coastal Zone Management Act (16 USC 1456[c][3][A]) requires that
16 applicants for federal licenses to conduct an activity in a coastal zone provide to the licensing
17 agency a certification that the proposed activity is consistent with the enforceable policies of the
18 State's coastal zone program. A copy of the certification is also to be provided to the State.
19 Within six months of receipt of the certification, the State is to notify the Federal agency whether
20 the State concurs with or objects to the applicant's certification. PNPS is within Massachusetts'
21 coastal zone for purposes of the Coastal Zone Management Act.
22

23 Entergy's certification that renewal of the PNPS license would be consistent with the
24 Massachusetts coastal zone management program is provided in Attachment D of its
25 Environmental Report (Entergy 2006a), which was submitted on January 27, 2006, as part of
26 the license renewal application for PNPS. The certification statement and accompanying
27 information was filed with the Massachusetts Office of Coastal Zone Management.
28

29 **2.2.2 Water Use**

30
31 Cape Cod Bay, with a surface area of approximately 430 square nautical mi, or about 365,000
32 ac, is the source of cooling and service water for PNPS. The facility uses a once-through
33 cooling system in which seawater is withdrawn from the bay via an embayment formed by two
34 breakwaters and is discharged into a 900-ft-long discharge canal immediately adjacent to the
35 intake embayment. The intake structure provides 311,000 gpm of condenser cooling water and
36 can provide up to 13,500 gpm of cooling water to the service water system. The condenser and
37 service cooling water systems are closed systems in which the water is withdrawn from and
38 returned to the bay (Entergy 2006a).
39

40
41
42 As designated in the PNPS NPDES Permit Number MA003557 (Federal) and Number 359

1 (State), the monthly average and daily maximum discharge limitations for condenser cooling
2 water (outfall no. 001) are 447 million gallons per day (mgd) and 510 mgd, respectively (EPA
3 1994). The monthly average discharge limitation for service cooling water (outfall no. 010) is
4 19.4 mgd (there is no daily maximum limitation specified in the NPDES permit). According to
5 the applicant's April 2005 to March 2006 Discharge Monitoring Reports (DMRs) for the NPDES
6 permit, flow for both the condenser and service cooling water systems did not exceed the permit
7 requirements during that time period (Entergy 2006d).

8
9 The PNPS facility obtains its potable and reactor makeup water from the Town of Plymouth
10 municipal water system (Entergy 2006a). The town water supply is derived solely from
11 groundwater. Estimated annual potable water consumption for a non-outage year at PNPS is
12 approximately 39.1 million gallons per year or 74.4 gpm (Town of Plymouth 2004b). The usage
13 represents approximately 2.3 percent of the town's total yearly consumption (Town of Plymouth
14 2004a). There is no direct groundwater use at the PNPS facility. The site has one groundwater
15 well (installed in 2000), which has been used in the past for irrigation purposes only. The well is
16 no longer in use and it is not anticipated that the well will be returned to service at anytime in the
17 future (Entergy 2006a). The Town of Plymouth Water Division obtains its drinking water supply
18 from 10 groundwater wells at nine locations throughout the town. The Plymouth-Carver aquifer,
19 which provides water for Plymouth and neighboring communities, is composed of saturated
20 glacial sand and gravel. It is designated by U. S. Environmental Protection Agency (EPA) as a
21 Sole Source Aquifer, the second largest in Massachusetts. These aquifers provide at least 50
22 percent of their communities' water supply (Town of Plymouth 2006a).

23 24 **2.2.3 Water Quality**

25 26 **2.2.3.1 Surface Water**

27
28 Pursuant to the Federal Water Pollution Control Act (also known as the Clean Water Act
29 [CWA]), PNPS effluent discharges are regulated by and NPDES permit. EPA Region I
30 administers the NPDES permit process in Massachusetts. The NPDES permit was issued to
31 PNPS on April 29, 1991 and the current NPDES permit (which is a modification of the permit
32 issued in 1991) was issued August 30, 1994 (Federal Permit Number MA0003557) in
33 conjunction with the Commonwealth of Massachusetts (Massachusetts Permit Number 359)
34 (EPA 1994). A provision of the CWA allows facilities to continue to operate under an expired
35 permit provided the permittee makes a timely renewal application. The PNPS NPDES permit,
36 which expired April 29, 1996, remains in effect while EPA Region I and the Commonwealth
37 review Entergy's application for renewal of the permit. The quantitative effluent limitations
38 regulated under the PNPS NPDES permit are shown in Table 2-2.

Table 2-2. Effluent Limitations - NPDES Permit for PNPS

Outfall No.(Outfall Description)	Flow (mgd)		Total Residual Oxidants (mg/L)		Max. Temp. (°F)		Temp. Rise (°F)		Total Suspended Solids (mg/L)		Oil and Grease (mg/L)	
	Avg. Monthly	Max. Daily	Avg. Monthly	Max. Daily	Avg. Monthly	Max. Daily	Avg. Monthly	Max. Daily	Avg. Monthly	Max. Daily	Avg. Monthly	Max. Daily
001 (Condenser Cooling Water)	447	510	0.1	0.1	NA	102	NA	32	NA	NA	NA	NA
002 (Thermal Backwash for Bio-fouling Control)	NA	255	NA	NA	NA	120	NA	NA	NA	NA	NA	NA
003 (Intake Screen Wash)	4.1	4.1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
004,005,006,007 (Yard Drains)	NA	NA	NA	NA	NA	NA	NA	NA	30	100	NA	15.0
008 (Sea Foam Suppression)	0.73	0.73	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
010 (Service Cooling Water)	19.4	NA	0.50	1.00	NA	NA	NA	NA	NA	NA	NA	NA
011 (Makeup Water and Demineralizer Waste Discharge)	0.015	0.06	NA	NA	NA	NA	NA	NA	30	100	NA	NA

Notes: For the majority of outfalls, the pH shall not be greater than or less than 0.5 standard units of the influent. There is no Outfall No. 009 (number 009 was not assigned). Source: EPA 1994.

Plant and the Environment

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December 2006

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Draft NUREG-1437, Supplement 29

Based on a review of the discharge data presented in the applicant's April 2005 to March 2006 monthly DMRs for the PNPS facility, an effluent limitation was outside of the permit requirement on three occasions. During April 2005, there was one permit exceedance. Analytical results for total suspended solids of 38.2 milligrams/liter (mg/L) at stormwater outfall 007 exceeded the monthly average limit (30 mg/L), but not the daily maximum limit (100 mg/L). The DMR attributed this to the unusually large amount of road sand used that winter. On one occasion in January 2006 and another in February 2006, there was a problem with the screenwash dechlorination system (outfall 003) in which chlorine was detected in the screenwash sluiceway. In each instance, one of the dechlorination pumps was not pumping adequately. One pump was repaired and the other replaced, and the system was restored to normal operation. These exceedances were not significant enough to result in issuance of a Notice of Violation (NOV) by EPA (Entergy 2006d).

2.2.3.2 Groundwater

According to the April 26, 1999, MDEP Groundwater Discharge Permit (Southeast Region, Permit #2-389), the PNPS sanitary wastewater treatment facility is authorized to discharge treated wastewater effluent into a leach field in compliance with specified discharge limitations (MDEP 1999). Groundwater flow at this site is toward Cape Cod Bay (Entergy 2006a). The parameters regulated under the MDEP groundwater discharge permit are shown in Table 2-3.

Table 2-3. Effluent Limitations – MDEP Groundwater Discharge Permit for PNPS Wastewater Treatment Facility

Effluent Characteristic	Discharge Limitation
Flow (gallons/day)	37,500 daily average
Biochemical Oxygen Demand, 5-day @ 20°C	30.0 mg/L
Total Suspended Solids	30.0 mg/L
Chloride	250.0 mg/L
Oils and Greases	15.0 mg/L
Total Dissolved Solids	1000 mg/L
pH	6.5 to 8.5

Source: MDEP 1999

Based on a review of the groundwater data presented in the applicant's January 2005 to March 2006 monthly DMRs for the facility, two effluent limits were exceeded over a three-month period. During January, February, and March 2005, total dissolved solids (TDS) and chloride concentrations exceeded the permit limits. The TDS effluent limit of 100 mg/L was exceeded by

1 100 to 400 mg/L and the chloride limit of 250 mg/L was exceeded by 10 and 80 mg/L. In order
2 to determine the source of these elevated TDS and chloride levels in the treated wastewater
3 effluent, PNPS sampled all three lift stations and the raw water coming into the facility. The
4 conclusion was reached that runoff containing road salt, which was used extensively due to
5 adverse weather conditions, as well as softener chemicals from the cafeteria may have
6 contributed to the high readings over those months. During May 2005, TDS exceeded the
7 permit limit by 100 mg/L, which was attributed to a contaminated sample.
8 These exceedances were not significant enough to result in issuance of an NOV by MDEP
9 (Entergy 2006e).

10
11 A site contamination assessment was conducted for PNPS in 1999. This assessment was
12 performed to identify any radioactive contamination in the vicinity of the PNPS facility. The
13 types of samples collected include shallow soil samples, deep soil samples, catch basin
14
15 sediment samples, and groundwater samples. Analytical results from these samples indicate
16 that radioactive contamination in the vicinity of the process buildings is minimal and thus would
17 not pose any significant effect on decommissioning efforts. In compliance with 10 CFR
18 50.751(g) recordkeeping requirements, PNPS maintains a file that documents spill events at the
19 facility and describes associated remediation and any residual concentrations remaining.
20 Information in this file was used to guide the sampling for the site contamination assessment
21 (Boston Edison 1999).

22
23 Impacts to site groundwater were evaluated after more than 15,000 gallons of transformer oil
24 were spilled from the main transformer at the PNPS site in March 1997. A response action was
25 conducted in 1997, and a completion and outcome statement was subsequently prepared for
26 submittal to MDEP. It documents the details of the release and cleanup, provides the analytical
27 results of the soil and groundwater samples collected, and presents the results of the risk
28 characterization conducted at the affected area. Total petroleum hydrocarbons (TPH) and
29 extractable petroleum hydrocarbons (EPH) were detected above screening criteria in
30 subsurface soil samples collected from the area around the transformer. Contaminated trap
31 rock and soil were excavated and removed from the site, and soil samples were collected to
32 confirm removal of the source of contamination. Analytical results indicated that elevated
33 concentrations of select EPH carbon chains and TPH remained in the soil. Three rounds of
34 groundwater samples were collected in the vicinity of the transformer following the removal of
35 trap rock and soil. EPH were detected above screening criteria in September 1997; however,
36 no exceedances were detected in the April or December 1997 samples. A risk characterization
37 was conducted for soil and groundwater to determine the level of risk to human health, safety,
38 welfare, and the environment at the PNPS site based on the transformer oil spill. Despite the
39 elevated concentrations of contaminants present, the risk characterization determined that a
40 condition of no significant risk of harm exists at the site. In addition, a background feasibility
41 evaluation was conducted, which determined that it is technologically infeasible to remediate the
42 impacted soil to background levels. Based on the results of the risk characterization and the

1 background feasibility evaluation, the response action was considered complete (RAM
2 Environmental 1998).

3 4 **2.2.4 Air Quality**

5
6 PNPS is situated on the western shoreline of Cape Cod Bay in Plymouth, Massachusetts on a
7 ridge of low hills running in a north-south direction reaching a height of 395 ft. Approximately 60
8 percent of the area within a 50-mi radius is open water (AEC 1972). Thus, the site has a
9 continental climate influenced by the sea. In these mid latitudes of the United States (U.S.), the
10 weather is influenced mostly by large-scale air masses and storm systems which enter the area
11 from southwesterly through northwesterly directions. The prevailing winds are likely to be from
12 the west, with a northwest component in the winter and spring, tending to be more
13 southwesterly during the remainder of the year (NOAA 2004).

14
15 The average annual temperature at Plymouth is 50° F with a high monthly average of 71° F in
16 July and monthly average of 27° F in January (Energy 2006a). The Atlantic Ocean moderates
17 the climate on local scales, with air temperatures along the coast being less extreme than those
18 inland. For example, western Massachusetts is generally colder than the eastern part of the
19 state. In the west, Pittsfield averages 68° F in July and 21° F in January. Worcester, in the
20 central portion of the state, has a July average of 70°F and a January average of 24°F. The
21 highest temperature ever recorded in the state was 107°F at New Bedford and Chester, on
22 August 2, 1975. The lowest recorded temperature, -35°F, occurred at Chester on January 12,
23 1981 (World Book 2006).

24
25 Hurricanes occasionally strike New England from the south and deliver strong winds and heavy
26 rains to these coastal locations in the summer and autumn months. Destructive hurricanes hit
27 the state in 1938, 1944, and 1945. Tornado activity in eastern Massachusetts is uncommon.
28 The relatively warm ocean waters off the east coast in winter can provide the energy for extra
29 tropical cyclones, many producing "northeasters" in the winter and spring, leading to strong
30 winds and heavy precipitation. Thunderstorms occur in the late spring and summer. Monthly
31 averages for precipitation at Plymouth vary from about 3 to 4.5 in. Although snowfall amounts
32 typically average 42 in. per year, the Plymouth area is subjected to a wide range of snowfall
33 since it is located in the northeastern part of the U.S. The State's precipitation (rain, melted
34
35 snow, and other forms of moisture) ranges from approximately 47 in. a year in the west to about
36 43 in. near the east. From 55 to 75 in. of snow falls in the western mountains each year. The
37 central part of the State averages about 49 in. a year and the coastal area about 42 in. (World
38 Book 2006).

39
40 PNPS is within the MDEP Southeast Region. Ozone is the only pollutant for which
41 Massachusetts monitors indicate violation of the National Ambient Air Quality Standards.
42 Massachusetts is in attainment for the other pollutants, including carbon monoxide, lead,

1 nitrogen dioxide, sulfur dioxide, and particulate matter with a mean aerodynamic diameter of
2 less than 10 micrometers (PM_{10}) and less than 2.5 micrometers ($PM_{2.5}$). The term "attainment"
3 means that the State-run ambient air quality network has verified that the air quality for various
4 pollutants is within established EPA Standards. Likewise, the term "non-attainment" is used to
5 indicate instances wherein key pollutants demonstrated monitoring values that exceed the EPA
6 Standards. Massachusetts has been in attainment for sulfur dioxide, nitrogen dioxide, and lead
7 based on decades of monitoring. With the adoption of numerous control programs,
8 Massachusetts has been in attainment for carbon monoxide since 1986 and was redesignated
9 as "in attainment" for carbon monoxide in 2002 (MA DEP 2005).

10
11 Massachusetts has been classified as in "serious non-attainment" for the 1-hour ozone standard
12 since the early 1990s. However, with greater controls there has been a reduction in the severity
13 of the 1-hour exceedances. Massachusetts was designated as being in "moderate non-
14 attainment" of the 8-hour ozone standard in June 2005.

15
16 There are no designated Class I Federal areas within a 50-mi radius of PNPS. The closest
17 non-attainment area for particulate matter is New Haven, Connecticut, approximately 135 mi
18 from PNPS. The closest non-attainment area for sulfur dioxide is Mansfield, New Jersey,
19 approximately 250 mi from PNPS (EPA 2003).

20
21 PNPS has heating boilers and diesel generators located onsite. Emissions from these sources
22 are regulated by an emissions cap approved by the MDEP in July 2005. This cap limits facility
23 emissions to less than 50 percent of the major source category emissions. This permit limits
24 the fuel usage and hours of operation of these emission sources (Entergy 2006a).

25 26 **2.2.5 Aquatic Resources**

27 28 **2.2.5.1 Water Body Characteristics**

29
30 Cape Cod Bay (Figure 2-1) is a large embayment in southeastern Massachusetts that is open to
31 the north, and enclosed by the mainland to the west and Cape Cod to the south and east.

32
33 Cape Cod Bay constitutes the southern end of Massachusetts Bay and the Gulf of Maine. Cape
34 Cod is a hook shaped, glacially-deposited peninsula whose northern tip extends about 6.2 mi
35 north of PNPS. Cape Cod Bay is approximately 18.6 mi wide at the latitude of PNPS. The
36 surface area of Cape Cod Bay is approximately 360,000 ac and the volume is approximately 36
37 million acre ft (Stone and Webster 1975, in ENSR 2000).

Plant and the Environment

1 Water depths in the vicinity of PNPS are typically 10 ft and up to 35 ft within several miles
2 offshore of the site. The nearshore waters and coastline in the immediate vicinity of PNPS are
3 shown in an aerial photograph in Figure 2-3. The nearshore depths to the north of PNPS
4 average approximately 12 ft. The greatest depth, approximately 180 ft, occurs at the mouth of
5 Cape Cod Bay. Approximately half of the surface area of Cape Cod Bay has depths greater
6 than 100 ft (Stone and Webster 1975 in ENSR 2000), with depths increasing as the bay floor
7 slopes toward deeper water at its northern connection with Massachusetts Bay and the Gulf of
8 Maine.

9
10 The bottom is mainly unconsolidated sediment, finer in deeper waters than near shore (Bridges
11 and Anderson 1984, in ENSR 2000). The sea floor in the vicinity of PNPS is generally sandy,
12 with depths of approximately 21 ft offshore and to the south of PNPS. Two shallow rocky
13 ledges bracket the PNPS area. One ledge extends northward from Rocky Point near the
14 northern tip of the PNPS property. The other ledge also extends northward for several hundred
15 meters from the vicinity of Manomet Point (ENSR 2000; Davis and McGrath 1984) (Figure 2-2).

16
17 The movement of water within Cape Cod Bay is controlled mainly by ocean circulation patterns,
18 tidal fluctuations, and wind. These factors affect the hydrodynamics of the bay to varying
19 degrees and result in currents that jointly control the exchange of water between Cape Cod Bay
20 and the much larger Massachusetts Bay. The waters of Cape Cod Bay exchange with water
21 from Massachusetts Bay through the processes of tidal exchange, the counterclockwise pattern
22 of ocean circulation, and wind induced motion. Tidal fluctuations largely control this exchange.
23 The intertidal volume represents approximately 9.3 percent of the mean volume of the bay. The
24 total bay flushing rate is approximately 7.2 percent per day, which corresponds to a mean
25 residence time in Cape Cod Bay of 13.9 days (Stone and Webster 1975, in ENSR 2000).

26
27 Ocean currents in the vicinity of PNPS are generally toward the south and are part of the large
28 scale, counterclockwise circulation pattern within Massachusetts Bay. In contrast, tidal currents
29 tend to rotate clockwise, completing one revolution per tide cycle (EG&G 1995, in ENSR 2000).
30 Tide heights in Massachusetts Bay are predominantly semi diurnal with a typical range of 9.1 ft.
31 The maximum tidal range at spring phase is 10.6 ft. At PNPS, the estimated average yearly
32 maximum astronomical high tide is 11.7 ft MLW, and the estimated average yearly minimum
33 astronomical low tide is 2.3 ft MLW (Stone and Webster 1975, in ENSR 2000).

34
35 Water temperatures in Cape Cod Bay fluctuate seasonally and due to processes such as
36 upwelling, downwelling, and turbulence. Seasonal temperature variations are significantly
37 greater near the surface of the bay than on the bottom, although seasonal climatic changes
38 produce temperature stratification during the summer months. Generally, during the summer
39 and early fall, bay temperatures exhibit a two-layer structure in which a very strong temperature
40 gradient exists at the interface of the layers, with temperatures decreasing with increasing water

1 depth. More gradual temperature changes generally occur over the entire depth of the water
2 column within this two-layer structure (Stone and Webster 1975, in ENSR 2000).

3
4 Water temperature measurements have been collected by the Massachusetts Water Resource
5 Authority (MWRA) in Boston Harbor, Massachusetts Bay, and Cape Cod Bay from 1989 through
6 2004. Over the 15-year period, temperatures have remained fairly consistent, ranging from
7 approximately 2 degrees Celsius ($^{\circ}\text{C}$) (in mid-winter) to 22°C (in mid-summer) in the
8 near-surface water and approximately 3°C (in mid-winter) to approximately 12°C (in
9 mid-summer) in the near-bottom water (Libby et al. 2006). Large fluctuations during the
10 summer are typical, resulting from upwelling–downwelling fluctuations as well as short-lived
11 wind-mixing events (Libby et al. 2006).

12
13 Salinity becomes vertically uniform throughout the water column during late winter. As the snow
14 melts in the spring and surface water runoff increases, the fresh water enters the bay at the
15 surface and, because it is less dense than saltwater, it stays at the surface. As a result of the
16 relative decrease in surface water salinity, a density gradient develops. At the same time the
17 additional solar warming increases the surface temperature and further enhances the density
18 gradient (Libby et al. 2006).

19
20 Dissolved oxygen (DO) concentrations in the water column of Cape Cod Bay are highest during
21 the winter and early spring when oxygen is well mixed throughout the water column. DO
22 measurements have been collected throughout the Massachusetts/Cape Cod Bay system since
23 1992 by the MWRA (Libby et al. 2006). Monitoring results from this program indicate that the
24 DO varies significantly throughout the year, with values in 2004 ranging from approximately 11
25 mg/L in March 2004 to a low of approximately 7.5 mg/L in Cape Cod Bay during early fall (Libby
26 et al. 2006). In general, the DO at the bottom is 1 to 2 mg/L less than at the surface throughout
27 the year (Galya et al. 1997 in ENSR 2000). This general cycle of mid-winter highs and early-fall
28 lows has been repeated during each of the monitoring years and suggests a fairly regular
29 pattern of steady decline through the period of increased algal production and a subsequent
30 increase during destratification and reduced algal production (Libby et al. 2006).

31 32 **2.2.5.2 Chemical Contaminants near PNPS**

33
34 At the site audit in May of 2006, the NRC staff was informed that analytical data for surface
35 water and sediment typically have not been collected by Entergy or its predecessor, Boston
36 Edison, at the PNPS facility. However, sediment has been collected and analyzed in support of
37 a dredging permit application. Dredge sediment data were collected from the cooling water
38 intake embayment at PNPS on four occasions between October 1992 and July 1996. These

39
40 analytical data are available in the report *Maintenance Dredging of Pilgrim Nuclear Power*
41 *Station Intake Channel Report* (BSC Group 1996).

Plant and the Environment

1 In 1992 and 1994, sediment samples were collected and analyzed for several physical and
2 chemical parameters. Eight inorganics (cadmium, chromium, copper, lead, mercury, nickel,
3 sodium, and zinc), the chloride ion, volatile organics, and total petroleum hydrocarbons were
4 detected at relatively low concentrations based on comparison to MDEP dredging material
5 classification guidelines. PAHs, pesticides, and PCBs were not detected in any sediment
6 sample. Samples were also analyzed for radionuclides and results indicated that the
7 concentrations detected would not pose any significant risk. Results of this sampling indicated
8 that sediment dredged from the PNPS intake embayment would be suitable for disposal at the
9 Massachusetts Bay Disposal Site (MBDS) without bioassay or bioaccumulation testing of the
10 samples (BSC Group 1996).

11
12 Sediment samples from the PNPS site were collected in 1996 to determine the environmental
13 impacts of proposed dredge spoils on the marine benthic populations using toxicological and
14 bioaccumulation tests. For comparison, control sediment samples were collected from a
15 contaminant-free area of the Hampton Harbor, and reference sediment samples were collected
16 outside the MBDS. Toxicological studies indicated that the PNPS intake embayment sediment
17 had no impact on the survival of the mysid shrimp (*Mysidopsis bahia*), the tidewater silverside
18 minnow (*Menidia beryllina*), the polychaete worm (*Nereis virens*), or the bivalve clam (*Macoma*
19 *nasuta*). However, these tests indicated that sediment from the intake embayment would have
20 a significant impact on the survival of the amphipod (*Ampelisca abdita*), and the development of
21 the larval stage of the blue mussel (*Mytilus edulis*). Bioaccumulation tests found no significant
22 uptake of any of the parameters tested (cadmium, cobalt, cobalt-60, and mercury) by either the
23 clam or the polychaete after exposure to the PNPS intake embayment sediment for 28 days
24 (BSC Group 1996).

25
26 A follow-up study on the January 1996 toxicological and bioaccumulation study was conducted
27 in July 1996 to assess potential acute impacts to the marine benthic populations exposed to
28 dredge sediment from the PNPS intake embayment. Toxicological studies indicated that
29 sediment had a significant effect on the survivability of the amphipod in only one location after
30 10 days exposure (BSC Group 1996).

31
32 Data are also available to evaluate overall contaminant distribution in Massachusetts Bay. As
33 part of a study conducted by Shea et al. (1991), sediment chemical contaminant data from a
34 total of 18 studies were compared. The studies included analytical results of metals, PAHs,
35 PCBs, pesticides, and radionuclides in Massachusetts Bay sediments. The study concluded
36 that Massachusetts Bay sediments were no more contaminated than those of other urban
37 estuarine and coastal regions on the east coast, and that based on comparison of the observed
38 data to the U. S. National Oceanic and Atmospheric Administration (NOAA) sediment toxicity
39 effects levels, the sediments in Massachusetts Bay are healthy (Shea et al. 1991).

2.2.5.3 Biological Communities

The aquatic biological communities in the waters of Cape Cod Bay surrounding PNPS include fish, pelagic invertebrates, plankton, benthic invertebrates, marine aquatic plants, marine mammals and Federally listed marine species (including some marine mammals and sea turtles). A discussion of their importance follows.

2.2.5.3.1 Fish

The species composition of the fish community found in western Cape Cod Bay reflects a transition between the Gulf of Maine and the Mid-Atlantic Bight (Lawton et al. 1995, in ENSR 2000). Due to the warm water intrusion from the Cape Cod Canal into the cold waters from the Gulf of Maine current, Cape Cod Bay maintains a seasonally diverse composition of finfish. Cape Cod serves as the southern boundary for several northern Atlantic fish species and the northern boundary for several fish species that inhabit the warmer waters south of Cape Cod, resulting in a wide variety of fish species (ENSR 2000). PNPS is situated on an open part of the coast and the biota in the vicinity of the station is more typical of marine than of estuarine environments (ENSR 2000).

Monitoring

Marine finfish populations in the vicinity of PNPS have been monitored since the initiation of station operations to determine if the station has had any effect on local populations. These studies have been conducted by independent researchers, State agencies, and consultants under contract with PNPS or its parent companies (Boston Edison, Entergy). These studies have been conducted in response to the NPDES permitting requirements, in response to advisory committee concerns, or due to PNPS concerns only. The results of these studies are published at least annually through the Marine Ecology Reports or are issued as special reports.

A variety of methods has been employed to sample the fish populations that inhabit the waters in the vicinity of the station. These methods have included:

- Bottom trawling
- Gill nets
- Haul seines
- Diver surveys
- Recreational creel surveys
- Ichthyoplankton surveys
- Impingement and entrainment monitoring

1 Bottom trawling gear was used to sample demersal fish species inhabiting inshore waters, gill
2 nets were set to sample pelagic species, and haul seining was employed to sample other
3 inshore species. In addition, visual transects were surveyed by divers in complex habitat areas
4 that could not be surveyed with typical sampling equipment in order to assess habitat-seeking
5 fish species such as the tautog (*Tautoga onitis*) and cunner (*Tautogolabrus adspersus*).
6 Recreational creel surveys also were conducted to assess the sport fisheries adjacent to PNPS.
7 In addition, ichthyoplankton studies were initiated in 1974 to determine the presence and extent
8 of early-life stages of local fish populations and assess possible detrimental effects from PNPS.
9 Impingement and entrainment sampling has been conducted at least once weekly since the
10 initiation of station operations.

11 12 ***Important Fish Species***

13
14 A discussion of the ecology, life history, status, and trends of the more important fish species in
15 the area surrounding PNPS follows. These species include commercially or recreationally
16 valuable species, species that are critical to the potentially affected ecosystem, and species for
17 which essential fish habitat (EFH) has been designated in the vicinity of PNPS. These species
18 are:

- 19
- 20 • Alewife (*Alosa pseudoharengus*)
- 21 • American plaice (*Hippoglossoides platessoides*)
- 22 • Atlantic butterfish (*Peprilus triacanthus*)
- 23 • Atlantic cod (*Gadus morhua*)
- 24 • Atlantic halibut (*Hippoglossus hippoglossus*)
- 25 • Atlantic herring (*Clupea harengus*)
- 26 • Atlantic mackerel (*Scomber scombrus*)
- 27 • Atlantic menhaden (*Brevoortia tyrannus*)
- 28 • Atlantic sand lance (*Ammodytes americanus*)
- 29 • Atlantic silverside (*Menidia menidia*)
- 30 • Atlantic tomcod (*Microgadus tomcod*)
- 31 • Black sea bass (*Centropristus striata*)
- 32 • Bluefin tuna (*Thunnus thynnus*)
- 33 • Bluefish (*Pomatomus saltatrix*)
- 34 • Cunner (*Tautogolabrus adspersus*)
- 35 • Fourbeard rockling (*Enchelyopus cimbrius*)
- 36 • Fourspot flounder (*Paralichthys oblongus*)
- 37 • Haddock (*Melanogrammus aeglefinus*)
- 38 • Little skate (*Leurcoraja erinacea*)
- 39 • Monkfish (*Lophius americanus*)
- 40 • Ocean pout (*Macrozoarces americanus*)
- 41 • Offshore hake (*Merluccius albidus*)

- 1 • Pollock (*Pollachius virens*)
- 2 • Rainbow smelt (*Osmerus mordax*)
- 3 • Redfish (*Sebastes fasciatus*)
- 4 • Red hake (*Urophycis chuss*)
- 5 • Rock gunnel (*Pholis gunnellus*)
- 6 • Scup (*Stenotomus chrysops*)
- 7 • Silver hake / whiting (*Merluccius bilinearis*)
- 8 • Smooth skate (*Malacoraja senta*)
- 9 • Spiny dogfish (*Squalus acanthias*)
- 10 • Summer flounder (*Paralichthys dentatus*)
- 11 • Tautog (*Tautoga onitis*)
- 12 • Thorny skate (*Amblyraja radiata*)
- 13 • Tilefish (*Lopholatilus chamaeleonticeps*)
- 14 • White hake (*Urophycis tenuis*)
- 15 • Windowpane flounder (*Scophthalmus aquosus*)
- 16 • Winter flounder (*Pseudopleuronectes americanus*)
- 17 • Winter skate (*Leurcoraja ocellata*)
- 18 • Witch flounder (*Glyptocephalus cynoglossus*)
- 19 • Yellowtail flounder (*Pleuronectes ferruginea*)

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An EFH assessment is provided in Appendix E to meet the consultation requirements according to the Magnuson-Stevens Fishery Conservation and Management Act.

An important component of the analysis in this SEIS is a determination of stock status. The status of a stock relates to two primary factors: the rate of removal of fish from the population (also known as the exploitation rate) and the current stock size or biomass. The exploitation rate is the proportion of the stock that is caught and removed from the population. If that proportion exceeds a sustainability threshold determined by fishery scientists, then overfishing of that stock is occurring (NEFSC 2004). The current stock size is typically defined by either the spawning stock biomass (SSB) or the total stock biomass. If the stock's biomass falls below the biomass sustainability threshold for that species, then the stock is considered to be in an overfished condition (NEFSC 2004). If a stock is considered to be in an overfished condition (i.e., a biomass level that is less than a biomass threshold level), then the Magnuson-Stevens Fishery Conservation and Management Act, as amended by the Sustainable Fisheries Act of 1996 mandates the development of plans for rebuilding and sustaining the stock (NEFSC 2004).

1 **Pelagic Species**

2
3 **Alewife (*Alosa pseudoharengus*)**

4
5 The alewife is an anadromous species common in New England (Mullen et al. 1986, in ENSR
6 2000), and in the area of PNPS. The species is historically one of the most commercially
7 important fish species in Massachusetts (Belding 1921, in ENSR 2000). Spawning occurs in
8 freshwater rivers and streams in the area of PNPS from the middle of April to early June
9 (Belding 1921, in ENSR 2000). Spawning occurs at water temperatures between 16 to 19 °C
10 (Kocik 1998, in ENSR 2000). The eggs adhere to the river bottoms until they harden and then
11 become pelagic. The adults become sexually mature and begin migrating to rivers and streams
12 to spawn when they are 4 or 5 years old (Marcy 1969, in ENSR 2000). Alewives are important
13 forage fish in the ocean, as well as in freshwater during their migration and spawning activities
14 (ENSR 2000). The species is planktivorous, feeding mainly on diatoms, algae, and small
15 crustaceans (ENSR 2000). The alewife is common in Cape Cod Bay, and is one of the most
16 commonly impinged species at PNPS (ENSR 2000). Alewife larvae and juveniles have been
17 collected in the PNPS entrainment sampling. Juveniles and/or adults have been consistently
18 collected in the PNPS impingement sampling program. Over the last 25 years they have had
19 the third highest impingement rate at PNPS.

20
21 **Atlantic butterfish (*Peprilus triacanthus*)**

22
23 The Atlantic butterfish is a small bony pelagic fish that forms loose schools, living near the water
24 surface (Schrieber 1973; Dery 1988b; Brodziak 1995, in Cross et al. 1999). The butterfish has
25 been commercially fished since the late 1800s (Murawski and Waring 1979, in Cross et al.
26 1999). All life stages, including eggs, larvae, juveniles, and adults are pelagic (Cross et al.
27 1999). Adult butterfish become sexually mature at the age of one year (Overholtz 2000c).
28 Spawning season varies depending on location and water temperature. In the Gulf of Maine,
29 spawning begins in May to June, peaks in July, and ends in August (Bigelow and Schroeder
30 1953, in Cross et al. 1999). Spawning occurs offshore, at temperatures above 15°C (Colton
31 1972, in Cross et al. 1999). Adult butterfish prey on small fish, squid, and crustaceans, and in
32 turn are preyed upon by many species, including silver hake (*Merluccius bilinearis*),
33 bluefish (*Pomatomus saltatrix*), swordfish (*Loligo pealei*), and longfin squid (*Xiphias gladius*)
34 (ENSR 2000). The butterfish is short-lived, rarely living to more than three years of age
35 (ENSR 2000).

36
37 The butterfish is found throughout the eastern coast of the U.S. and Canada, from Florida to
38 Newfoundland. It is most commonly found from Cape Hatteras to the Gulf of Maine (Bigelow
39 and Schroeder 1953, in ENSR 2000). In summer, the butterfish can be found over the entire
40 continental shelf from sheltered bays and estuaries, over substrates of sand, rock, or mud, to a
41 depth of 200 meters (m) (656 ft) (Cross et al. 1999). The butterfish migrates annually in

1 response to seasonal changes in water temperature. During the summer, they migrate inshore
2 into southern New England and Gulf of Maine waters, and in winter they migrate to the edge of
3 the continental shelf in the Mid-Atlantic Bight (Cross et al. 1999).

4
5 The butterfish is managed as a single stock unit (Brodziak 1995, in Cross et al. 1999). The
6 species is managed under the Mid-Atlantic Fishery Management Council's (MAFMC) Atlantic
7 Mackerel, Squid, and Butterfish Plan (Overholtz 2000c). An assessment in 2004 determined
8 that overfishing was not occurring (NMFS 2004a). However, fishing mortality was near the
9 overfishing definition, with the discards estimated to amount to twice the amount of landings.
10 Because of this, the stock assessment report recommended that measures be implemented to
11 reduce mortality due to discards (NMFS 2004a). Eggs and larvae of the Atlantic butterfish have
12 been collected in the PNPS entrainment sampling. Juveniles and/or adults have also been
13 observed in the PNPS impingement sampling program.

14 15 **Atlantic herring (*Clupea harengus*)**

16
17 The Atlantic herring is a coastal pelagic, schooling species found on both sides of the Atlantic
18 Ocean (Stevenson and Scott 2005). Atlantic herring have been an important commercial
19 species in New England for 400 years (Anthony and Waring 1980, in ENSR 2000). In recent
20 years, large-scale fisheries for adult herring have developed in the western Gulf of Maine, on
21 Georges Bank, and on the Scotian Shelf (ENSR 2000).

22
23 The Atlantic herring lays eggs on the bottom, in gravel, rock, or shell substrates. The eggs
24 adhere to the bottom in layers and form beds (Bigelow and Schroeder 1953; Mansueti and
25 Hardy 1967, in ENSR 2000). As juveniles, Atlantic herring form large aggregations in coastal
26 areas. Herring in the Gulf of Maine reach sexual maturity at an age of about three years
27 (Stevenson and Scott 2005). Spawning occurs in high energy environments with strong tidal
28 action (Iles and Sinclair 1982, in Stevenson and Scott 2005). Spawning occurs in water below
29 15°C, at water depths between 20 and 80 m (66 to 262 ft) (NEFMC 1998, in ENSR 2000). In
30 the Gulf of Maine and Georges Bank, spawning occurs from July to December (Stevenson and
31 Scott 2005). Both the larvae and juveniles feed on zooplankton, including copepods
32 (ENSR 2000). The Atlantic herring of all life stages is preyed upon by other fishes, including
33 cod (*Gadus morhua*), pollock (*Pollachius virens*), haddock (*Melanogrammus aeglefinus*), silver
34 hake, mackerel (*Scomber scombrus*), dogfish (*Squalus acanthias*), and squid (Hildenbrand
35 1963; Bigelow and Schroeder 1953, in ENSR 2000), as well as marine mammals and birds.
36 Adult Atlantic herring feed on zooplankton, and capture prey by direct, predatory snapping
37 action (Blaxter and Holliday 1963, in ENSR 2000). Atlantic herring become sexually mature
38 between the ages of 3 and 4 years (Reid et al. 1999b).

39
40 In the western Atlantic, herring inhabit the continental shelf from Labrador to Cape Hatteras. In
41 the U.S., herring are managed as a single stock, and a separate stock located further north is

Plant and the Environment

1 managed by Canada (Stevenson and Scott 2005). There is an annual migration of adult
2 Atlantic herring from summer feeding areas along the Maine coast to southern New England
3 (Stevenson and Scott 2005). The adults live in water at depths of 20 to 130 m (66 to 427 ft),
4 and at temperatures less than 10°C (NEFMC 1998, in ENSR 2000). Trawl surveys in
5 Massachusetts identified large catches of adult herring in Cape Cod Bay in the fall (Stevenson
6 and Scott 2005).

7
8 Although the herring is managed as a single stock unit in the U.S., there may actually be
9 separate Georges Bank and Gulf of Maine stocks (Stevenson and Scott 2005). The fishery is
10 managed under an interstate fishery management plan (FMP) adopted by the Atlantic States
11 Marine Fisheries Commission (ASMFC) in coordination with the New England Fishery
12 Management Council (NEFMC) (Overholtz 2000a). Trawl survey data collected in 2003
13 determined that the herring biomass was stable and increasing over time (NEFMC 2004). While
14 the stock as a whole is considered to be under-utilized, the population within the Gulf of Maine
15 is heavily exploited and being over-harvested (Stevenson and Scott 2005), while the overall
16 stock is considered to be at sustainable levels at the time of 2006 ASMFC report (i.e., the SSB
17 and/or total stock biomass are considered to be at levels greater than sustainable biomass
18 thresholds, while the exploitation or fishing pressure is less than the threshold of sustainable
19 fishing pressure) (ASMFC 2006). Atlantic herring eggs, larvae, and juveniles have been
20 collected in the PNPS entrainment sampling. Juveniles and/or adults have been consistently
21 collected in the PNPS impingement sampling program. Over the last 25 years they have been
22 one of the numerically dominant impinged species.

23 **Atlantic mackerel (*Scomber scombrus*)**

24
25
26 The Atlantic mackerel is a pelagic, schooling species found in the northwest Atlantic between
27 Labrador and North Carolina (Overholtz 2000b). Both the eggs and larvae of the species are
28 pelagic, and transition from drifting to free swimming when they reach a size of 30 to 50
29 millimeters (mm) (1 to 2 in.) (Sette 1943, in Studholme et al. 1999). The Atlantic mackerel
30 becomes sexually mature by the age of three years (O'Brien et al. 1993, in Studholme et al.
31 1999). Spawning occurs at two distinct times of the year; a southern population spawns in April
32 and May, and a northern population spawns in June and July (ENSR 2000). Spawning takes
33 place in the upper portion of the water column, in shoreward areas, at temperatures above 10°C
34 (ENSR 2000). Cape Cod Bay is reported to be an important spawning area in the months from
35 May to August (Studholme et al. 1999). The adult mackerel can feed both by filter feeding, and
36 by preying on individuals. The prey consists of plankton such as amphipods, euphausiids,
37 shrimp, crab larvae, small squid, and fish eggs (Scott and Scott 1988, in ENSR 2000).

38
39 Mackerel are found in both cold and temperate continental shelf areas, and form large schools
40 near the surface (Collette and Nauen 1983, in ENSR 2000). The mackerel perform annual
41 migrations, with movement generally northeast and inshore in the spring, and offshore to deeper

1 water in the winter (ENSR 2000). Migration is closely related to seasonal temperature changes,
2 as the mackerel prefers to live in waters with temperatures of 6 to 15°C (Overholtz and
3 Anderson 1976, in Studholme et al. 1999). Both juveniles and adults have been caught in trawl
4 surveys in Cape Cod Bay. Juveniles were primarily found in the fall, while adults were identified
5 in the spring (Studholme et al. 1999).

6
7 There are two separate spawning populations in the northwest Atlantic, but all mackerel are
8 considered to be a single stock and are managed as a single stock (Sette 1943; Anderson
9 1982; MAFMC 1994, in Studholme et al. 1999). The mackerel stock reached low biomass
10 levels in the 1970s due to heavy exploitation by distant water fleets (NMFS 2006a). Since 1983,
11 the species has been managed under the MAFMC Atlantic Mackerel, Squid, and Butterfish Plan
12 (Overholtz 2000b), and biomass levels had improved as of the mid 1990s (Anderson 1995, in
13 Studholme et al. 1999). The current ASMFC report states the stock is considered to be at
14 sustainable levels (i.e., the SSB and/or total stock biomass are considered to be at levels
15 greater than sustainable biomass thresholds, while the exploitation or fishing pressure is less
16 than the threshold of sustainable fishing pressure) (NMFS 2006a). Eggs and larvae of the
17 Atlantic mackerel have been consistently collected in the PNPS entrainment sampling and are
18 one of the numerically dominant species in the entrainment collections. Juveniles and/or adults
19 have also been observed in the PNPS impingement sampling program.

20 21 **Atlantic menhaden (*Brevoortia tyrannus*)**

22
23 The Atlantic menhaden is a migratory fish species found in coastal and estuarine waters from
24 Nova Scotia to Florida. Menhaden is a schooling fish species and serves as an important
25 forage fish to larger predators (Rogers and Avyle 1989). The menhaden is one of the most
26 commercially important fish species along the Atlantic Coast, and is used for fish meal, fish oil,
27 and bait for other species (VIMS 2006). The species becomes sexually mature at the age of
28 three years, and spawns in March to May and September to October (VIMS 2006). The larvae
29 live in brackish or freshwater areas, and when they become juveniles, they migrate south in
30 schools (VIMS 2006). The status of the population is healthy, with stable stock size and high
31 biomass (VIMS 2006). The current ASMFC report indicates the Atlantic menhaden population
32 is considered to not be in an overfished condition, and overfishing is not occurring (ASMFC
33 2006).

34
35 Atlantic menhaden eggs, larvae, and juveniles have been consistently collected in the PNPS
36 entrainment sampling and are one of the numerically dominant species in the entrainment
37 collections. Juveniles and/or adults have also been consistently collected in the PNPS
38 impingement sampling program. Over the last 25 years they have had the second highest
39 impingement rate.

1 **Atlantic silverside (*Menidia menidia*)**

2
3 The Atlantic silverside is found through the western Atlantic Ocean, and generally associates in
4 large schools. The habitat includes shallow water with sand or gravel substrate. The species
5 typically preys on small crustaceans, including copepods, shrimp, amphipods, and cladocerans
6 (ENSR 2000). Silversides are an important forage fish in the diet of several other fish species,
7 including bluefish, striped bass, cunner, and Atlantic cod (Bayliff 1950, in ENSR 2000).
8 Spawning occurs in the late spring and early summer, mostly in shallow water where eggs and
9 milt are deposited in strands that cling to vegetation (ENSR 2000). The silverside only live for
10 about one year (ENSR 2000). The Atlantic silverside is the most commonly impinged fish at
11 PNPS, and had the highest catch rate in Massachusetts Division of Marine Fisheries (MDMF)
12 beach haul seines conducted in western Cape Cod Bay (ENSR 2000, Kelly et al. 1992).

13
14 Atlantic silverside eggs, larvae, and juveniles have been collected in the PNPS entrainment
15 sampling. Juveniles and/or adults have also been consistently collected in the PNPS
16 impingement sampling program. Over the last 25 years they have had the highest impingement
17 rate.

18
19 **Black Sea Bass (*Centropristis striata*)**

20
21 The black sea bass is a temperate species found in structured habitats of the continental shelf,
22 such as reefs and shipwrecks (Steimle et al. 1999d). Eggs and larvae of the black sea bass are
23 pelagic, and are found in spawning areas on the continental shelf (Steimle et al. 1999d). As
24 juveniles, the species moves inshore, where they form nurseries in estuaries
25 (Able and Fahay 1998, in Steimle et al. 1999d). Juveniles mature as females, and then change
26 to males as they grow larger (Lavenda 1949, in Steimle et al. 1999d). Juveniles begin to mature
27 at one year of age, with most of the adults of this age being females (Mercer 1978, in Steimle et
28 al. 1999d). Spawning occurs on the inner continental shelf, in water depths of 20 to 50 m (66 to
29 164 ft), between the Chesapeake Bay and Long Island (Steimle et al. 1999d). Larvae have
30 been reported in Cape Cod Bay, but these are interpreted to have been spawned in Buzzards
31 Bay and moved through the Cape Cod Canal (MAFMC 1996b, in Steimle et al. 1999d).
32 Spawning in Massachusetts coastal waters occurs on sandy bottoms broken by rocky ledges
33 (Kolek 1990; MAFMC 1996b, in Steimle et al. 1999d). Larval black sea bass probably prey on
34 zooplankton (Steimle et al. 1999d). The juveniles are visual predators that feed on benthic
35 crustaceans and small fish (Richards 1963; Allen et al. 1978; Werme 1981, in Steimle et al.
36 1999d).

37
38 The black sea bass in the western Atlantic occurs from southern Nova Scotia and Bay of Fundy
39 south to Florida, and into the Gulf of Mexico (Steimle et al. 1999d). The population in the U.S. is
40 managed as three separate stocks, including the Gulf of Mexico, the southern stock (south of
41 Cape Hatteras), and the northern stock (north of Cape Hatteras) (Steimle et al. 1999d). The

1 species is primarily a warm water fish, and begins to migrate offshore to depths of 30 to 240 m
2 (98 to 787 ft) as bottom water temperatures reach 7°C (Steimle et al. 1999d). The species lives
3 in benthic areas where structures such as reefs provide shelter (Steimle et al. 1999d). Trawl
4 surveys in Massachusetts in the spring found abundant juvenile populations south and west of
5 Cape Cod, with a few juveniles collected in Cape Cod Bay (Steimle et al. 1999b).

6
7 The fishery for the black sea bass is managed under the MAFMC Summer Flounder, Scup, and
8 Black Sea Bass FMP (Shepherd 2000a). As of 1997, the black sea bass population was
9 considered to be over-exploited (NMFS 1997, in Steimle et al. 1999d). However, the 2004
10 Stock Assessment Summary (NMFS 2004b) concluded that the species is not overfished, and
11 that overfishing was not occurring. This was attributed to the fact that commercial landings
12 were limited by quotas, while recreational landings were similar to long-term averages
13 (NMFS 2004b). In 2006, the National Marine Fisheries Service (NMFS) determined that the
14 overfishing status could not be determined (NMFS 2006b). The 2006 ASMFC report, indicates
15 the black sea bass population is considered to be overfished, while the overfishing status is not
16 known (ASMFC 2006). Black sea bass larvae have been collected in the PNPS entrainment
17 sampling. Juveniles and/or adults have also been observed in the PNPS impingement sampling
18 program.

19 **Bluefin tuna (*Thunnus thynnus*)**

20
21
22 The bluefin tuna is found in two separate populations in the eastern and western Atlantic Ocean
23 (Buck 1995). The species is among the largest bony fish in the Atlantic Ocean, and can reach
24 sizes of up to 1200 pounds (ENSR 2000). Bluefin tuna in the western Atlantic become sexually
25 mature at the age of about eight years (NMFS 2005c). The prey of the bluefin tuna includes
26 mackerel, herring, whiting (*Merluccius bilinearis*), and squid (Buck 1995).

27
28 The range of the bluefin tuna in the western Atlantic Ocean is from Newfoundland to Brazil
29 (Buck 1995). The western Atlantic population is managed as a single stock unit (Buck 1995).
30 Bluefin tuna primarily live in the upper 100 to 200 m (328 to 656 ft) of the water column in the
31 open ocean (NMFS 1999). The bluefin tuna migrates extensively. Following spawning in the
32 Gulf of Mexico area in spring and early summer, the species migrates north along the U.S.
33 coast to waters off of Canada (Buck 1995).

34
35 The latest stock assessment for the bluefin tuna was conducted in 2001. This assessment
36 determined that the SSB had declined about 80 percent between 1970 and the late 1980s, and
37 had then leveled off (NMFS 2005c). In 2001, the stock of the bluefin tuna in was determined to
38 be overfished, and overfishing was continuing (NMFS 2001d). No life stages of the bluefin tuna
39 have ever been observed in the PNPS entrainment or impingement sampling.

1 **Bluefish (*Pomatomus saltatrix*)**

2
3 Bluefish is a migratory, pelagic species found in temperate coastal zones throughout the world
4 (Shepherd 2000b). Bluefish are very common along the east coast of the U.S., and are very
5 popular among recreational fishermen, with recreational landings regularly exceeding
6 commercial catches (NMFS 2005b). Bluefish reach sexual maturity at the age of 2 years (Deuel
7 1964, in Shepherd and Packer 2006, ENSR 2000). Spawning occurs in the area from New York
8 south to Florida (Shepherd and Packer 2006). Spawning was previously thought to occur at two
9 distinct times of year, with one population spawning in the spring and one in the summer (ENSR
10 2000). However, recent studies suggest that there is a single spawning season from spring to
11 summer, but that there is high mortality among the young in the middle of the event, making it
12 appear as two separate events in population studies
13 (Shepherd and Packer 2006). Bluefish eggs and larvae are buoyant and live within surface
14 waters, only within open oceanic waters (Able and Fahay 1998, in Shepherd and Packer 2006).
15 The larvae feed on surface plankton until they reach juvenile stage, and then migrate to coastal
16 nursery areas to feed on other fish species (Kendall and Watford 1979, in ENSR 2000;
17 Shepherd and Packer 2006). Adult bluefish are voracious predators, and prey on squid, shrimp,
18 crabs, alewives, menhaden, silver hake, butterfish and smaller bluefish (ENSR 2000).

19
20 Within the western Atlantic, bluefish are found from Maine to Florida, migrating northward in the
21 spring and southward in the fall (ENSR 2000). Adults live in a variety of locations, including the
22 open ocean, bays, and estuaries. In Massachusetts coastal areas, adults are found in water
23 depths of between 6 and 25 m (20 to 82 ft), and temperatures from 10 to 20 °C (Shepherd and
24 Packer 2006). Bluefish migrate in response to temperature changes in order to remain in water
25 with temperatures above 14 to 16 °C (Bigelow and Schroeder 1953, in Shepherd and Packer
26 2006). They live in southern New England waters in spring and summer, and migrate to waters
27 off of the southeastern U.S. in autumn (Shepherd and Packer 2006).

28
29 Bluefish are managed as a single stock unit (Fahay et al. 1999b; Shepherd and Packer 2006).
30 The population of bluefish has varied widely through time, but appears to have declined
31 significantly since the early 1980s (Fahay et al. 1999b). The Bluefish FMP was implemented in
32 2000 by the MAFMC and the ASMFC (Shepherd 2000b; NMFS 2005b). However, at the time of
33 the 2006 stock assessment, the stock is considered to be at sustainable levels (i.e., the SSB
34 and/or total stock biomass are considered to be at levels greater than sustainable biomass
35 thresholds, while the exploitation or fishing pressure is less than the threshold of sustainable
36 fishing pressure) (NMFS 2005b; ASMFC 2006). Bluefish juveniles and adults are reported to
37 have been observed in the vicinity of PNPS (ENSR 2000). No life stages of the bluefish have
38 ever been observed in the PNPS entrainment sampling. Juveniles and/or adults have been
39 observed in the PNPS impingement sampling program.

Pollock (*Pollachius virens*)

The pollock is a benthopelagic fish found on both sides of the Atlantic Ocean (Mayo 2004). Pollock live throughout the water column (McGlade 1984, in ENSR 2000). Pollock are commercially important, but were primarily taken only as bycatch until the 1980s, at which time commercial fishing of the species began (Mayo 1998b, in ENSR 2000). Pollock eggs and larvae are pelagic until the larvae reach an age of about 3 to 4 months. At that time, the small juveniles migrate inshore and inhabit rocky subtidal and intertidal zones. At the end of their second year, the juveniles move offshore, where they remain through their adult life (Cargnelli et al. 1999e). Adults reach sexual maturity between the ages of 3 and 6 years (Mayo 1998b, in ENSR 2000), but the age and size at maturity has been decreasing, possibly due to size-selective overfishing (Cargnelli et al. 1999e).

The western Gulf of Maine, including Massachusetts Bay, is one of the principle spawning sites for pollock (Cargnelli, et al. 1999e). Spawning in the Gulf of Maine occurs from November to February (Steele 1963; Colton and Marak 1969, in Cargnelli 1999e), at water temperatures from 4.5 to 6°C (Cargnelli 1999e). Eggs are spawned on hard substrates in water depths between 10 and 365 m (33 to 1198 ft) (NEFMC 1998a, in ENSR 2000). Larvae living in near-surface waters feed on larval copepods, while juvenile pollock feed on crustaceans and fish, including young Atlantic herring (Steele 1963; Cargnelli et al. 1999e; Ojeda and Dearborn 1991). The primary food course for adults is krill and Atlantic herring (Cargnelli et al. 1999e).

The most common locations for Pollock in the northwest Atlantic include the Scotian Shelf and the Gulf of Maine (Mayo 2004). Pollock migrate between these locations considerably, resulting in the three areas being managed as a single stock unit (Cargnelli et al 1999e). Adults live in a wide range of temperatures and depths, but are most frequently found in water depths between 100 to 125 m (328 to 410 ft), and temperatures of 0 to 14°C (Hardy 1978). There is no obvious preference for bottom type (Scott 1982a in Cargnelli et al. 1999e). Pollock is a schooling species, but does not have substantial migration, except for small movements related to temperature change (Hardy 1978).

The U.S. portion of the pollock fishery is managed under the NEFMC Northeast Multispecies FMP (Mayo 2004). Commercial landings and stock size of pollock in the Gulf of Maine and Georges Bank decreased substantially through the late 1980s, and reached historic lows in 1996 (Cargnelli et al 1999e). However, an assessment conducted in 2004 concluded that the stock is considered to be at sustainable levels (i.e., the SSB and/or total stock biomass are considered to be at levels greater than sustainable biomass thresholds, while the exploitation or fishing pressure is less than the threshold of sustainable fishing pressure) (Mayo et al 2005b). Eggs and larvae of the pollock have been collected in the PNPS entrainment sampling. Juveniles and/or adults have also been observed in the PNPS impingement sampling program.

1 **Rainbow smelt (*Osmerus mordax*)**

2
3 The rainbow smelt is an anadromous fish, rarely found more than 1 mi from shore or deeper
4 than 6 m (20 ft). Smelt are cold water fish (ENSR 2000). Information on the smelt's
5 temperature preference is limited, but available data indicates they prefer water temperatures
6 cooler than 59°F (15°C) in the freshwater habitat of Lake Michigan (ENSR 2000). In addition to
7 marine populations found from Labrador to Virginia, there are landlocked populations in New
8 England lakes, the Maritime Provinces, and the Great Lakes. The center of abundance for
9 marine populations is the southern Maritime Provinces of Canada and Maine, and the southern
10 limit of large populations is Massachusetts (Lee et al. 1980; Clayton et al. 1978 in ENSR 2000).
11 The rainbow smelt is a schooling fish and serves a vital role in the ecological food web as a
12 forage fish preyed upon by both marine and freshwater predators (Buckley 1989 in ENSR
13 2000). Although adult smelt are found in deeper waters outside of estuaries during the summer,
14 the species gathers in harbors and brackish estuaries in the fall.

15
16 The principal spawning ground of smelt in the Plymouth area is the Jones River population
17 (Lawton et al. 1990). Jones River, located approximately several miles north of PNPS, has its
18 headwaters in Pembroke, Kingston, and Plympton before it empties into Plymouth Harbor
19 (Lawton et al. 1990 in ENSR 2000). Spawning of the demersal, adhesive eggs begins when
20 water temperatures increase to around 40°F (4.4°C), usually in March. Peak egg production
21 occurs at water temperatures of 50 to 57°F (10 to 13.9°C), and spawning is completed by May
22 (Buckley 1989 in ENSR 2000). Lawton et al. (1990, in ENSR 2000) also observed in the Jones
23 River population that spawning was concluded in early May and that the smelt emigrated from
24 the spawning ground when water temperature reached 16°C. A qualitative comparison of data
25 collected in 2004 by the MDMF indicated that the smelt population data when compared to data
26 from previous seasons had a relatively poor run in the four rivers sampled, including the Jones
27 River (Chase 2006a). Sexual maturity typically occurs during the second winter
28 (McKenzie 1964 in ENSR 2000). In the Jones River population, 2-year-old fish made up
29 approximately 88 percent of the spawning run (Lawton et al. 1990 in ENSR 2000).

30
31 Sea-run smelt populations have been declining throughout the western North Atlantic during the
32 1990s (Lawton and Boardman 1999). In the late 1980s and early 1990s a decline of rainbow
33 smelt was observed in the spawning runs of the Jones River. The depressed spawning
34 numbers made the rainbow smelt a species of special concern to MDMF (Lawton et al. 1990).
35 In 2004, the NMFS designated the rainbow smelt as a species of concern due to habitat
36 degradation, structural impediments to spawning habitat, and recreational and commercial
37 fishing pressures (NOAA Fisheries 2004). NOAA Fisheries (2004) reports that there has been a
38 region-wide decline in smelt populations over the last two decades. According to the MDMF,
39 populations are still at depressed levels (Chase 2006b). Eggs and larvae of the rainbow smelt
40 have been collected in the PNPS entrainment sampling. Juveniles and/or adults have been
41 consistently collected in the PNPS impingement sampling program. Over the last 25 years they

1 have had the fourth highest impingement rate.

3 **Redfish (*Sebastes* spp.)**

4
5 Redfish is a common name used to describe several species of fish such as the Acadian redfish
6 (*Sebastes fasciatus*) and the golden redfish (*S. norvegicus*). Redfish have been commercially
7 fished in the U.S. since the 1930s (Pikanowski et al 1999). The two species are difficult to
8 distinguish, and are managed as a single fishery (Templeman 1959; Mayo 1980, in Pikanowski
9 et al. 1999). Eggs are fertilized internally, and the females give birth to larvae (Pikanowski et al.
10 1999). The new larvae live in the upper 10 m (33 ft) of the water column, and then live within
11 the thermocline [10 to 30 m (33 to 98 ft)] when they become larger
12 (Kelly and Barker 1961a, in Pikanowski et al. 1999). Juveniles are also pelagic until the fall of
13 their first year, at which time they migrate to the bottom (Kelly and Barker 1961b, in Pikanowski
14 et al 1999). Adults become sexually mature at an age of about 5 to 6 years (Mayo 2000). The
15 demersal adults typically live within 3 to 7 m (10 to 23 ft) from the bottom (Atkinson 1989, in
16 Pikanowski et al 1999). Very little is known about redfish spawning. Fertilization probably
17 occurs in February to April (Ni and Templeman 1985, in Pikanowski et al 1999), and larvae are
18 released throughout the range where the adults are found, in spring and summer
19 (Steele 1957; Kelly and Wolf 1959; Kelly et al 1972; Kenchington 1984, in Pikanowski et al
20 1999). The larvae feed on copepods, euphausiids, and fish and invertebrate eggs
21 (Marak 1973, in Pikanowski et al 1999). Juvenile and adult redfish prey on euphausiids,
22 mysids, and bathypelagic fish (Pikanowski et al 1999).

23
24 Acadian redfish range from New Jersey to Iceland in the western Atlantic (Pikanowski et al.
25 1999). Acadian redfish can be found within shallow waters in the Gulf of Maine, but redfish are
26 most common at depths of 128 to 366 m (420 to 1200 ft), and have been found as deep as 592
27 m (1950 ft) (Kelly and Barker 1961a, in Pikanowski et al. 1999). The redfish does not migrate
28 latitudinally (Murawski 1973, in Pikanowski et al. 1999). The preferred temperature range is
29 from 3 to 7°C (Kelly et al. 1972, in Pikanowski et al. 1999). Redfish are found in areas of silt,
30 mud, or sandy bottom substrates (Pikanowski et al. 1999). Larvae were identified in the Gulf of
31 Maine from April to September, while juveniles and adults were found in the Gulf of Maine in all
32 seasons (Pikanowski et al. 1999). Substantial numbers were reported to have been observed in
33 Massachusetts Bay (NMFS 2001b).

34
35 The U.S. fishery for redfish is managed under the NEFMC Northeast Multispecies FMP
36 (Mayo 2000). Redfish were not classified as overfished, or approaching an overfished
37 condition, in 1997 (NMFS 1997, in Pikanowski 1999). In 2001, a stock assessment concluded
38 that the stock was overfished at that time, but that overfishing was not occurring (NMFS 2001b).
39 The most recent assessment, in 2004, concluded that the stock is considered to be at
40 sustainable levels (i.e., the SSB and/or total stock biomass are considered to be at levels
41 greater than sustainable biomass thresholds, while the exploitation or fishing pressure is less

1 than the threshold of sustainable fishing pressure) (Mayo et al. 2005c). Larvae of one of the
2 redfish species (*Sebastes norvegicus*) have been collected in the PNPS entrainment sampling.
3 No life stages have been observed in the PNPS impingement sampling program.
4

5 **Spiny dogfish (*Squalus acanthias*)**

6

7 The spiny dogfish is the most abundant shark in the western North Atlantic (McMillan and Morse
8 1999). The spiny dogfish bears live young in litters numbering from 2 to 15 pups (NOAA 1998,
9 in ENSR 2000). The adult spiny dogfish is a voracious and opportunistic predator, and is
10 reported to prey on a variety of fish, mollusks, and crustaceans. The species travels in large
11 packs, and attacks schools of fish, including cod, haddock, capelin (*Osmerus villosus*),
12 mackerel, herring, and sand lance (*Ammodytes americanus*) (McMillan and Morse 1999). Spiny
13 dogfish are known to live up to 35 to 40 years of age (Nammack et al. 1985, in McMillan and
14 Morse 1999).
15

16 The range of spiny dogfish in the western North Atlantic is from Labrador to Florida. In the
17 spring and autumn, the species is common in coastal waters, including estuaries and closed
18 bays, between North Carolina and southern New England (Rago et al. 1994, in McMillan and
19 Morse 1999). Spiny dogfish migrate annually, in schools, from winter habitat on the edge of the
20 continental shelf to summer grounds in the Gulf of Maine and Georges Bank. Trawl surveys
21 conducted in Massachusetts identified an abundance of adult spiny dogfish within Cape Cod
22 Bay in the spring. Both juveniles and adults were abundant within Cape Cod Bay in the fall
23 (McMillan and Morse 1999).
24

25 The spiny dogfish is the target of a commercial fishery within U.S. waters, with a large increase
26 in activity beginning in 1996 (McMillan and Morse 1999). The population in U.S. waters is
27 managed as a single unit (McMillan and Morse 1999) and is managed under a FMP developed
28 by MAFMC and NEFMC (Sosebee 2000b). The stock was classified as overfished in 1998, due
29 to an increase in commercial landings by a factor of six from 1991 to 1998
30 (MAFMC 1998, in McMillan and Morse 1999). It was also classified as overfished in 2003,
31 although overfishing was not occurring (NMFS 2003). The stock assessment summary for 2006
32 concluded that the species is not overfished, and that overfishing is not occurring
33 (NMFS 2006b). However, most recently, the 2006 ASMFC Stock Status Overview
34 (ASMFC 2006) indicated that the stock is overfished, although overfishing is not occurring.
35 Juveniles and/or adult spiny dogfish have been observed in the PNPS impingement sampling
36 program. They have not been detected in the PNPS entrainment sampling program.
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41

1 Demersal Species

3 American plaice (*Hippoglossoides platessoides*)

5 The American plaice is a benthic, right-eyed flounder that exists in deeper waters of the
6 continental shelf on both sides of the North Atlantic (Cooper and Chapleau 1998, in ENSR
7 2000). The American plaice is the most abundant flatfish species in the western North Atlantic,
8 and became important as a commercial species in the Gulf of Maine after 1975
9 (Johnson 2004). Both the eggs and larvae of the American plaice are pelagic, and are found in
10 shallow surface waters, including in southern New England and Cape Cod Bay (ENSR 2000).
11 Adults are primarily benthic, but are known to migrate off of the bottom at night to prey on
12 non-benthic species (DFO 1989, in Johnson 2004). The American plaice reaches sexual
13 maturity at an age from 2 to 4 years (O'Brien 2000, in Johnson 2004). Spawning occurs
14 between the months of March and May, in water temperatures between 3 to 6 °C
15 (Johnson 2004). The Gulf of Maine and Georges Bank are considered to be areas of maximum
16 spawning for the species (Johnson 2004). Larvae prey on plankton, diatoms, and copepods
17 found in surface water layers. As larvae turn into juveniles, they feed on small crustaceans,
18 polychaetes, and cumaceans (Bigelow and Schroeder 1953, in Johnson 2004). Benthic
19 crustaceans, mollusks, and small forage fish species make up the diet of the adults.

21 The range of the American plaice in the western North Atlantic includes the area from southern
22 Labrador to Rhode Island. The species inhabits mostly deep waters, in depths ranging from 90
23 to 250 m (295 to 820 ft) (O'Brien 1998, in ENSR 2000), and they do not normally occur in water
24 shallower than 25 to 35 m (82 to 115 ft) (O'Brien 2000, in Johnson 2004). Both juveniles and
25 adults live and spawn on a variety of substrates, including fine sand, sand, and gravel, in water
26 temperatures below 17° C (NEFMC 1998a, in ENSR 2000). The American plaice does not
27 migrate substantially. Results from tagging studies have found that most recaptured individuals
28 were found within 30 mi from the tagging site, even as long as 7 years later (DFO 1989, in
29 Johnson 2004).

31 The American plaice is managed as a single stock unit (Johnson et al. 1999b). The American
32 plaice fishery is managed under the NEFMC Northeast Multispecies FMP (O'Brien 2000).
33 American plaice populations in the western Atlantic have declined dramatically since the early
34 1980s (Johnson 2004). The reasons for this are unknown, but may be attributed to temperature
35 changes (Morgan 1992, in Johnson 2004), pollution
36 (Nagler and Cyr 1997, in Johnson 2004), or overfishing (Nagler et al. 1999, in Johnson 2004).
37 Northeast stock assessment reports through 2001 determined that the species is overfished,
38 and that overfishing is occurring in the Gulf of Maine – Georges Bank stock
39 (O'Brien et al. 2002, in Johnson 2004; NMFS 2001a). However, an updated assessment in
40 2005 concluded that the species was overfished, but overfishing was no longer occurring
41 (O'Brien et al. 2005). In 2005, an analysis of juvenile populations resulted in a proposal for the

1 potential designation of Habitat Area of Particular Concern (HAPC) for the American plaice,
2 including areas within Cape Cod Bay, adjacent to PNPS (Crawford et al. 2005). Eggs and
3 larvae of the American plaice have been collected in the PNPS entrainment sampling.
4 Juveniles and/or adults have also been observed in the PNPS impingement sampling program.

5
6 **Atlantic cod (*Gadus morhua*)**
7

8 The Atlantic cod is a demersal fish found on both sides of the Atlantic Ocean
9 (Mayo and O'Brien 2000, in Fahay et al. 1999a). As the cod become juveniles and adults, they
10 are able to withstand deeper, colder, and more saline water, and become more widely
11 distributed (Fahay et al. 1999a). Some studies have shown that juveniles tend to prefer shallow
12 areas with cobble substrates, in order to avoid predation (Gotceitas and Brown 1993, in Fahay
13 et al. 1999a). The average age and size of cod at maturity has changed through time, with
14 adults reaching maturity at smaller size and younger age. In 1959, median age at maturity was
15 reported to be 5.4 years (males) and 6.2 years (females), and by 1994 the ages were reported
16 to be between 1.7 years (males) and 2.3 years (females) (Lough 2004). This trend is attributed
17 to harvesting of the adult cod (Fahay et al. 1999a). Peak spawning within Massachusetts Bay
18 occurs in January and February (Lough 2004). Juveniles and younger adults tend to consume
19 pelagic and benthic invertebrates, while adult cod also feed on both crustaceans and other fish,
20 including sand lance, cancer crabs (*Cancer* spp.), and herring (Lough 2004). Eggs and larvae
21 are subject to being preyed upon by planktivorous fish, including Atlantic herring and Atlantic
22 mackerel, and juveniles can be preyed upon by piscivorous fish such as dogfish, silver hake,
23 sculpin, and larger cod (Edwards and Bowman 1979, in Fahay et al. 1999a).

24
25 The Atlantic cod is distributed throughout the western North Atlantic Ocean from Greenland to
26 Cape Hatteras, with the highest densities in the U.S. being highest on Georges Bank and the
27 western Gulf of Maine (Lough 2004). There are two separate stocks of cod within U.S. waters:
28 a stock within the Gulf of Maine and a second stock at Georges Bank and southward
29 (Mayo and O'Brien 2000). Within the temperate part of their range, including offshore New
30 England, cod are non-migratory, and only make minor seasonal movements in response to
31 temperature changes. At the extremes of their range, including Labrador and south of the
32 Chesapeake, the cod migrate annually (Fahay et al. 1999a). Cod are generally found in rough
33 bottom waters at depths of between 10 and 150 m (33 to 492 ft), and at temperatures between
34 0 and 10°C (ENSR 2000). All stages of cod are reported to be common in Cape Cod Bay
35 (Fahay et al. 1999a). Adult cod are reported to be abundant in the western portion of Cape Cod
36 Bay in the spring (Fahay et al. 1999a), and occur in large numbers throughout Cape Cod Bay in
37 the fall (Lough 2004).

38
39 Commercial and recreational fisheries for cod in the U.S. are managed under the NEFMC
40 Northeast Multispecies FMP (Mayo and O'Brien 2000). The status of the Gulf of Maine stock
41 indicates that the cod is possibly in an overfished condition. Annual landings have declined

1 since 1991, and the stock is considered depressed and overexploited (Fahay et al. 1999a). In
2 2001, NMFS reported that the Gulf of Maine stock was not overfished, but that overfishing was
3 occurring, and recommended further management actions to enhance spawning potential and
4 the rate of recovery of the stock (NMFS 2001b, in Fahay et al. 1999a). Additional assessments
5 were conducted in 2002 and 2005, and concluded that the stock was in an overfished condition,
6 and that overfishing was still occurring (Mayo and Col 2005a). In 2005, an analysis of juvenile
7 populations resulted in a proposal for the potential designation of HAPCs for the Atlantic cod,
8 including areas within Cape Cod Bay, adjacent to PNPS (Crawford et al. 2005). Eggs and
9 larvae of the Atlantic cod have been collected in the PNPS entrainment sampling. Juveniles
10 and/or adults have also been observed in the PNPS impingement sampling program.

11 12 **Atlantic halibut (*Hippoglossus hippoglossus*)**

13
14 The Atlantic halibut, the largest flatfish species, is found on both sides of the North Atlantic
15 Ocean, as well as in the Arctic Ocean (Cargnelli et al. 1999c). The halibut supported a U.S.
16 commercial fishery beginning in the early 1800s, but the fishery had collapsed by the 1940s
17 (Cargnelli et al. 1999c). The eggs of the halibut are bathypelagic, suspended within the water
18 column at a depth of 54 to 200 m (175 to 656 ft) (Scott and Scott 1988; Blaxter et al. 1983, in
19 Cargnelli et al. 1999c). Larvae are pelagic and live within this zone until they reach juvenile
20 stage, at which time they transform into flatfish and migrate to the bottom (BMLSS 1997/8, in
21 ENSR 2000). The age of maturity for halibut is approximately 10 years (Cargnelli et al. 1999c).

22
23 The Atlantic halibut in the Gulf of Maine and Georges Bank spawns over rough or rocky bottom
24 substrates on the slopes of the continental shelf, or on offshore banks, at depths greater than
25 183 m (600 ft) (Scott and Scott 1988, in Cargnelli et al. 1999c). Spawning is reported to occur
26 in late fall or spring, with peak spawning between November and December (NEFMC 1998a, in
27 ENSR 2000). However, spawning is thought to no longer occur in the Gulf of Maine
28 (Cargnelli et al. 1999c). The diet of the Atlantic halibut changes through its lifespan. Juveniles
29 and smaller adults prey mostly on invertebrates, including annelids and crustaceans. As they
30 grow larger, the adults prey primarily on other fish (Kohler 1967, in Cargnelli et al. 1999c). In
31 the Gulf of Maine, the primary prey is squid, crabs, silver hake, northern sand lance, ocean pout
32 (*Macrozoarces americanus*), and alewife (Cargnelli et al. 1999c).

33
34 The range of the western North Atlantic halibut is from Labrador to Long Island
35 (Cargnelli et al. 1999c). In U.S. waters, their abundance is greatest in the Georges Bank,
36 Nantucket Shoals, Stellwagen Bank, and off the coast of Maine and Massachusetts
37 (Cargnelli et al. 1999c). However, only 18 halibut, all juveniles, were captured in trawl surveys
38 in Massachusetts between 1978 and 1997 (Cargnelli et al. 1999c). Juveniles live within their
39 nursery areas until the age of 3 to 4 years, and after that time perform annual migrations
40 (Stobo et al. 1988, in Cargnelli et al. 1999c). The species lives at depths of 100 to 700 m
41 (328 to 2297 ft), with most commercial catches made at 200 to 300 m (656 to 984 ft)

1 (Scott and Scott 1988, in Cargnelli et al. 1999c). The species is found in areas with substrates
2 of sand, gravel and clay (NEFMC 1998a, in ENSR 2000), and at temperatures from -0.5 to
3 13.6°C (Mahon 1997, in Cargnelli et al. 1999c).

4
5 The Atlantic halibut population was considered to be in an overfished condition in the late 1990s
6 (NMFS 1997, in Cargnelli et al. 1999c). It was designated as a species of concern in 2004, and
7 no directed fishing mortality is permitted until the stock is rebuilt (Cargnelli et al. 1999c). In a
8 2004 stock assessment, it was determined that the stock was overfished, but that there were
9 not enough data upon which to determine whether overfishing was occurring
10 (Brodziak and Col 2005). No life stages of the Atlantic halibut have ever been observed in the
11 PNPS entrainment or impingement sampling.

12 13 **Atlantic sand lance (*Ammodytes americanus*)**

14
15 The Atlantic sand lance is found in the western North Atlantic from Cape Hatteras north to
16 Labrador, Hudson Bay, and western Greenland (Fisheries and Oceans Canada 2006). The
17 species is small (rarely over 6 in. long), and forms schools consisting of thousands of
18 individuals. The species is not directly fished for commercial purposes, but it is an important
19 bait fish in fisheries such as those in the Stellwagen Bank area. Spawning occurs in the winter,
20 with females releasing over 20,000 eggs that settle and attach to the sandy substrate. Larval
21 sand lance are pelagic and drift with tides and currents for approximately 2 months. The
22 species becomes sexually mature at an age of 2 years, and may live to about 5 years of age
23 (Provincetown Center for Coastal Studies 2006).

24
25 Sand lance is an important prey species for many demersal fish species and the endangered fin
26 whale (*Balaenoptera physalus*) and humpback whale (*Megaptera novaengliae*) (Winters 1983).
27 Sand lance typically live in shallow water less than 90 m (295 ft) deep, along the coast or above
28 offshore banks, and in areas with sand or gravel substrates. The species burrows into the sand
29 in the intertidal zone, allowing it to be harvested by persons on foot, with shovels, to be used as
30 bait (Fisheries and Oceans Canada 2006). Larvae of the Atlantic sand lance are frequently
31 observed in the PNPS entrainment sampling and are periodically observed in the impingement
32 sampling (Normandeau Associates 2006a, Normandeau Associates 2006b). Eggs and larvae
33 of the Atlantic sand lance have been collected in the PNPS entrainment sampling. Juveniles
34 and/or adults have also been observed in the PNPS impingement sampling program.

35 36 **Atlantic tomcod (*Microgadus tomcod*)**

37
38 The Atlantic tomcod is a demersal, anadromous species found from southern Labrador to
39 Virginia. Eggs of the species form globules that sink to the bottom, and only develop in fresh or
40 brackish water. Spawning occurs from November to February, in estuaries north of the Hudson
41 River (Stewart and Auster 1987). After hatching, the larvae float to the surface and are swept

1 out to estuaries, where they develop into juveniles. The species generally lives in brackish or
2 fresh water at depths shallower than 10 m (33 ft) in coastal areas, and has been found in
3 landlocked lakes in Canada (Fishbase 2006). Atlantic tomcod feed principally on small
4 crustaceans and to a lesser extent on polychaete worms, mollusks, and fish
5 (Bigelow and Schroeder 1953 in Stewart and Auster 1987).
6

7 The species was an important commercial species in the 1800s in Massachusetts, but was not
8 targeted in the 20th century (Stewart and Auster 1987). Currently, the species is the target of a
9 minor commercial fishery, and is also fished recreationally (Fishbase 2006). Atlantic tomcod
10 larvae have been observed in the PNPS entrainment sampling
11 (Normandeau Associates 2006a); juveniles and/or adults are also one of the numerically
12 dominant species collected as part of the PNPS impingement sampling
13 (Normandeau Associates 2006b).
14

15 **Cunner (*Tautoglabrus adspersus*)**

16
17 The cunner is a marine species that is common along the western North Atlantic coast from
18 Labrador to the Chesapeake Bay. Cunner become sexually mature at the age of 2 years
19 (Serchuk and Cole 1974, in ENSR 2000). Cunner spawn from late spring to summer in water
20 temperatures between 12 to 22 °C. In Cape Cod Bay, cunner spawning occurs primarily from
21 late March through mid-July (MRI 1992, in ENSR 2000). Cunner commonly spawn in pairs or
22 groups, depending on the conditions (Wicklund 1970, Pottle and Green 1979; in ENSR 2000).
23 The species forages on a variety of benthic invertebrates, predominantly blue mussels
24 (*Mytilus edulis*), barnacles, soft shell clams, amphipods, shrimp, and small lobsters.
25

26 Cunner are associated with rocky subtidal environments such as that found in the vicinity of
27 PNPS. The cunner typically lives in rocky areas that are covered with algae, and among pilings
28 and shipwrecks that can provide shelter (ENSR 2000). Because of this association with shelter
29 in shallow water, the intake breakwaters and discharge jetties at PNPS provide a high-relief,
30 structurally complex habitat for the cunner (ENSR 2000). Additionally, two nearby areas,
31 Rocky Point and White Horse Beach, provide habitat important for settlement of cunner larvae,
32 although these areas do not appear to be as important to recruitment success as the discharge
33 area (Lawton et al. 2000). Cunner are found primarily between 3 and 10 meters deep, but have
34 been caught as deep as 150 m (492 ft) on Georges Bank (ENSR 2000). Cunner are year-round
35 residents, and do not migrate except for movements to deeper water during deep freezes
36 (Green and Farwell 1971, in ENSR 2000). Because the species does not migrate long
37 distances, population trends may be an indicator of local stressors (ENSR 2000). The PNPS
38 area is a cunner spawning and nursery grounds, and cunner have a high incidence of
39 entrainment and impingement at PNPS relative to other species (Lawton et al. 2000).
40

41 Cunner eggs and larvae are commonly found in the entrainment samples, and adult cunner are

1 frequently found in the impingement collections. The species was the focus of investigative
2 programs at PNPS from 1990 to 1997, because of the relatively high incidence of eggs and
3 larvae entrained. Based on the results of these studies, it appears that PNPS had a minor
4 effect on recruitment success to the local cunner population (Lawton et al. 2000). Eggs and
5 larvae of the cunner have been consistently collected in the PNPS entrainment sampling and
6 are one of the numerically dominant species in the entrainment collections. Juveniles and/or
7 adults have also been observed in the PNPS impingement sampling program.

8
9 **Fourbeard rockling (*Enchelyopus cimbrius*)**

10
11 The fourbeard rockling is a demersal fish found from the northern Gulf of Mexico to
12 Newfoundland, Greenland, and throughout the northeast Atlantic coast of Europe. The species
13 typically spawns in waters less than 140 m (459 ft) deep. Adults feed on flatfish, amphipods,
14 decapods, copepods, and small crustaceans (Census of Marine Life 2006). The species
15 reaches a maximum age of about 9 years (Deree 1999).

16
17 The species is a sedentary bottom dweller, living on mud or muddy sand substrates on the
18 continental slope (Census of Marine Life 2006; Bigelow and Schroeder 1953, in Deree 1999).
19 The typical depth range for the species is from 20 to 650 m (66 to 2132 ft) (Census of Marine
20 Life 2006). Fourbeard rockling eggs and larvae are frequently observed in the PNPS
21 entrainment sampling (Normandeau Associates 2006a). Fourbeard rockling have also been
22 collected as part of the PNPS impingement sampling; however, this only occurred during one
23 year, 1998 (Normandeau Associates 2006b). Eggs and larvae of the fourbeard rockling have
24 been collected in the PNPS entrainment sampling. Juveniles and/or adults have also been
25 observed in the PNPS impingement sampling program.

26
27 **Fourspot flounder (*Paralichthys oblongus*)**

28
29 The fourspot flounder is a benthic species found along the western Atlantic coast from Georges
30 Bank to South Carolina (Gulf of Maine Research Institute 2006). The eggs are buoyant, but the
31 larvae complete transformation and move to the bottom within 3 months of hatching (Gulf of
32 Maine Research Institute 2006). Spawning occurs from May to mid-July (Census of Marine Life
33 2006). The species' habitat includes bays and sounds, at water depths up to 275 m (902 ft)
34 (Robins et al. 1986).

35
36 Fourspot flounder eggs and larvae have been observed in the PNPS entrainment sampling
37 (Normandeau Associates 2006a). Fourspot flounder have also been periodically collected as
38 part of the PNPS impingement sampling (Normandeau Associates 2006b). Eggs and larvae of
39 the fourspot flounder have been collected in the PNPS entrainment sampling. Juveniles and/or
40 adults have also been observed in the PNPS impingement sampling program.

41

Haddock (*Melanogrammus aeglefinus*)

The haddock is a demersal gadoid species found on both sides of the North Atlantic (Brown 2000). Eggs, larvae, and juveniles all live within the upper part of the water column until the juveniles reach a size of 3 to 10 cm (1 to 4 in.) (Brodziak 2005). At that time, juveniles travel to the bottom, identify suitable habitat, and become demersal (Klein-MacPhee 2002, in Brodziak 2005). Spawning varies by location and time of year, with spawning generally occurring from February to May in the Gulf of Maine. The largest spawning area in U.S. waters is Georges Bank, and for the Gulf of Maine stock, spawning occurs at the Jeffrey's Ledge and Stellwagen Bank areas (Brodziak 2005). Spawning can occur over substrates of various types, including rock, gravel, sand, or mud (Klein-MacPhee 2002, in Brodziak 2005). The size and age at maturity vary by location and population density, and have also been decreasing through time (Cargnelli et al. 1999a). Spawning in the Gulf of Maine peaks from February to April (Bigelow and Schroeder 1953, in Cargnelli et al. 1999a). The diet of haddock changes through their life cycle. Larvae and small juveniles feed on phytoplankton, copepods, and invertebrate eggs suspended in the water column. Once juveniles move to the bottom, they primarily eat small crustaceans, polychaetes, and small fish. As adults, the haddock feed primarily on benthic organisms such as echinoderms, crustaceans, polychaetes, and mollusks (Brodziak 2005).

The haddock is distributed throughout the western North Atlantic Ocean from Cape May, New Jersey to Newfoundland (Brodziak 2005). Haddock are generally found at depths of between 45 and 135 m (147 to 443 ft), and at temperatures between 2 and 10 °C (Brown 2000). The preferred bottom types include gravel, pebbles, and smooth hard sand, and this preference appears to result in the location of primary spawning areas on Georges Bank, and in isolated locations within the Gulf of Maine (Lough and Bolz 1989; Colton 1972, in Cargnelli et al. 1999a). Data suggest that larvae drift with currents from Canadian waters as far south as Cape Cod, and then live a portion of their life in this area (Colton and Temple 1961, in Cargnelli et al. 1999a). Haddock are not migratory, with only minor movements shoreward in summer, and to deeper water in winter (Brodziak 2005). In inshore trawl surveys, juveniles were found in Cape Cod Bay in low numbers in autumn, but were not found in the bay in spring, while adults were not found in the bay (Cargnelli et al. 1999a; GOMCML 2006).

Six separate haddock stocks have been identified in the western North Atlantic, with two stocks recognized in U.S. waters in the Gulf of Maine and Georges Bank (Brodziak 2005). The U.S. fishery for haddock is managed under the NEFMC Northeast Multispecies FMP (Brown 2000). The status of the Gulf of Maine stock indicates that the haddock was overfished as of 2004 (NMFS 2001a; Brodziak 2005). However, numbers of haddock in the Gulf of Maine have increased since they reached their lowest levels in the early 1990s, and the age structure has broadened as well. In a 2004 assessment, the determination was made that the stock was overfished, but that overfishing was not occurring (Brodziak and Traver 2005). Similarly, the Georges Bank stock, although still in an overfished condition, had rebounded substantially due

1 to fishery management measures (Brodziak 2005). However, in 2005, an analysis of juvenile
2 populations resulted in a proposal for the potential designation of HAPCs for the haddock,
3 including areas within Cape Cod Bay, adjacent to PNPS (Crawford et al. 2005). Eggs and larvae
4 of the haddock have been collected in the PNPS entrainment sampling. Juveniles and/or adults
5 have not been observed in the PNPS impingement sampling program.
6

7 **Little skate (*Leucoraja erinacea*)**
8

9 The little skate is a dominant species among the demersal fish community in the western North
10 Atlantic (Bigelow and Schroeder 1953, in Packer et al. 2003b). The little skate is often confused
11 with the larger winter skate due to similarity in appearance, but the little skate is far more
12 common (McEachran and Musick 1975, in Packer et al. 2003b). Skates are fished
13 commercially, but with no distinction between the seven species (Packer et al. 2003b). Most
14 commercial use of skates, including the little skate, is for lobster bait (Sosebee 2000c). Eggs of
15 all skates are encapsulated in a leathery capsule that rests on the bottom
16 (Sosebee 2000c; Packer et al. 2003b). The eggs hatch fully developed, so there is no larval
17 stage (Sosebee 2000c; McEachran 2002, in Packer et al. 2003b). Adults are estimated to
18 reach sexual maturity at the age of 4 years (NMFS 2000, in Packer et al. 2003b). Spawning
19 may occur at any time during the year, with a peak in southern New England from July to
20 September (Bigelow and Schroeder 1953, in Packer et al. 2003b). The major prey reported for
21 the little skate in the Gulf of Maine area includes decapod crustaceans, amphipods, and
22 polychaetes. (McEachran 1973; McEachran et al. 1976, in Packer et al. 2003b).
23

24 The little skate is most commonly found on the Georges Bank, and in the northern section of the
25 Mid-Atlantic Bight (McEachran and Musick 1975, in Packer et al. 2003b). The little skate is
26 found through the year in these areas, including the entire range of temperatures that occur in
27 those areas (McEachran and Musick 1975, in Packer et al. 2003b). Skates have been landed
28 as bycatch in New England since the late 1960s, but were not directly targeted as a fishery until
29 the 1980s. There is no differentiation between the different skate species in terms of
30 differentiation of stocks. Little skate have a reported depth range of 0 to 137 m (0 to 450 ft),
31 with most being found less than about 100 m (328 ft) deep (Bigelow and Schroeder 1953;
32 McEachran and Musick 1975, in Packer et al. 2003b). The corresponding water temperature
33 ranges from 1 to 21°C (Bigelow and Schroeder 1953; Tyler 1971; McEachran and Musick 1975,
34 in Packer et al. 2003b). Little skates typically prefer sandy or gravelly substrates
35 (Bigelow and Schroeder 1953, in Packer et al. 2003b), and are known to bury themselves in
36 depressions during the day (Michalopoulos 1990, in Packer et al. 2003b). Skates do not
37 migrate substantially, but do generally move offshore in summer and early autumn, and
38 onshore during winter and spring (Sosebee 2000c). Bottom trawl surveys found juvenile little
39 skates in heavy concentrations nearshore in Cape Cod Bay in the spring
40 (Packer et al. 2003b). Adults were also found in Cape Cod Bay during the spring, summer,
41 and fall (Packer et al. 2003b). Little skate abundance has increased since the early 1980s, and

1 as of 2000 was at its highest numbers since 1975 (Sosebee 2000c). In a 2000 stock
2 assessment, it was concluded that the little skate was not overfished, and that overfishing was
3 not occurring (NMFS 2000, in Packer et al. 2003b). No life stages of the little skate have ever
4 been observed in the PNPS entrainment sampling. Juveniles and/or adults have been
5 observed in the PNPS impingement sampling program.

7 **Monkfish (*Lophius americanus*)**

8
9 The common name used for this species in commercial fishing is monkfish, but the name
10 recognized by the American Fisheries Society is goosefish (Steimle et al. 1999c). The monkfish
11 is a solitary, bottom-dwelling angler fish occurring all along the eastern coast of the U.S.
12 (primarily north of Cape Hatteras) and Canada up to Newfoundland (Steimle et al. 1999c).
13 Eggs are buoyant, and are laid in rafts that may be up to 6 to 12 m (20 to 39 ft) long
14 (Steimle et al. 1999c). Larvae and juveniles are also pelagic, and eventually descend to the
15 bottom to live their adult lifespan as benthic fish (NOAA 1998, in ENSR 2000). Once they have
16 settled to the bottom, juveniles prefer a substrate of sand-shell mix, algae covered rocks, hard
17 sand, pebbly gravel, or mud, with water temperatures below 15°C (NEFMC 1998a, in ENSR
18 2000). Adults spend most of their lives resting on the bottom in depressions within sandy
19 sediment (Steimle et al. 1999c). The monkfish becomes sexually mature between the ages of 4
20 and 5 years (Wood 1982, in Steimle et al. 1999c). Spawning occurs in locations including
21 inshore shoals and offshore surface water, in temperatures below 18°C, in the months of May
22 and June within the Gulf of Maine (Scott and Scott 1988; Hartley 1995, in Steimle et al. 1999c).
23 The larvae feed on zooplankton, including copepods and crustacean larvae, while juveniles eat
24 smaller fish, including sand lance, and shrimp and squid (Bigelow and Schroeder 1953, in
25 Steimle et al. 1999c). Adults eat a variety of benthic and pelagic species, sea birds, and even
26 younger monkfish, and capture prey with an ambush or sudden rush (Steimle et al. 1999c). The
27 age span of the monkfish ranges from 9 years for males to 12 years for females.

28
29 Monkfish are found throughout the continental shelf in waters shallower than 668 m (2192 ft).
30 They are most commonly found in shallow waters of the Gulf of Maine during the summer
31 (Steimle et al. 1999c). Although the monkfish population appears to comprise only one distinct
32 stock, it is managed as two separate stocks, one north and one south of the Georges Bank
33 (Steimle et al. 1999c; NEFMC 2006a). Adult monkfish generally inhabit waters from 70 to
34 100 m (230 to 328 ft) deep, and may also be found in inshore areas or at depths greater than
35 800 m (2625 ft) (Richards 2000). The monkfish are found in temperatures ranging from 0 to
36 24°C, most abundantly between 4 to 14°C (Steimle et al. 1999c). The monkfish has annual
37 migrations in response to spawning preference and food availability. Monkfish were not
38 extensively fished commercially until the 1970s. Since that time, harvests have increased and
39 stock numbers have declined dramatically (Ildoine 1995, in Steimle et al. 1999c). In 2000, the
40 Monkfish FMP was developed by the NEFMC and MAFMC (NEFMC 2006b). Neither stock was
41 considered to be overfished based on a stock assessment performed in 2004 (NMFS 2005a),

1 but a 2006 assessment has concluded that both stocks are overfished (NEFMC 2006b). Eggs
2 and larvae of the monkfish have been collected in the PNPS entrainment sampling. Juveniles
3 and/or adults have also been observed in the PNPS impingement sampling program.
4

5 **Ocean pout (*Macrozoarces americanus*)**

6

7 The ocean pout is also known as eel pout or muttonfish. It is a bottom-dwelling, cool-temperate
8 species that lives on the western North Atlantic continental shelf from Labrador to Virginia
9 (Steimle et al. 1999b). The species lays eggs in nests, which it then guards until they hatch
10 (Steimle et al. 1999b). Both the larvae and adults are demersal, and are not known to form
11 schools (Steimle et al. 1999b). The ocean pout spawns in areas with hard bottom substrates,
12 including artificial reefs or in rock crevices, in late summer through the early winter
13 (Steimle et al. 1999b). Spawning peaks in the months of September and October
14 (NEFMC 1998a, in ENSR 2000). Spawning occurs at depths of less than 50 m (164 ft), and
15 temperatures of 10°C or less (Clark and Livingstone 1982, in Steimle et al. 1999b). There are
16 differing reports on how the ocean pout feeds. According to a report by MacDonald
17 (1983, in Steimle 1999b), ocean pout feed by sorting through mouthfuls of sediment for fauna
18 contained within the sediment, and do not appear to visually follow prey, or leave the bottom to
19 feed. However, Auster (1985, in Steimle et al. 1999b) reported that ocean pout hide within
20 sediment depressions to wait for prey to swim or drift by. The prey is reported to consist of
21 echinoderms, crustaceans, and other benthic invertebrates (Anderson 1994, in ENSR 2000).
22

23 The range of the ocean pout on the continental shelf extends from Labrador to Delaware. It is
24 managed as two separate stocks, a northern stock in the Gulf of Maine and a southern stock in
25 Cape Cod Bay, Georges Bank, and south to Delaware (Wigley 2000a). However, studies
26 suggest that there are up to five separate stocks, including one confined to the Gulf of Maine
27 and Cape Cod Bay (Orach-Meza 1975, in Steimle et al. 1999b). The ocean pout does not
28 migrate, although it moves seasonally within a limited region (Bigelow and Schroeder 1953, in
29 Steimle et al. 1999b). The ocean pout lives at depths from 15 to 80 m (50 to 262 ft)
30 (Wigley 2000a) and in water temperatures below 10°C (50°F) (NEFMC 1998a, in ENSR 2000).
31 The ocean pout typically live and feed in areas with soft or sandy substrates, and move to rocky
32 areas to spawn (Wigley 2000a). Juvenile ocean pout were reported to be commonly found in
33 saline water [greater than 25 parts per thousand (ppt)] in many estuaries and coastal areas,
34 including Cape Cod Bay, through the year (Jury et al. 1994, in Steimle et al. 1999b).
35 Of the two managed stocks, only the southern stock, which includes Cape Cod Bay, is
36 commercially fished (Wigley 1998, in Steimle et al. 1999b). The population of ocean pout has
37 varied considerably, with highs in the 1960s, lows in the 1970s, and record high levels again in
38 the 1980s (Steimle et al. 1999b). The ocean pout are managed under the NEFMC Northeast
39 Multispecies FMP (Wigley 2000a). Although there is no clear trend, the population is
40 considered to be fully exploited (Wigley 1998, in Steimle et al. 1999b). In a 2004 assessment,
41 the stock was found to be overfished, but overfishing was not occurring at that time

1 (Wigley and Col 2005b). In 2005, an analysis of juvenile populations resulted in a proposal for
2 the potential designation of HAPCs for the ocean pout, including areas within Cape Cod Bay,
3 adjacent to PNPS (Crawford et al. 2005). The ocean pout has not been observed in the PNPS
4 entrainment sampling. Juveniles and/or adults have been observed in the PNPS impingement
5 sampling program.
6

7 **Offshore hake (*Merluccius albidus*)**

8

9 Offshore hake are found throughout the continental shelf and slope of the western North
10 Atlantic, from the Scotian Shelf to the Gulf of Mexico. The species has often been confused
11 with the silver hake, which it resembles, resulting in a lack of research and fishery data specific
12 to the species (Chang et al. 1999c). The offshore hake has mostly been fished as bycatch of
13 the silver hake fishery (Chang et al. 1999c). Very little information exists on the early life
14 stages, growth, or ages of the species (Chang et al. 1999c). Eggs and larvae are pelagic, and
15 have been found off of Massachusetts from the months of April to July
16 (Marak 1967, in Chang et al. 1999c). Juvenile offshore hake feed on small fish, shrimp, and
17 other crustaceans, while adults eat other fish, including lantern fishes, sardines, and anchovies
18 (Chang et al. 1999c).
19

20 In the northwest Atlantic, the offshore hake is most commonly found along the outer edge of the
21 Scotian Shelf (Chang et al. 1999c). Offshore hake in the Georges Bank-New England-Mid-
22 Atlantic area are considered to be a single stock (Chang et al. 1999c). No information is
23 available on migration of the offshore hake. The species appears to live at depths ranging from
24 70 to 640 m (230 to 2100 ft), with a concentration found at about 200 m (656 ft), throughout the
25 year (Chang et al. 1999c). Larvae are reported to be abundant in continental shelf waters of the
26 Gulf of Maine during the months of August and September. However, juveniles and adults were
27 reported to be only rarely found within the Gulf of Maine (Chang et al. 1999c).
28

29 There is no directed fishery for offshore hake, so there has been no evaluation of the status of
30 the stock (Chang et al. 1999c). No life stages of the offshore hake have ever been observed in
31 the PNPS entrainment or impingement sampling.

1 **Red hake (*Urophycis chuss*)**

2
3 Red hake is a demersal species inhabiting bottom waters, ranging from Nova Scotia to North
4 Carolina in the western North Atlantic continental slope (Cohen et al. 1990, in ENSR 2000).
5 Both the eggs and larvae of the red hake are pelagic, occurring in surface waters less than 10°C
6 (eggs) and 19°C (larvae) (NEFMC 1998a, in ENSR 2000). Shelter is an important habitat
7 requirement for red hake (Steiner et al. 1982, in Steimle et al. 1999a). When the fish become
8 juveniles, they migrate to shallower waters along the coast, and live among shell litter or live
9 scallop beds (Cohen et al. 1990; NEFMC 1998a, in ENSR 2000). Adult red hake typically live in
10 areas with soft sediment bottoms, and less commonly near gravel or rock bottoms (Steimle et
11 al. 1999a). Adults become mature at an age of about 1.5 years (Steimle et al. 1999a). The
12 adults migrate in the spring to shallow waters for spawning, which can take place between May
13 and November, with peaks in June and July (Sosebee 1998; NEFMC 1998a, in ENSR 2000).
14 Spawning occurs in temperatures of 5-10°C (Steimle et al. 1999a), within depressions in muddy
15 or sandy substrates (NEFMC 1998a, in ENSR 2000). The primary spawning grounds include
16 the southern edge of Georges Bank, and shallow areas off of the southern New England coast
17 (Sosebee 1998, in ENSR 2000). Larvae feed mainly on copepods and other micro-crustaceans
18 (Steimle et al. 1999a). Juvenile red hake feed primarily on crustaceans such as amphipods and
19 shrimp, and the adults feed on amphipods and shrimp, as well as squid, herring, flatfish, and
20 mackerel (Cohen et al. 1990, in ENSR 2000).

21
22 Red hake are most commonly found between Georges Bank and New Jersey
23 (Sosebee 1998, in Steimle et al. 1999a). Red hake migrate extensively due to seasonal and
24 temperature variations. During winter, they live offshore in water greater than 100 m (328 ft)
25 deep, but in summer, red hake migrate into shallow coastal water and estuaries of the Gulf of
26 Maine, and live in water less than 10 m (33 ft) deep (Steimle et al. 1999a). Red hake generally
27 live in bottom waters over a substrate of mud or sand (Cohen et al. 1990; NEFMC 1998a, in
28 ENSR 2000). In the spring and summer, red hake undergo seasonal migration from offshore
29 deeper water to nearshore shallow waters (Sosebee 1998, in ENSR 2000).

30
31 Two stocks are recognized for management of the red hake, a northern stock from the Gulf of
32 Maine to northern Georges Bank and a southern stock from Georges Bank to the Mid-Atlantic
33 Bight (Sosebee 1998, in Steimle et al. 1999a; Brodziak 2001b). The red hake fishery is
34 managed under the NEFMC Northeast Multispecies FMP under the "nonregulated multispecies"
35 category (Brodziak 2001b). Both the northern and southern stocks were considered
36 underexploited as recently as 1998. In 2001, the stock appeared to be healthy, and yields could
37 be increased (Brodziak 2001b). Eggs and larvae of the red hake have been collected in the
38 PNPS entrainment sampling. Juveniles and/or adults have also been observed in the PNPS
39 impingement sampling program.

Rock gunnel (*Pholis gunnellus*)

The Rock gunnel is a demersal species found on both sides of the Atlantic, with the population in the western Atlantic ranging from Labrador to Delaware Bay (Robins et. al 1986). In warm months, the species lives in shallow coastal waters, and is often stranded in tide pools (Biomes Marine Biology Center 2006). In winter, the species migrates to offshore waters up to 100 m (328 ft) deep (Census of Marine Life 2006). The habitat consists of areas with rocky or shell fragment substrates where the species finds shelter, and feeds on worms and small crustaceans (Biomes Marine Biology Center 2006). The spawning season occurs from November to January (Census of Marine Life 2006). The species is not the target of commercial fisheries.

Rock gunnel larvae have been observed in the PNPS entrainment sampling (Normandeau Associates 2006a); rock gunnel have also been periodically collected as part of the PNPS impingement sampling (Normandeau Associates 2006b). Rock gunnel larvae have been collected in the PNPS entrainment sampling. Juveniles and/or adults have also been observed in the PNPS impingement sampling program.

Scup (*Stenotomus chrysops*)

The scup is a demersal, temperate fish found in the western Atlantic (Steimle et al. 1999f). Scup are fished both commercially and recreationally, although both types of landings have declined (MAFMC 1996a, in Steimle et al. 1999f). Both eggs and larvae are pelagic, and the larvae become demersal in shoal areas in early July (Able and Fahay 1998, in Steimle et al. 1999f). The adults can occupy a variety of benthic habitats, from open water to structured areas (Steimle et al. 1999f). Adult scup become sexually mature by the age of 3 years (Gabriel 1998, in Steimle et al. 1999f). Southern New England, including Massachusetts Bay, is considered to be a primary spawning area for scup (Steimle et al. 1999f). Scup spawn in shallow shoal waters less than 10 m (33 ft) deep until late June, and then move to deeper water (MAFMC 1996a, in Steimle et al. 1999f). Both juvenile and adult scup are benthic feeders. Adults eat small crustaceans, polychaetes, mollusks, small squid, detritus, insect larvae, sand dollars, and small fish (Bigelow and Schroeder 1953; Morse 1978; Sedberry 1983, in Steimle et al. 1999f).

The scup is known to occur in the western Atlantic from the Bay of Fundy to Florida, but is most commonly found from Massachusetts to South Carolina (Steimle et al. 1999f). Adults are abundant in schools in the Mid-Atlantic Bight from spring to fall, and live in areas with bottom substrates ranging from open sandy bottoms to mussel beds, reefs, or rocks (Steimle et al. 1999f). The temperature range for scup is from 6 to 27°C, with 7°C apparently being a lower limit (Neville and Talbot 1964, in Steimle et al. 1999f). Smaller scup are frequently found in bays and estuaries, but larger adult scup usually live in deeper water ranging

1 from 70 to 180 m (230 to 590 ft) (Steimle et al. 1999f). Larval scup were reported in Cape Cod
2 Bay in May through September, in water temperatures of 14 to 22°C
3 (MAFMC 1996a, in Steimle et al. 1999f).

4
5 Some researchers have considered the population in the Mid-Atlantic Bight area to be two
6 separate stocks, but it is now considered to be a single stock (Pierce 1981; Mayo 1982, in
7 Steimle et al. 1999f; Terceiro 2001a). The fishery is managed under the Summer Flounder,
8 Scup, and Black Sea Bass FMP (Terceiro 2001a). In the late 1990s, the Mid-Atlantic Bight
9 stock was considered overfished because the biomass was at near record low levels
10 (Gabriel 1998; NMFS 1997, in Steimle et al. 1999f). However, a 2002 stock assessment
11 concluded that the stock is not overfished, and that the status with respect to overfishing could
12 not be evaluated (NMFS 2002a). This report noted that this conclusion was based on
13 anomalously high abundance estimates in 2002, compared to 2001, and that the sudden
14 increase created uncertainty in the data (NMFS 2002a). The 2006 ASMFC report considers the
15 scup population to be overfished, while the overfishing status is not known (ASMFC 2006).
16 Eggs and larvae of the scup have been collected in the PNPS entrainment sampling. Juveniles
17 and/or adults have also been observed in the PNPS impingement sampling program.

18 19 **Silver hake / Whiting (*Merluccius bilinearis*)**

20
21 Silver hake, also known as whiting, is a demersal fish that lives in a range from Nova Scotia to
22 South Carolina (Bigelow and Schroeder 1953; NEFMC 1998a, in ENSR 2000), and is most
23 abundant from Nova Scotia to New Jersey (Lock and Packer 2004). Silver hake eggs and
24 larvae are pelagic, existing in the water column at depths between 50 and 150 m (164 to 492 ft)
25 (NEFMC 1998a, in ENSR 2000). As larvae mature into juveniles, they settle to the bottom
26 (Lock and Packer 2004). As adults, silver hake are found in water ranging from shallow to
27 depths greater than 400 m (1312 ft) (Dery 1988a; Bolles and Begg 2000, in Lock and Packer
28 2004). Silver hake become sexually mature between the ages of 2 and 3 years
29 (Mayo 1998a, in ENSR 2000). The adults spawn over a variety of substrates in the Gulf of
30 Maine, Georges Bank, and the southern New England area south of Martha's Vineyard
31 (Lock and Packer 2004). Spawning within the Gulf of Maine generally begins in June, with a
32 peak in July to August (Lock and Packer 2004). Juvenile silver hake feed mainly on
33 crustaceans (Cohen et al. 1990, in ENSR 2000), and the adults feed on both fish and pelagic
34 invertebrates, such as shrimp and squid (Mayo 1998a, in ENSR 2000). Silver hake are a
35 dominant predator species on the continental shelf in the northwest Atlantic, and their dominant
36 biomass and high consumption affect help to regulate the ecosystem
37 (Bowman 1984; Garrison and Link 2000, in Lock and Packer 2004).

1 Silver hake spend the winter in deep waters of the Gulf of Maine and outer continental shelf,
2 and then migrate annually to shallow offshore waters in the spring
3 (Mayo 1998a, in ENSR 2000). Adults tend to live in cool bottom water at temperatures lower
4 than 13°C, and with a variety of substrates (NEFMC 1998a, in ENSR 2000). The migration of
5 silver hake is seasonal. The northern stock moves to the deep basins of the Gulf of Maine
6 during the winter, and migrates into nearshore waters in the Gulf of Maine in the spring and
7 summer (Lock and Packer 2004). Trawl surveys conducted for silver hake in 1999 identified
8 concentrations of silver hake in Cape Cod Bay in spring and autumn
9 (Reid et al. 1999a, in Lock and Packer 2004). A summary of annual NMFS Bottom Trawl
10 Survey data identified substantial numbers of silver hake in Cape Cod Bay during the fall every
11 year between 1979 and 2003, but found a more limited number in the bay during the spring in
12 those years (GOMCML 2006).

13
14 Silver hake in the U.S. are divided into northern (Gulf of Maine to northern Georges Bank) and
15 southern (Georges Bank to Cape Hatteras) stocks for management purposes (NEFMC 2003b).
16 The silver hake fishery is managed under the NEFMC Northeast Multispecies FMP under the
17 "nonregulated multispecies" category (Brodziak 2001a). Based on data presented in the 2006
18 Assessment Summary Report, neither the northern nor southern stock of the silver hake is in an
19 overfished condition, and overfishing is not occurring (NMFS 2006a). The northern stock is at a
20 high biomass level (Lock and Packer 2004). The southern stock was reported to be overfished
21 in 2001 (NMFS 2001a), and although not currently overfished, the southern stock still has a low
22 biomass level resulting from this overfishing in 1998-2000 (NEFMC 2003b). Eggs and larvae of
23 the silver hake have been collected in the PNPS entrainment sampling. Juveniles and/or adults
24 have also been observed in the PNPS impingement sampling program.

25 26 **Smooth skate (*Malacoraja senta*)**

27
28 The smooth skate occurs along the Atlantic coast of North America from the Gulf of St.
29 Lawrence and the Labrador Shelf to South Carolina (Bigelow and Schroeder 1953; McEachran
30 1973; McEachran and Musick 1975, in Packer et al. 2003d). It is one of seven species of
31 skates found throughout the northwest Atlantic (Sosebee 2000c). Skates are fished
32 commercially, but with no distinction between the seven species (Packer et al. 2003d). Most
33 commercial use of skates, including the smooth skate, is for lobster bait (Sosebee 2000c). Little
34 information is known of the life history of the smooth skate (Packer et al. 2003d). Eggs of all
35 skates are known to be encapsulated in a leathery capsule that rests on the bottom (Sosebee
36 2000c; Packer et al. 2003d). The eggs hatch fully developed, so there is no larval stage
37 (Sosebee 2000c; also McEachran 2002, in Packer et al. 2003d). Females with fully formed egg
38 capsules are found in both summer and winter (McEachran 2002, in Packer et al. 2003d), but
39 no other information on spawning times or locations is available. The primary food source for
40
41

1 the smooth skate is epifaunal crustaceans, with decapod shrimps and mysids also being
2 important (McEachran 1973; McEachran et al. 1976; Bowman et al. 2000; McEachran 2002, in
3 Packer et al. 2003d).

4
5 The Gulf of Maine is reported to be the center of abundance for the smooth skate (Bigelow and
6 Schroeder 1953; McEachran and Musick 1975; McEachran 2002, in Packer et al. 2003d),
7 including Massachusetts Bay (Collette and Hartel 1988, in Packer et al. 2003d). Skates have
8 been landed as bycatch in New England since the late 1960s, but were not directly targeted
9 until the 1980s. There is no differentiation between the skate species in terms of differentiation
10 of stocks.

11
12 The water depth range for the smooth skate is from 31 to 874 m (102 to 2867 ft), with most
13 being found from 110 to 457 m (361 to 1499 ft) (McEachran and Musick 1975; McEachran
14 2002, in Packer et al. 2003d). The temperature range of the species is from 2 to 13°C for
15 juveniles and adults, with most found between temperatures of 4 to 8°C (Packer et al. 2003d).
16 The smooth skate is found mostly on bottom substrates of soft mud and fine sediments (Bigelow
17 and Schroeder 1953; McEachran and Musick 1975; Scott 1982a, in Packer et al. 2003d).
18 Skates do not migrate substantially, but do generally move offshore in summer and early
19 autumn, and onshore during winter and spring (Sosebee 2000c). No seasonal trends in
20 abundance were identified by McEachran and Musick (1975, in Packer et al. 2003d). Inshore
21 trawl surveys in Massachusetts identified juveniles in both the spring and fall near Cape Cod
22 Bay (Packer et al. 2003d).

23
24 In a 2000 stock assessment, the smooth skate was considered to be overfished
25 (NMFS 2000, in Packer et al. 2003d). However, a 2002 assessment determined that the
26 species was not in an overfished condition at that time (NMFS 2002b, in Packer et al. 2003d).
27 No life stages of the smooth skate have ever been observed in the PNPS entrainment or
28 impingement sampling.

30 **Summer flounder (*Paralichthys dentatus*)**

31
32 The summer flounder, also known as fluke, inhabits shallow estuarine waters and the outer
33 continental shelf from Nova Scotia to Florida (Packer et al. 1999). The species is important
34 along the east coast both as a commercial and recreational fishing resource, with recreational
35 landings exceeding commercial landings in some years (Packer et al. 1999). Both eggs and
36 larvae of the species are buoyant and pelagic. Eggs are most abundant in the western North
37 Atlantic in October and November, and larvae are most abundant from October to December
38 (Able et al. 1990, in Packer et al. 1999). The larvae are transported toward coastal areas by the
39 prevailing water currents, and development of post-larvae and juveniles occurs primarily within
40 bays and estuarine areas (ENSR 2000). Sexual maturity is reached by the age of 2 years
41 (Morse 1981, in Packer et al. 1999). The timing of spawning varies by location. In southern

1 New England and the Mid-Atlantic, spawning occurs primarily in September
2 (Berrien and Sibunka 1999, in Packer et al. 1999). Spawning occurs in open ocean areas of the
3 shelf (Packer et al. 1999), in waters ranging from 30 to 200 m (98 to 656 ft) deep
4 (ENSR 2000). The timing of spawning appears to coincide with the maximum production of
5 autumn plankton, which is the primary food source for larvae (Morse 1981, in Packer et al.
6 1999). Juvenile summer flounder feed upon crustaceans and polychaetes, and as they grow
7 larger they begin to feed more on fish (Packer et al. 1999). Adults are opportunistic feeders,
8 preying mostly on fish and crustaceans (Packer et al. 1999). Species preyed upon include
9 windowpane flounder, winter flounder, Atlantic menhaden, red hake, silver hake, scup, Atlantic
10 silverside, and bluefish, among others (Packer et al. 1999).

11
12 Although found all along the east coast, the primary center of abundance for the summer flounder
13 is the area from Cape Cod to Cape Hatteras (Packer et al. 1999). Adult summer flounder in
14 Massachusetts migrate inshore in May, and migrate to offshore waters in late fall (Packer et al.
15 1999). Inshore trawl surveys in Massachusetts found seasonal variation in the depths and
16 temperatures at which adults were caught. In the spring, adults were found at depths from 0 to
17 360 m (0 to 1181 ft), at temperatures between 8 to 16°C. In the summer and autumn, the
18 species was found almost entirely at depths shallower than 100 m (328 ft), in water between 15
19 to 28°C. In the winter, the species is found in deeper locations, greater than 70 m (230 ft), in
20 temperatures between 5 to 11°C (Sissenwine et al. 1979, in Packer et al. 1999). The shoal
21 waters of Cape Cod Bay, including estuaries and harbors, are considered to be critically
22 important habitat for the species (Packer et al. 1999).

23
24 The species is managed as a single stock, although it is possible that different stocks exist, with
25 some information suggesting different stocks north and south of Cape Hatteras
26 (Packer et al. 1999). The fishery is managed under the Summer Flounder, Scup, and Black
27 Sea Bass FMP (Terceiro 2001b). As of 1999, the stock was considered to be at a medium level
28 of its historical abundance and was over-exploited (Terciero 1995; NMFS 1997, in Packer et al.
29 1999). More recently, total stock biomass is reported to have increased substantially since
30 1989 (NMFS 2005b). The 2006 ASMFC report indicates the stock is not currently considered to
31 be overfished, but overfishing is occurring (NMFS 2005b, ASMFC 2006). Eggs and larvae of
32 the summer flounder have been collected in the PNPS entrainment sampling. Juveniles and/or
33 adults have also been observed in the PNPS impingement sampling program.

34 35 **Tautog (*Tautoga onitis*)**

36
37 The tautog is an inshore species ranging from Nova Scotia to South Carolina, and is popular for
38 recreational fishing from Cape Cod south to Delaware (MDMF 2006). The eggs of the tautog
39 are buoyant, and hatch within 2 days. Within 4 days after hatching, the pelagic larvae begin
40 feeding on plankton. Juvenile and adult tautog feed on shallow water invertebrates, and have
41 flat, grinding teeth that allow them to open the shells of mussels. Spawning in Massachusetts

Plant and the Environment

1 occurs in June, in inshore waters containing eelgrass beds, at water temperatures of 62 to 70°F
2 (17 to 21°C). The species becomes sexually mature at an age of about 3 to 4 years, and can
3 live to be 35 years of age (MDMF 2006).
4

5 The species lives in inshore areas at water depths of less than 60 ft deep, including rocky areas
6 around breakwaters and pilings along the coast (Robins et. al 1986). Adults do not undertake
7 long migrations, but feed inshore in spring and move offshore to waters 50 to 150 ft. deep in
8 winter (MDMF 2006).
9

10 Until recently, population levels were considered to have remained relatively stable since
11 colonial times, as the species was not commercially fished. In the early 1980s, a commercial
12 fishery developed, and recreational landings increased substantially as well. By the early
13 1990s, the average size of landed tautog was much smaller, leading to State fishery restrictions
14 (MDMF 2006). In a 2004 assessment, Tautog were considered to be overfished and believed to
15 be at low population levels (NFSC 1998 as cited in Normandaeu Associates 2006a). Tautog
16 eggs and larvae have been observed in the PNPS entrainment sampling
17 (Normandaeu Associates 2006a); tautog have also been periodically collected as part of the
18 PNPS impingement sampling (Normandaeu Associates 2006b). No life stages of the tautog
19 have ever been observed in the PNPS entrainment sampling. Juveniles and/or adults have
20 been observed in the PNPS impingement sampling program.
21

22 **Thorny skate (*Amblyraja radiata*)**

23

24 The thorny skate occurs on both sides of the Atlantic Ocean (Packer et al. 2003c), and is one of
25 seven species of skates found throughout the western North Atlantic (Sosebee 2000c). Skates
26 are fished commercially, but with no distinction between the seven species (Packer et al.
27 2003c). Most commercial use of skates is for lobster bait, but two skates (including the thorny
28 skate) are used for human consumption (Packer et al. 2003c). Eggs of all skates are known to
29 be encapsulated in a leathery capsule that rests on the bottom (Sosebee 2000c; Packer et al.
30 2003c). The eggs hatch fully developed, so there is no larval stage (Sosebee 2000c; also
31 McEachran 2002, in Packer et al. 2003c). Based on the capture of females with fully formed
32 egg capsules, spawning is thought to occur throughout the year, but with a peak during the
33 summer (Templeman 1982a; McEachran 2002, in Packer et al. 2003c). The primary prey for
34 the thorny skate is fish, including haddock, sand lance, and redfish (Templeman 1982b, in
35 Packer et al. 2003c). Thorny skates may live up to 20 years (Templeman 1984, in Packer et al.
36 2003c).
37

38 In the western Atlantic, the thorny skate ranges from Greenland to South Carolina, and it is one
39 of the most common skates found within the Gulf of Maine (McEachran and Musick 1975, in
40 Packer et al. 2003c). Skates have been landed as bycatch in New England since the late
41 1960s, but were not directly targeted as a fishery until the 1980s. There is no differentiation

1 between the skate species in terms of differentiation of stocks. The water depth of the thorny
2 skate habitat can range from 18 to 1200 m (59 to 3937 ft) (McEachran 2002, in Packer et al.
3 2003c). Trawl surveys in the Gulf of Maine found most adults in the range from 71 to 300 m
4 (233 to 984 ft), and at temperatures between 4 to 9°C (Packer et al. 2003c). The species can
5 be found over a variety of substrates, including sand, gravel, broken shell, pebbles, and soft
6 mud (Bigelow and Schroeder 1953, in Packer et al. 2003c). Skates do not migrate substantially,
7 but do generally move offshore in summer and early autumn, and onshore during winter and
8 spring (Sosebee 2000c).

9
10 The abundance of thorny skate is reported to be near historic lows, with a population of about
11 10 to 15 percent of the peak population in the early 1970s (Sosebee 2000c). The thorny skate
12 was first designated as a species of concern in 2004 (NMFS 2004c). In a 2000 stock
13 assessment, the thorny skate was considered to be overfished (NMFS 2000, in Packer et al.
14 2003c). No life stages of the thorny skate have ever been observed in the PNPS entrainment or
15 impingement sampling.

16 **Tilefish (*Lopholatilus chamaeleonticeps*)**

17
18
19 Tilefish, also known as golden tilefish, is a burrowing fish that inhabits the outer continental shelf
20 from Nova Scotia to South America (Nitschke 2000). The tilefish began supporting a fishery in
21 the U.S. in 1879 (Steimle et al. 1999e). Tilefish eggs and larvae are buoyant and pelagic, and
22 are found over the outer continental shelf in the Mid-Atlantic Bight
23 (Steimle et al. 1999e). As they grow into juveniles, the tilefish descend to the bottom and
24 occupy existing shelters or burrows (Able et al. 1982; Freeman and Turner 1977, in Steimle et
25 al. 1999e). As adults, the tilefish either occupy existing shelter such as rocks or boulders, or dig
26 their own burrows. The burrowing habits of the tilefish are reported to modify significantly the
27 topography of the outer continental shelf (Able et al. 1982, in Steimle et al. 1999e). The adults
28 become sexually mature at an age of 5 to 7 years (Grimes et al. 1988, in Steimle et al. 1999e).
29 Information on spawning is sparse, but it may be pair-specific, as male and female pairs are
30 observed to share burrows (Grimes et al. 1988, in Steimle et al. 1999e). Tilefish are reported to
31 eat a large variety of benthic and pelagic prey, including crabs, conger eels, bivalve mollusks,
32 polychaetes, and many types of fish (Dooley 1978, in Steimle et al. 1999e).

33
34 They occupy submarine canyons, and are restricted to depths of 80 to 540 m (262 to 1772 ft)
35 deep, in waters between 8 and 17°C (Bigelow and Schroeder 1953; Freeman and Turner 1977;
36 Dooley 1978, in Steimle et al. 1999e). There does not appear to be any major migration
37 performed by the tilefish (Freeman and Turner 1977; Grimes et al. 1986, in Steimle et al.
38 1999e). In 1999, Steimle et al. (1999e) summarized a variety of surveys to identify tilefish. In
39 these reports, tilefish were only identified in offshore areas, including submarine canyons. No
40 tilefish in any life stage were reported in Massachusetts Bay or the Gulf of Maine
41 (Steimle et al. 1999e).

1 Tilefish are most commonly found from southern New England to the Mid-Atlantic region
2 (Nitschke 2000). The species is managed as two separate stocks, with one occurring in the
3 Mid-Atlantic Bight and the other south of Cape Hatteras and into the Gulf of Mexico
4 (Steimle et al. 1999e). The tilefish fishery established in 1879 was eliminated by a mass
5 mortality of tilefish between Nantucket and Maryland in 1882. This event killed an estimated 1.5
6 billion tilefish (Bigelow and Schroeder 1953, Dooley 1978, in Steimle et al. 1999e). The fishery
7 recovered by 1915, and has remained active ever since. In 1986, it was estimated that the
8 effects of fishing had been drastic, reducing stock size by a half to two-thirds
9 (Turner 1986, in Steimle et al. 1999e). However, a 2005 stock assessment determined the
10 stock is considered to be at sustainable levels (i.e., the SSB and/or total stock biomass are
11 considered to be at levels greater than sustainable biomass thresholds, while the exploitation or
12 fishing pressure is less than the threshold of sustainable fishing pressure) (NMFS 2005b). No
13 life stages of the tilefish have ever been observed in the PNPS entrainment or impingement
14 sampling.

15 **White hake (*Urophycis tenuis*)**

16
17
18 The white hake occurs from the Gulf of St. Lawrence to the Mid-Atlantic Bight, and at depths
19 from estuaries to submarine canyons (Chang et al. 1999a). The species generally inhabits
20 bottom waters, with either muddy or fine-grained sand substrates (Sosebee 2000a). The eggs,
21 larvae, and early juvenile stages of the white hake are pelagic (Chang et al. 1999a), and are
22 found in surface waters of the Gulf of Maine, Georges Bank, and southern New England
23 (NEFMC 1998a, in ENSR 2000). White hake reach sexual maturity at an age of about 1.5 years
24 (Chang et al. 1999a). The white hake spawning grounds are centered on the Gulf of St.
25 Lawrence, and the southern Georges Bank, and Mid-Atlantic Bight. However, the contribution
26 of the Gulf of Maine as a spawning ground is reported to be negligible (Fahay and Able 1989, in
27 Chang et al. 1999a). Spawning occurs in shallow water over mud or fine-grained sand
28 substrates. Juvenile white hake feed mainly on polychaetes, shrimp, and other crustaceans,
29 while the adults feed primarily on crustaceans and other fish, including juvenile white hakes
30 (Langston et al. 1994, in Chang et al. 1999a).

31
32 White hake are distributed from the Gulf of St. Lawrence to Cape Hatteras, with the highest
33 concentrations in the Gulf of St. Lawrence, southern edge of the Grand Bank, Scotian Shelf,
34 Gulf of Maine, and Georges Bank (Chang et al. 1999a). White hake live at depths of 5 to 325
35 m (16 to 1066 ft), usually at temperatures below 14°C (NEFMC 1998a, Sosebee 1998, in ENSR
36 2000). Migration of adults occurs annually, with adults moving to shallower waters in the spring
37 to spawn, and then moving offshore in the autumn. A summary of annual NMFS Bottom Trawl
38 Survey data identified no white hake in Cape Cod Bay during the fall between 1979 and 2003,
39 and only a few limited occurrences in the bay during the spring in those years
40 (GOMCML 2006).

1 The white hake fishery is managed under the NEFMC Northeast Multispecies FMP
2 (Sosebee 2000a). Within U.S. waters, the Gulf of Maine and Georges Bank populations are
3 managed as separate stocks (Chang et al. 1999a). The populations of white hake in both areas
4 has fluctuated without a consistent trend, but neither stock was considered to be overfished in
5 1999 (Chang et al. 1999a). In 2005, the stock was considered to be overfished, and overfishing
6 was occurring (Sosebee 2005). In 2005, an analysis of juvenile populations resulted in a
7 proposal for the potential designation of HAPCs for the white hake, including areas within Cape
8 Cod Bay, adjacent to PNPS (Crawford et al. 2005). Eggs and larvae of the white hake have
9 been collected in the PNPS entrainment sampling. Juveniles and/or adults have also been
10 observed in the PNPS impingement sampling program.
11

12 **Windowpane flounder (*Scopthalmus aquosus*)**

13
14 Windowpane flounder are a left-eyed, benthic flatfish species that inhabit estuaries, nearshore
15 waters, and the continental shelf in the western North Atlantic (Chang et al. 1999b). The
16 windowpane is not itself a target of commercial fishing, but it is caught as a bycatch in other
17 groundfish fisheries (Chang et al. 1999b). Both the eggs and larvae are pelagic, and exist in
18 surface waters cooler than 20°C (NEFMC 1998a, in ENSR 2000). Sexual maturity is reached at
19 ages of 3 to 4 years (O'Brien et al. 1993). The windowpane flounder prefers a soft substrate for
20 spawning, and generally spawns between April and December, with peak spawning activity in
21 July and August on Georges Bank and in May in the Mid-Atlantic (NEFMC 1998a; Hendrickson
22 1998, in ENSR 2000). Spawning occurs in water temperatures from 6 to 21°C (Bigelow and
23 Schroeder 1953, in Chang et al. 1999b). The prey for the windowpane flounder is small benthic
24 invertebrates, including polychaete worms and amphipods. The species may also prey on small
25 forage bony fish species (Langton and Bowman 1981, in ENSR 2000).
26

27 The distribution of windowpane flounder includes the northwestern continental shelf in the Gulf
28 of Maine, Georges Bank, southern New England and the Mid-Atlantic south to Florida
29 (NEFMC 1998a; Robins and Ray 1986; Hendrickson 1998, in ENSR 2000). South of Cape
30 Cod, the windowpane lives in bays and estuaries, including the Chesapeake Bay and Delaware
31 Bay, but north of Cape Cod, it lives in nearshore waters and is not documented within estuaries
32 (Chang et al. 199b). The windowpane is managed as two separate stocks, a Gulf of Maine
33 Georges Bank stock and a southern New England Mid-Atlantic Bight stock
34 (Chang et al. 1999b). The species lives at shallow depths from 1 to 75 (3 to 246 ft), and lives
35 within soft muddy and fine sand substrates (NEFMC 1998a, in ENSR 2000). Juveniles living in
36 shallow waters tend to move to deeper waters as they mature (Chang et al. 1999b). In studies
37 in Massachusetts, juveniles were most abundant in inshore waters at depths of less than 20 m
38 (66 ft), at water temperatures between 5 to 12°C in the spring, and between 12 to 19°C in the
39 fall (Chang et al. 199b).
40
41

1 The windowpane flounder fishery is managed as a single stock, which includes the Gulf of
2 Maine and Georges Bank (Hendrickson 2005). The windowpane flounder fishery is managed
3 under the NEFMC Northeast Multispecies FMP (Hendrickson 2000b). In the late 1990s, the
4 stock in the Gulf of Maine – Georges Bank stock was considered to be fully exploited
5 (Hendrickson 1998, in Chang et al. 1999b). In a 2004 assessment, it was concluded that the
6 stock is considered to be at sustainable levels (i.e., the SSB and/or total stock biomass are
7 considered to be at levels greater than sustainable biomass thresholds, while the exploitation or
8 fishing pressure is less than the threshold of sustainable fishing pressure) (Hendrickson 2005).
9 However, in 2005, an analysis of juvenile populations resulted in a proposal for the potential
10 designation of HAPCs for the windowpane flounder, including areas within Cape Cod Bay,
11 adjacent to PNPS (Crawford et al. 2005). Eggs and larvae of the windowpane flounder have
12 been collected in the PNPS entrainment sampling. Juveniles and/or adults have also been
13 observed in the PNPS impingement sampling program.
14

15 **Winter flounder (*Pseudopleuronectes americanus*)**

16
17 The winter flounder is a right-eyed flatfish species commonly found along the Atlantic coast from
18 Labrador to Georgia. The winter flounder commonly inhabits estuarine and coastal waters, but
19 may be found as deep as 420 ft (128 m) (Bulloch 1986). The various life stages of winter
20 flounder can generally be found in areas where the bottom habitat has a substrate of mud,
21 sand, or gravel (NEFMC 1998b). Winter flounder eggs are demersal, adhesive, and stick
22 together in clusters. Hatching may occur in 2 to 3 weeks, depending upon the water
23 temperature (Bulloch 1986, Pereira et al. 1999). Larvae are initially planktonic but as
24 metamorphosis continues, they settle to the bottom. Newly metamorphosed young-of-year fish
25 take up residence in shallow water. Winter flounder typically mature at 3 to 4 years. Spawning
26 takes place at night over sandy bottoms in shallow estuaries starting in mid-December and
27 ending in May, with a peak in the February to March time frame. Spawning will occur at water
28 temperatures between 34 and 50°F, with the optimum temperature around 40°F (Bulloch 1986).
29 Pereira et al. (1999) describes winter flounder as omnivorous or opportunistic feeders,
30 consuming a wide variety of prey, with polychaetes and amphipods making up the majority of
31 their diet. Typically adult winter flounder migrate inshore in the fall and early winter and spawn
32 in late winter and early spring; they then may leave inshore areas if the water temperature
33 exceeds 15°C, although there may be exceptions to this due to water temperature and food
34 availability (Pereira et al. 1999). Winter flounder may move significant distances
35 (Pereira et al. 1999). However, they also can exhibit a high degree of fidelity and, in general,
36 their movement patterns are localized (Nitschke et al. 2000). Studies done by PNPS have
37 shown that winter flounder in the area immediately surrounding PNPS (i.e., in Plymouth Outer
38 Harbor) have relatively localized movements and are basically confined to inshore waters
39 (Lawton et al. 1999), resulting in highly localized populations (Lawton et al. 2000).
40
41

1 Winter flounder are managed as three distinct stocks: Gulf of Maine, Southern New England
2 Mid-Atlantic, and Georges Bank (Pereira et al. 1999). Winter flounder in the local area
3 surrounding PNPS would be considered part of the Gulf of Maine stock. According to Nitschke
4 et al. (2000), the commercial landings of the winter flounder Gulf of Maine stock has continued
5 to trend downward, and the stock is at a low biomass level and is considered to be
6 overexploited. However, more recent data (through 2001) from the 36th Northeast Regional
7 Stock Assessment Workshop (NMFS 2003a) indicate that the stock is not overfished and that
8 overfishing is not occurring. The Northeast Fisheries Science Center (NEFSC) (NMFS 2003a)
9 also states that recruitment to the stock has been near or above average since 1995. The 2005
10 Groundfish Assessment Review Meeting (GARM) also concluded, that based on 2004 data, the
11 Gulf of Maine winter flounder stock is not overfished and overfishing is not occurring. The SSB
12 has also been steadily increasing; however, there is a high degree of uncertainty associated
13 with these estimates (NEFSC 2005) (Figure 2-7).

14 .
15 These trends, however, contrast with data from the local population (MRI 2006), which indicate
16 that the annual abundance estimates of winter flounder in western Cape Cod Bay continue to
17 decline (Figure 2-8). The authors hypothesize that the low numbers, particularly those
18 associated with the 2005 data, may be partially due to natural and fishing-induced mortalities
19 that precipitated a decline in the strong 1997 and 1998 year classes. Based on a review of
20 other resource assessments (NEFSC and MDMF abundance indices Figures 2-9 and 2-10), the
21 decline in eastern Cape Cod Bay may not just be local to the PNPS area (MRI 2006). Eggs and
22 larvae of the winter flounder have been consistently collected in the PNPS entrainment
23 sampling and are one of the numerically dominant species in the entrainment collections.
24 Juveniles and/or adults also have been consistently collected in the PNPS impingement
25 sampling program. Over the last 25 years winter flounder has been one of the numerically
26 dominant impinged species.

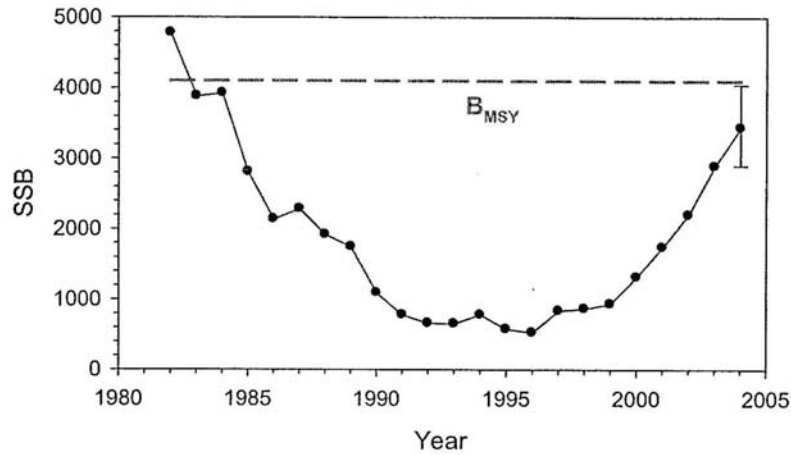


Figure 2-7. Gulf of Maine Winter Flounder Spawning stock biomass (SSB) estimates during 1982 to 2004 reported in GARM (2005) and the total biomass that produces the maximum sustainable yield for the fishery (B_{MSY}) (As provided in: NEFMC 2006)

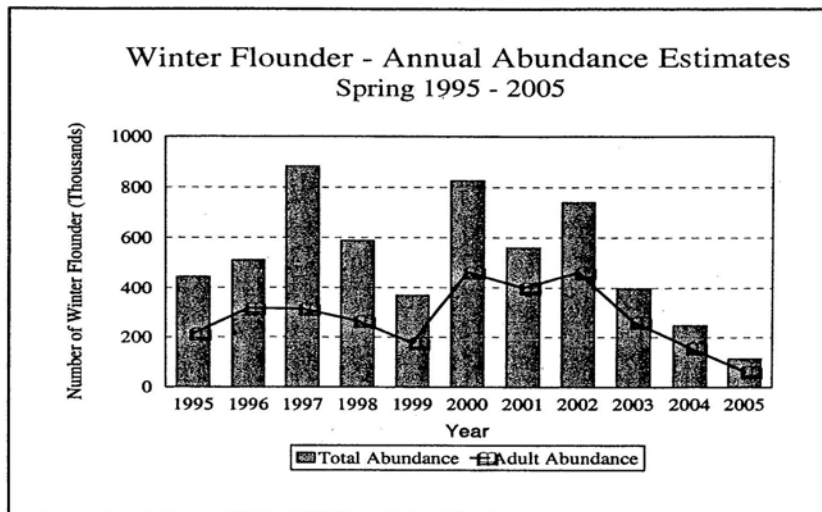


Figure 2-8. Winter Flounder Abundance Estimates in Northwest Cape Cod Bay (As provided in: MRI 2006)

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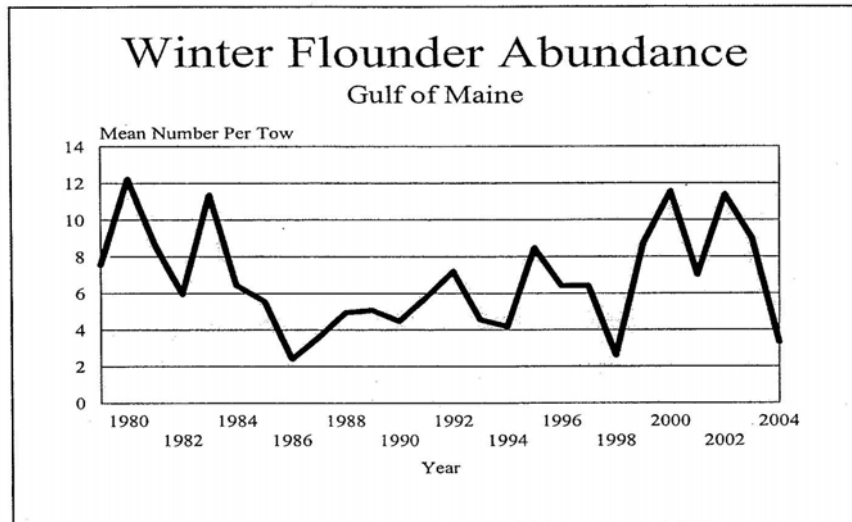


Figure 2-9. NMFS Winter Flounder Abundance in the Gulf of Maine (As provided in: Normandeau Associates 2006a)

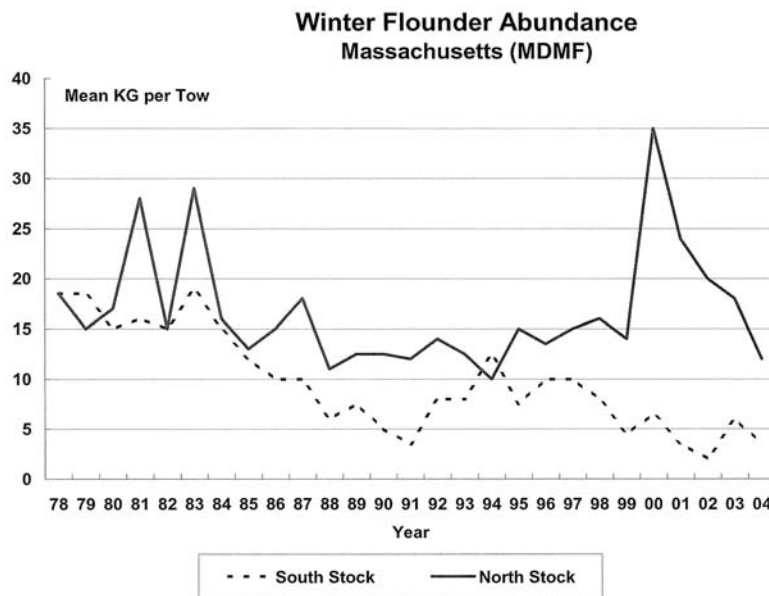


Figure 2-10. MDMF Winter Flounder Abundance in the Gulf of Maine (Recreated from: Normandeau Associates 2006a)

1 **Winter skate (*Leucoraja ocellata*)**

2
3 The winter skate is one of seven species of skates found throughout the western North Atlantic
4 (Sosebee 2000c). The winter skate is often confused with the little skate due to similarity in
5 appearance, but the winter skate is not as abundant (McEachran and Musick 1975, in Packer et
6 al. 2003a). Skates are fished commercially, but with no distinction between the seven species
7 (Packer et al. 2003a). Most commercial use of skates is for lobster bait, but two skates
8 (including the winter skate) are used for human consumption (Packer et al. 2003a). Little
9 information on the life history of the winter skate exists. Eggs of all skates are known to be
10 encapsulated in a leathery capsule that rests on the bottom (Sosebee 2000c; Packer et al.
11 2003a). The eggs hatch fully developed, so there is no larval stage (Sosebee 2000c;
12 McEachran 2002, in Packer et al. 2003a). Off of Nova Scotia and in the Gulf of Maine,
13 spawning occurs during summer and fall (Bigelow and Schroeder 1953, in Packer et al. 2003a).
14 The predominant food source for winter skates is polychaetes and amphipods, with additional
15 feeding upon decapods, isopods, bivalves, and fish (McEachran 1973, in Packer et al. 2003a).
16 Fish species that are prey for the winter skate include smaller skates, eels, alewives, blueback
17 herring, menhaden, smelt, sand lance, chub mackerel (*Scomber japonicus*), butterfish, cunners,
18 and silver hake (Bigelow and Schroeder 1953, in Packer et al. 2003a).

19
20 The winter skate is most commonly found on the Georges Bank and in the northern section of
21 the Mid-Atlantic Bight (McEachran and Musick 1975; in Packer et al. 2003a). Skates have been
22 landed as bycatch in New England since the late 1960s, but were not directly targeted as a
23 fishery until the 1980s. There is no differentiation between the skate species in terms of
24 differentiation of stocks. Winter skates in the Gulf of Maine primarily live at depths of 46 to 64
25 m (151 to 210 ft) (Bigelow and Schroeder 1953; McEachran 2002, in Packer et al. 2003a). The
26 species can live in a variety of water temperatures, and are reported near the Massachusetts
27 coast in water from 1 to 20°C (Bigelow and Schroeder 1953; in Packer et al. 2003a). The
28 species prefers sandy and gravel bottom substrates (Scott 1982a, in Packer et al. 2003a).
29 Skates do not migrate substantially, but do generally move offshore in summer and early
30 autumn and onshore during winter and spring (Sosebee 2000c).

31
32 In 2001, NMFS determined that the winter skate was in an overfished condition, and that
33 overfishing was occurring (NMFS 2001c). In 2002, a new assessment resulted in a change of
34 the status to not overfished (NMFS 2002b, in Packer et al. 2003a). No life stages of the winter
35 skate have ever been observed in the PNPS entrainment sampling. Juveniles and/or adults
36 have been observed in the PNPS impingement sampling program.

Witch flounder (*Glyptocephalus cynoglossus*)

The witch flounder is a deep water flatfish that occurs on both sides of the Atlantic Ocean (Wigley et al. 2003). Prior to the 1980s, witch flounder was not targeted and was landed mostly as bycatch (Wigley 2000b). Eggs are released on the bottom, but are pelagic and rise to the surface. Larvae are also pelagic, and the species descend to the bottom as juveniles at the age of 4 to 12 months (Bigelow and Schroeder 1953; Evseenko and Nevinsky 1975, in Cargnelli et al. 1999d). Sexual maturity is reached at various ages, with a range of from 5 to 9 years (Beacham 1983, in Cargnelli et al. 1999d). Spawning occurs from March to November, with peak spawning during the summer, at temperatures from 0 to 10°C (Bigelow and Schroeder 1953, in Cargnelli et al. 1999d). The western and northern areas of the Gulf of Maine are reported to be the most active spawning areas for the species (Burnett et al. 1992, in Cargnelli et al. 1999d). The primary prey for the witch flounder are polychaetes and crustaceans, with additional contribution from mollusks and echinoderms (Cargnelli et al. 1999d).

In U.S. waters, the witch flounder is common in the Gulf of Maine and lives in deeper areas of the Georges Bank and along the continental shelf as far south as Cape Hatteras (Cargnelli et al. 1999d). The witch flounder lives in deep water, down to depths of 1500 m (4921 ft), in water about 2 to 9 °C (Lange and Lux 1978; Scott 1982b, in Cargnelli et al. 1999d). The witch flounder is associated with mud, silt, and clay substrates, and is rarely found on any other bottom types (Powles and Kohler 1970; Martin and Drewry 1978; Scott 1982a, in Cargnelli et al. 1999d). All life stages of witch flounder are common in Massachusetts Bay. Eggs were found to be abundant in Massachusetts Bay in the months of May and June (Cargnelli et al. 1999d). Bottom trawl surveys and inshore surveys found the greatest concentrations of juveniles on Stellwagen Bank in Massachusetts Bay. Adults were found in the highest concentrations in Massachusetts Bay in the autumn, including some catches in Cape Cod Bay (Cargnelli et al. 1999d).

The species is managed as a single stock under the NEFMC Northeast Multispecies FMP (NEFMC 1993, in Cargnelli et al. 1999d; Wigley and Col 2005a). The stock extends from the northern Gulf of Maine to southwestern Georges Bank (NMFS 2003b). As of 1997, the witch flounder stock was reported to be in an overfished condition (NMFS 1997). In 2003, the stock was reported to not be overfished, but overfishing was occurring (NMFS 2003b, Wigley et al. 2003). Eggs and larvae of the witch flounder have been collected in the PNPS entrainment sampling. No life stages have been observed in the PNPS impingement sampling program.

1 **Yellowtail flounder (*Pleuronectes ferruginea*)**

2
3 The yellowtail flounder is a right-eyed, benthic flatfish that is an important commercial species
4 (Cadrin 2000). Both the eggs and larvae of the yellowtail flounder reside in the water column,
5 and are found between mid March and July, peaking between April and June. Larvae may drift
6 in surface waters before developing into juveniles, and dropping to the bottom
7 (Overholtz and Cadrin 1998, in ENSR 2000). The median age for sexual maturity is about 2.6
8 years for females off of Cape Cod (O'Brien et al. 1993, in Johnson et al. 1999a). Spawning
9 occurs in the Gulf of Maine, Georges Bank, and southern New England shelf during the spring
10 and summer months (Overholtz and Cadrin 1998; NEFMC 1998a, in ENSR 2000). Adult
11 yellowtail flounder feed on small benthic invertebrates such as polychaete worms, isopods,
12 shrimp, and amphipods, and also can feed on small forage fish species (Cooper et al. 1998, in
13 ENSR 2000).

14
15 The yellowtail flounder ranges from Labrador to the Chesapeake Bay, and is most abundant in
16 the western Georges Bank, western Gulf of Maine, east of Cape Cod, and southern New
17 England (Johnson et al. 1999a). Mark and recapture studies have shown that yellowtail
18 flounder do not migrate, other than minor movements between shallow and deeper water in
19 response to seasonal temperature variation (Royce et al. 1959; Lux 1964, in Johnson et al.
20 1999a). Yellowtail flounder typically live at depths of between 37 to 87 m (121 to 285 ft), with
21 substrates of mud or sand (Cooper et al. 1998; DFO 1997; Overholtz and Cadrin 1998, in ENSR
22 2000). Adults live in waters ranging from 2 to 12°C (Johnson et al. 1999a). In a MDMF
23 bottom-trawl survey, both adults and juveniles were found to concentrate seasonally in coastal
24 waters from northwestern Cape Cod Bay to Ipswich Bay. Juveniles were found to migrate
25 inshore in Cape Cod Bay in the fall (Johnson et al. 1999a).

26
27 In the U.S., the populations are managed as four separate stocks, including southern New
28 England, Georges Bank, Cape Cod, and Mid-Atlantic Bight (Johnson et al. 1999). The yellowtail
29 flounder fishery is managed under the NEFMC Northeast Multispecies FMP
30 (Cadrin 2000b). Yellowtail flounder has been a major constituent of the commercial fishery
31 since the early 1930s. Population data evaluated by Johnson et al. (1999a) for all four stocks
32 showed significant variation through time, with increases and decreases occurring throughout
33 the 1960s through the 1990s. The Cape Cod – Gulf of Maine stock was considered to be at low
34 biomass and overexploited in 2001 (Cadrin et al. 2005). In 2005, an analysis of juvenile
35 populations resulted in a proposal for the potential designation of HAPCs for the yellowtail
36 flounder, including areas within Cape Cod Bay, adjacent to PNPS (Crawford et al. 2005). Eggs
37 and larvae of the yellowtail flounder have been collected in the PNPS entrainment sampling.
38 Juveniles and/or adults have also been observed in the PNPS impingement sampling program.

2.2.5.3.2 Pelagic Invertebrates

Longfin squid (*Loligo pealei*)

The longfin squid is a schooling species, which is distributed in the waters of the continental shelf and slope from Newfoundland to the Gulf of Venezuela (Cadrin 2000a in ENSR 2000). During late autumn to winter, longfin squid migrate to warmer waters along the edge of the continental shelf (Cadrin 2000a in ENSR 2000). During the spring and early summer, the species moves inshore to spawn (Cadrin 2000a in ENSR 2000). The species is known to spawn year round, which varies seasonally and geographically (Brodziak et al. 1996 and Hatfield and Cadrin 2002 in Jacobson 2005). Males can grow to reach more than 40 cm (16 in.) in dorsal-mantle length, even though the majority of squid collected in the commercial fishery are smaller than 30 cm (12 in.) long (Cadrin 2000a). Food habits of longfin squid depend on size; small individuals consume planktonic organisms (Vovk 1972; Tibbetts 1977 in Cargnelli et al. 1999g) whereas larger individuals consume crustaceans and small fish (Vinogradov and Noskov 1979 in Cargnelli et al. 1999g). Seasonal and inshore/offshore variances in the diets of longfin squid were demonstrated by Maurer and Bowman (1985 in Cargnelli et al. 1999). Longfin squid are typically observed in waters with temperatures of at least 9°C (Lange and Sissenwine 1980 in Cargnelli et al. 1999g).

Overfishing of longfin squid is an important issue due to the fact that the species recruits to the population and to the spawning stock in the same year (Cadrin 2000a). During 1998, the stock was reported to be approaching an overfished condition and overfishing was also occurring (Cadrin 2000a). Based on data presented in the 2002 Assessment Status Summary, the stock is not in an overfished condition, and overfishing is not occurring (NMFS 2002c). The longfin squid has not been observed in the PNPS entrainment sampling program. It has been collected within the impingement sampling program.

Shortfin squid (*Illex illecebrosus*)

The shortfin squid is highly migratory and is found primarily in the offshore waters of the continental shelf and slope from Florida to Labrador (Hendrickson 2004). Individuals experience an extensive spawning migration to warmer waters south of Cape Hatteras during the autumn (Hendrickson 2004). Peak spawning occurs during the winter, and larvae and juveniles drift northward in the warm waters of the Gulf Stream (Hendrickson 2000a in ENSR 2000). The squid that spawned throughout the winter will migrate during late spring onto the continental shelf (Hendrickson 2000a in ENSR 2000). Shortfin squid live for approximately 1 year and grow rapidly during the first few months of existence (NOAA 1998). Shortfin squid can reach dorsal-mantle lengths up to 35 cm (14 in.), even though the majority of squid collected in

1 the commercial fishery are smaller than 25 cm (10 in.) (Hendrickson 2004). The diet of shortfin
2 squid typically consists of fish and crustaceans (Squires 1957; Froerman 1984; Mauer and
3 Bowman 1985; Dawe 1988 in Cargnelli et al. 1999h).

4
5 Data collected during 1994 to 1998 demonstrated that the stock was probably not in an
6 overfished condition (Hendrickson 2000a). Based on data presented in the 2003 Advisory
7 Report, the stock did not experience overfishing during 1999 to 2002 (NMFS 2003b). However,
8 according to the 2005 Assessment Summary, the current stock was not able to be evaluated
9 due to the lack of reliable data for determining stock biomass and fishing mortality rate
10 (NMFS 2006a). The shortfin squid has not been observed in the PNPS entrainment or
11 impingement sampling program.

12 13 **2.2.5.3.3 Plankton**

14 15 **Phytoplankton**

16
17 The western Cape Cod Bay phytoplankton community, including the surrounding area of PNPS,
18 seems to be more similar to the Gulf of Maine (to the north of Cape Cod) than to the
19 communities located south of the Cape (ENSR 2000). In the 1970s, two studies were
20 performed to identify the phytoplankton communities in the PNPS surrounding area
21 (ENSR 2000). Various samples were taken from the intake and discharge areas of PNPS and
22 from a station positioned 1000 ft (305 meters) offshore during 1971 (ENSR 2000). A
23 widespread study was also conducted to identify phytoplankton entrained at the plant between
24 1973 and 1975 (Toner 1984a, in ENSR 2000). The samples gathered at the discharge were
25 examined to determine the onshore species composition and then compared to populations
26 collected monthly at various distances offshore (i.e., 0.25, 0.5, and 1 mi) between December
27 1974 and February 1975 (ENSR 2000). The 1971 onshore samples consisted of 46 species of
28 phytoplankton and 3 unidentifiable taxa (ENSR 2000). The offshore samples collected in
29 1974/1975 included 73 taxa, with 50 identified to the species level (ENSR 2000). No significant
30 difference in species composition was detected between the onshore and offshore samples.

31
32 Based on these two studies, diatoms appear to be the most abundant taxa throughout the year
33 (Marshall 1978 in ENSR 2000). These studies have also demonstrated a seasonal pattern in
34 the phytoplankton communities adjacent to PNPS (ENSR 2000).

35
36 Phytoplankton density peaks were observed, which included two annual peaks, one in February
37 to March (11 million cells/L) referred to as the spring bloom, and a second peak was noted in
38 July (1 to 2 million cells/L) (ENSR 2000). The December/January densities were the lowest
39 noted, followed by April (ENSR 2000). These results are somewhat confirmed by Thomas et al.
40
41

1 (2003) who used satellite-based imaging of the Gulf of Maine to evaluate chlorophyll levels,
2 detected both a spring and fall bloom. Thomas et al. (2003) also determined that seasonal
3 cycles in chlorophyll are dependent upon the relationship of tidal mixing, bathymetry, and
4 residual circulation with the most dominant seasonal cycles occurring in deeper basins.

6 Zooplankton

7
8 New England zooplankton studies have focused on the Gulf of Maine and the Georges Bank
9 area southeast of Cape Cod (ENSR 2000). The effects of the Cape Cod Canal on the
10 copepods of Buzzards Bay and Cape Cod Bay were examined (Anjaru 1964 in ENSR 2000).
11 During 1970 and 1971, the samples collected from Cape Cod Bay in the surrounding area of
12 PNPS demonstrated a zooplankton community that was minimal during the winter months,
13 followed by increasing densities in the summer (ENSR 2000). Copepods, which included
14 *Pseudocalanus elongates*, *Temora longicornus*, and *Acartia clause*, dominated the zooplankton
15 community throughout this study (Stone and Webster 1975 in ENSR 2000). This study
16 demonstrated seasonal cycles for zooplankton abundances, attaining maximum densities in
17 August and minimum densities in January and February (ENSR 2000) (Figure 2-2).

18 2.2.5.3.4 Benthic Invertebrate

19
20
21 Habitats found within the area of PNPS include both rocky and sandy intertidal and rocky and
22 sandy subtidal areas (ENSR 2000). Surveys of all four habitat types were included in the
23 long-term benthic monitoring program at PNPS (1974 to 1991), with sampling transects located
24 at Rocky Point in, the vicinity of the discharge canal, near White Horse Beach, and near
25 Manomet Point (Davis and McGrath 1984; SAIC 1992 in ENSR 2000).

26
27 The sandy intertidal areas close to PNPS, while limited, are typically composed of coarse gravel
28 overlying finer sands in a fairly high-energy environment (ENSR 2000). Interstitial organisms or
29 larger, mobile organisms, such as hermit crabs, participate in the limited faunal colonization
30 (ENSR 2000). A discussion follows of monitoring studies for the other three habitat types:
31 rocky intertidal, rocky subtidal, and sandy subtidal (ENSR 2000).

32
33 The rocky intertidal habitat is composed of large boulders interspersed with smaller rocks and
34 patches of cobble, gravel, and coarse sand (ENSR 2000). The fauna in this zone are adjusted
35 to the extreme conditions associated with the tidal cycles, including the physical stresses of
36 temperature fluctuations, desiccation, and ice scouring (ENSR 2000). Populations also are
37 controlled by predation and competition for space (Menge 1976 in ENSR 2000). Rocky
38 intertidal samples were taken from late 1971 through mid-1979 (ENSR 2000). The barnacle
39 *Balanus balanus* is common throughout the area and is the primary macrofaunal organism in
40 the upper rocky intertidal zone (ENSR 2000). The gastropods *Littorina littorea* and *L. obtusata*
41 are also frequent in this habitat. In the middle and lower intertidal zones, the blue mussel and

Plant and the Environment

1 macroalgae replaced barnacles (ENSR 2000). *Asterias* spp. and the carnivorous gastropod
2 *Nucella lapillus* are regular predators of sessile species in this zone (ENSR 2000). The
3 holdfasts of the macroalgae supply a habitat for small polychaetes, mollusks, and amphipods,
4 including the sabellid polychaete *Fabricia sabella* and the amphipods *Hyale nilsoni* and *Caprella*
5 *penantis* (Davis and McGrath 1984 in ENSR 2000). Faunal densities typically ranged from 104
6 to 105 individuals/m² (10 individuals/ft²)(ENSR 2000).

7
8 The most heavily studied benthic habitat in the PNPS area is the rocky subtidal habitat (ENSR
9 2000). Sampling started in 1971 and continued through 1991 at Rocky Point, near the
10 discharge and Manomet Point. Crustaceans were the biggest taxonomic group collected in the
11 samples (ENSR 2000). The main crustaceans included 34 species of amphipods and also 30
12 species each of polychaetes and mollusks (ENSR 2000). Twelve percent of the total fauna was
13 represented by nemerteans, echinoderms, and anemones (ENSR 2000). The dominant 15
14 species represented 90 to 98 percent of the observed fauna at each of the three stations and
15 between 40 and 80 species represented the remaining 2 to 10 percent (ENSR 2000). Total
16 faunal densities in the rocky subtidal habitat fluctuated widely from 1983 through 1991, mainly
17 because of periodic mass settlements of *Mytilus edulis* (ENSR 2000). Densities still
18 demonstrated a seasonal and a long-term cyclic pattern even when *M. edulis* is taken away
19 from the total (ENSR 2000). The data reveal a seasonal pattern of low diversity in the spring
20 followed by higher values in the fall (ENSR 2000). Rocky Point typically had the highest
21 diversity, even though Manomet Point samples had very similar results (ENSR 2000).

22
23 Sandy subtidal habitat is extensive all through western Cape Cod Bay (ENSR 2000). The area
24 immediately surrounding PNPS is predominantly sand, although just to the north in the Rocky
25 Point area, rock ledges and boulders are found (ENSR 2000).

26
27 At White Horse Beach and close to the discharge area at PNPS, transects of sandy subtidal
28 locations were established (ENSR 2000). Two sites were established at each of the sampling
29 locations, one located at the 10 ft (3 m) depth and the other at the 30 ft (9 m) depth (ENSR
30 2000). Quantitative sampling was performed at these locations from 1971 through 1979 (ENSR
31 2000). Amphipods *Acanthohaustodus millsii* and *Protohaustorius deichmannae* were the most
32 prevalent species discovered, regularly resulting in 75 percent of the total individuals in a
33 sample (ENSR 2000). The common sand shrimp, *Crangon septemspinosus*, the moon snail
34 *Lunatia heros*, and the sand dollar *Echinarachnius parma* were other species discovered in this
35 environment (ENSR 2000). These species, while prevalent and dispersed throughout the area,
36 were not present in significant quantities (ENSR 2000). Davis and McGrath (1984 in ENSR
37 2000) demonstrated that faunal densities ranged from 10³ to 10⁴ individuals/m² (93 to 929
38 individuals / ft²) at both the 10-ft (3-m) and 30-ft (9.1-m) depths; these densities are
39 approximately an order of magnitude lower than those found at the rocky subtidal stations.

1 In addition to the benthic species described above, there are several species of larger benthic
2 invertebrates, which are found in the area and are considered to be important to the benthic
3 community of western Cape Cod Bay. These include the American lobster (*Homarus*
4 *americanus*), Atlantic sea scallop (*Placopecten magellanicus*), surf clam (*Spisula solidissima*),
5 and ocean quahog (*Arctica islandica*). Discussions of the ecology, life history, and status of
6 these species follow.

7 8 **American lobster (*Homarus americanus*)**

9
10 The American lobster is a large, mobile, benthic macroinvertebrate of the sublittoral zone
11 (ENSR 2000). It is a marine crustacean that occurs in a wide range of habitats along the
12 continental shelf and upper slope of the western North Atlantic from Labrador to Cape Hatteras
13 (ENSR 2000). The primary depth range is from the sublittoral fringe to 50 m (164 ft), but lobster
14 may be fished out to depths of 700 m (2297 ft) (ENSR 2000). Off the coast of Newfoundland to
15 Maine, the largest numbers of this species occur near the middle of this range, where ambient
16 bottom water temperatures typically range from 28 to 75°F (2.2 to 23.9°C) (McLeese and Wilder
17 1958 in ENSR 2000). Changes in temperature initiate seasonal migrations to offshore waters in
18 the fall and inshore waters in the spring (McLeese and Wilder 1958 in ENSR 2000) to reach
19 temperatures for proper synchrony of molting and reproductive cycles (Harding 1992 in ENSR
20 2000).

21
22 The majority of lobster populations hatch from mid-June through September (Perkins 1972 in
23 ENSR 2000). The typical hatching process of lobsters was documented by Sherman and Lewis
24 (1967) as occurring from June through August as water temperatures range from 54 to 59°F
25 (12.2 to 15°C) (ENSR 2000). The early larval stages I, II, and III are planktonic, lasting from 6
26 to 8 weeks, and stage IV postlarvae, also planktonic, metamorphose into adult shape and start
27 to demonstrate actions that result in the lobster settling to the bottom (ENSR 2000). The newly
28 settled juveniles reside in burrows, steadily adjusting to life on the surface of the substrate
29 (ENSR 2000).

30
31 Various special studies relating to the lobster have been performed within the PNPS area due to
32 the commercial importance of this species (ENSR 2000). Results of studies performed from
33 1974 to 1977 on the seasonal occurrence, abundance, and distribution of larval lobsters
34 proposed that a major percentage of the larval lobsters discovered in Cape Cod Bay in June
35 may have traveled through the Cape Cod Canal due to the warmer temperatures favorable to
36 hatching (ENSR 2000). Matthiessen (1984) proposes that the Cape Cod Canal may be a major
37 source of recruitment to the Cape Cod Bay lobster stocks due to the intricate dispersal patterns
38 (ENSR 2000). From 1970 to 1977, in the PNPS area, a tag and retrieval study was performed
39 to examine the movement and growth of sublegal, sexually immature lobsters that were
40 captured and released (Lawton et al. 1984 in ENSR 2000). Examination of the data implied that
41 movement of this population was very restricted, since 71 percent of the returns were

1 recaptured on the ledges where they had initially been released (ENSR 2000). The remaining
2 29 percent had moved from 4.8 to 45 km (3.0 to 28 mi), in various directions such as northwest
3 towards Boston and east southeast through the Cape Cod Bay (ENSR 2000). Comparable
4 research implied that there was a moderate seasonal movement to inshore waters in the spring
5 and offshore waters in the fall, but not as great as the migrations of larger, sexually mature
6 individuals (Lawton et al.1984 in ENSR 2000).

7
8 The second largest U.S. lobster fishery is the Massachusetts lobster fishery, accounting for
9 about 28 percent of the U.S. landings (Estrella and Morissey 1997 in ENSR 2000).
10 Predominantly during the months of March and November, the lobster is prevalent in western
11 Cape Cod Bay and enhances an important commercial fishery in the PNPS area (Lawton et al.
12 1984 in ENSR 2000). The most economically valuable fishery in Massachusetts territorial
13 waters is the commercial lobster fishery in the PNPS area (ENSR 2000). American lobster
14 larvae have been collected in the PNPS entrainment sampling. Juveniles and/or adults have
15 been observed in the PNPS impingement sampling program.

16
17 **Atlantic sea scallop (*Placopecten magellanicus*)**

18
19 The Atlantic sea scallop is a bivalve distributed along the western North Atlantic shelf between
20 the Gulf of St. Lawrence and Cape Hatteras (Hart and Chute 2004). North of Cape Cod, the
21 sea scallop is generally found at depths of less than 20 m (65 ft) on hard substrates of cobble,
22 shell litter, or coarse gravel/sand (NEFMC 1998a; Lai and Rago 1998 in ENSR 2000). Some
23 sea scallops begin reaching sexual maturity at age 2; however, most do not reach sexual
24 maturity until age 3 (Hart and Chute 2004). Spawning season begins in May and extends
25 through October. Peak spawning activity depends on location. Spawning peaks between May
26 and June in the mid Atlantic and in September and October in Georges Bank, usually in water
27 temperatures below 16°C (61°F) (NEFMC 1998a). Scallops spawn as many as one million
28 eggs per year, depending on the size of the female (MacKenzie 1979, as cited in Hart et al.
29 2004). Eggs are not buoyant and remain on the substrate until hatching into free swimming
30 larvae (NEFMC 1998a). Larvae occupy pelagic waters and bottom habitats of gravel, shell litter,
31 algae, or sedentary benthic infauna (NEFMC 1998a). Sea scallops are suspension filter
32 feeders, and their diet typically consists of phytoplankton and microzooplankton (Hart and Chute
33 2004).

34
35 The Atlantic sea scallop supports one of the most valued shellfish fisheries in the U.S. (Hart and
36 Chute 2004). Based on the 2004 stock assessment, the stock in the area appears to be healthy
37 with recent landings data being the highest on record and recruitment to the stock being above
38 average (NEFSC 2004). No life stages of the Atlantic sea scallop have ever been observed in
39 the PNPS entrainment or impingement sampling.

Cancer crabs (*Cancer* spp.)

Two species of cancer crabs found in Massachusetts are the rock crab (*Cancer irroratus*) and the Jonah crab (*C. borealis*). Both species are distributed from Nova Scotia to the southeastern U.S. (Estrella undated). All species of cancer crabs share similar life history characteristics. Eggs undergo a development period of several weeks and, after hatching, the larvae are planktonic. The larvae advance through six stages of successive increases in size by molting, a process which take several weeks. Once the larvae reach the first crab stage (first instar), they sink to the bottom and begin their benthic phase. Both species become sexually mature within 1 to 2 years. Mating occurs while they are in the soft-shell molt condition, usually in winter (Hines 1991 in RWQCB 2004).

Rock crabs exist in rocky habitats, but can be displaced onto sandy habitat by shelter-space competition with Jonah crabs and the American lobster (Estrella undated). Rock crabs are found in intertidal habitats north of Cape Cod, and in progressively deeper water farther south along the Atlantic coast (Gosner 1978). Jonah crabs live in exposed locations on rocky coasts, but can also be found on muddy bottom substrates in deeper waters. Both species are commercially fished within Massachusetts, and the Commonwealth places restrictions on landings from December 1 to March 31, which includes the rock crab's molting period. The population of rock crabs within Massachusetts is at or below its median population for the past 24 years, while the Jonah crab population is considered to be stable (Estrella undated). Cancer crabs are frequently observed in the PNPS impingement monitoring program (Normandeau Associates 2006b). Cancer crabs have been collected as part of the PNPS impingement monitoring program; however, they have not been observed in the PNPS entrainment monitoring program.

Sevenspine bay shrimp (Sand shrimp) (*Crangon septemspinous*)

The sevenspine bay shrimp, also known as the sand shrimp, is an ecologically important species of coastal and estuarine waters of the western Atlantic. The range of the species extends from the northern Gulf of St. Lawrence to Florida (Squires 1996 in Locke et. al 2005). The species lives in shallow subtidal areas up to 90 m (295 ft) deep, and up to the low tide line (Gosner 1978). The species prefers sandy bottoms and eelgrass beds, but mostly lives at the sediment-water interface, as opposed to burrowing (Gosner 1978).

Sevenspine bay shrimp are the numerically dominant invertebrate species collected as part of the PNPS impingement sampling (Normandeau Associates 2006b). They have not been collected as part of the entrainment sampling at PNPS (Normandeau Associates 2006b).

1 **Ocean quahog (*Arctica islandica*)**
2

3 The ocean quahog is a bivalve mollusk distributed from Newfoundland to Cape Hatteras at
4 depths of up to 256 m (840 ft). In the Gulf of Maine region, they are found in relatively
5 nearshore waters (Weinberg 2001). They are among the longest lived and slowest growing of
6 marine bivalves and may reach an age of 225 years (Cargnelli et al.1999f). Similar to surf
7 clams, they are planktivorous, siphon feeders and are preyed upon by moon snails, boring
8 snails, and predatory fish such as haddock and cod. (Cargnelli et al.1999f). Estimates for
9 attaining sexual maturity have ranged from 9 to 13 years (Cargnelli et al.1999f). No life stages
10 of the ocean quahog have ever been observed in the PNPS entrainment or impingement
11 sampling.
12

13 **Surf clam (*Spisula solidissima*)**
14

15 The surf clam is a bivalve mollusk that is distributed in waters of the western North Atlantic from
16 the Gulf of St. Lawrence to Cape Hatteras (Cargnelli et al.1999b). Surf clams inhabit sandy
17 bottom habitats and are most common at depths of 8 to 66 m (26 to 217 ft) in the turbulent
18 areas beyond the breaker zone (Cargnelli et al. 1999b). Surf clams are planktivorous, siphon
19 feeders including diatoms and ciliates (Cargnelli et al.1999b). They are preyed upon by moon
20 snails, boring snails, and predatory fish such as haddock and cod. Surf clams are capable of
21 reproduction in their first year of life, although they may not reach full maturity until the second
22 year (Weinberg 2000). Water currents in areas where planktonic surf clam larvae live are
23 important in determining eventual patterns of distribution and settlement for developing juveniles
24 (ENSR 2000). Based on the 2003 stock assessment, the stock throughout the entire Exclusive
25 Economic Zone (EEZ) is not overfished and overfishing is not occurring (NMFS 2003b). No life
26 stages of the surf clam have ever been observed in the PNPS entrainment or impingement
27 sampling.
28

29 **2.2.5.3.5 Marine Aquatic Plants**
30

31 The marine environment in the vicinity of PNPS is typical of shallow, exposed areas in western
32 Cape Cod Bay and is characterized by sand and gravel interspersed with large rocks and
33 boulders. Several surveys of macroalgae have been conducted at PNPS and have included
34 intertidal (through 1978) and subtidal (through 1991) qualitative and quantitative sampling.
35

36 In the intertidal zone, qualitative sampling was performed for 4 years, beginning in October
37 1974, at four locations: Rocky Point, northwest of the PNPS discharge canal, White Horse
38 Beach, and Manomet Point. At each station, a 6-in.-wide transect extending from the mean
39 high to the mean low water levels was established. A total of 137 species was recorded,
40 including two cyanophyta, 40 chlorophyta, 48 phaeophyta, and 47 rhodophyta. The number of
41 species per station over the sampling period ranged from a low of 97 at Manomet Point to a

1 high of 111 at the station discharge. Species richness generally ranged between 60 and 70
2 representative taxa each year, with a greater number of species recorded after the first year of
3 sampling. The dominant algae at all elevations were the brown fucoids *Ascophyllum nodosum*
4 and *Fucus vesiculosus*. The greatest cover by *Ascophyllum* was at the Manomet Point and
5 Rocky Point station, whereas *Fucus* was more common at the discharge location. Five species
6 were recorded only at the discharge location: *Enteromorpha aragonensis*, *Bryopsis plumosa*,
7 *Codium fragile*, *Gracilaria follifera*, and *Soliera tenera*. These species are known to prefer the
8 warmer waters south of Cape Cod, and their presence at this location was probably a
9 consequence of the thermal discharge (ENSR 2000).

10
11 In the subtidal zone, the long-term benthic monitoring program at PNPS (1974 to 1991) included
12 surveys of subtidal macroalgae at three sampling sites: Rocky Point, near the PNPS discharge
13 canal, and Manomet Point (Grocki 1984; SAIC 1992). Over 112 species of algae were identified
14 from the samples taken over the course of the monitoring program. The subtidal macrophytes
15 are dominated by the rhodophyta or red algae. There are no reports of eelgrass (*Zostera*
16 *marina*) in the immediate vicinity of PNPS. Irish moss (*Chondrus crispus*) is the dominant
17 subtidal macrophyte in Cape Cod Bay and is the chief component of the subtidal flora near
18 PNPS. Depending on depth, Irish moss covers up to 90 percent of the available substrate,
19 attaining a maximum density between MLW and 14 ft (4.3 m) below MLW.

20
21 Irish moss is a benthic, marine red alga found from New Jersey to Labrador, with highest
22 abundances near the center of this range. It inhabits rocky substrates from below MLW to a
23 depth of 38 m (125 ft), with maximum densities in the PNPS area occurring between MLW and
24 a depth of 6 m (19.7 ft). The lower limits of its distribution are controlled by light, water
25 transparency, availability of substrate, and competition for space. It is euryhaline, occurring in
26 salinities between 8 and 40 ppt, and it is a dominant component of the subtidal flora in the
27 vicinity of PNPS (ENSR 2000).

28
29 The PNPS thermal discharge is located in the middle of an Irish moss commercial bed (MDMF
30 1992). The immediate area of the discharge is denuded; just beyond the denuded area is an
31 area of stunted or sparse growth of Irish moss. Through 1998, the largest affected area ever
32 observed was in 1997. This included denuded areas as well as areas of stunted or sparse
33 growth, covered about 1.1 ac.

34
35 Irish moss is an important commercial species that has been harvested along the western shore
36 of Cape Cod Bay since the 1800s (MDMF 1992). The seaweed is harvested as a source of
37 carrageenan, a hydrocolloid unique for its jelling, suspension, and viscosity properties.
38 Carrageenan is widely used as a suspending and thickening agent in the brewing, baking,
39 pharmaceutical, and dairy industries. The harvesting season extends from early June through
40 August, with peak harvest usually occurring in July. However, since the 1990s, harvesting of
41 Irish moss has been virtually nonexistent in the Plymouth area (Lawton et al.1992).

1 At greater depths, Irish moss density decreases and phyllophora (*Pyllophora brodiaei* and
2 *Pyllophora membranifolia*) become the dominant macrophytes. *Laminaria* sp., *Corrallina*
3 *officinalis*, *Polydesrotundus* sp., and *Lithothamnion* sp. are the remaining conspicuous
4 representatives of the subtidal algal flora. Epiphytic species include the rhodophytes *Ceramium*
5 *rubrum*, *Cystoclonium purpureum*, and *Spermothamnion repens*. The warm-water species
6 *Gracilaria tikvahiae* has been recorded on several occasions, primarily in the area of the
7 discharge canal. No life stages of the Irish moss have been observed in the impingement
8 monitoring; however, spores have been observed in the entrainment sampling.
9

10 **2.2.5.3.6 Marine Mammals**

11
12 A variety of marine mammals may occur within Cape Cod Bay for at least a part of their life
13 cycle. Several of these marine mammals species are Federally listed whales, which are
14 additionally protected under the Endangered Species Act of 1976, as amended (ESA). Such
15 species are discussed further in Section 2.2.5.3.7.
16

17 All marine mammals are protected under the Marine Mammal Protection Act (MMPA) of 1972
18 as amended. The MMPA, prohibits, with certain exception, the direct or indirect taking of
19 marine mammals. The two major groups of marine mammals that may occur within Cape Cod
20 Bay include the cetaceans (whales, dolphins, and porpoises) and pinnipeds (seals, sea lions,
21 and walruses).
22

23 Among the non-Federally listed whale species that may occur in this area are sperm whale
24 (*Physeter macrocephalus*), beluga whale (*Delphinapterus leucas*), killer whale (*Orcinus orca*),
25 minke whale (*Balaenoptera acutorostrata*), and long-finned pilot whale (*Globicephala melaena*)
26 (Provincetown Center for Coastal Studies 2006a, Short and Michelin 2006). Of these five
27 species only the long-finned pilot whale and the minke whale are seen with any regularity in the
28 Gulf of Maine, which includes Cap Cod Bay (Provincetown Center for Coastal Studies 2006a,
29 Short and Michelin 2006).
30

31 Non-Federally listed dolphin and porpoise species that may occur in this area include the white-
32 beaked dolphin (*Lagenorhynchus albirostris*), Atlantic white-sided dolphin (*L. acutus*), common
33 dolphin (*Delphinus delphis*), bottlenose dolphin (*Tursiops truncatus*), Risso's dolphin (*Grampus*
34 *griseus*), striped dolphin (*Stenella coeruleoalba*), and the harbor porpoise
35 (*Phocoena phocoena*) (Provincetown Center for Coastal Studies 2006a). Of these seven
36 species, only the Atlantic white-sided dolphin and the harbor porpoise are regularly observed in
37 the Gulf of Maine (Provincetown Center for Coastal Studies 2006a). Both of these species are
38 also commonly observed in Cape Cod Bay (Short and Michelin 2006).
39
40

1 Sea lions and walruses are not found in Gulf of Maine, thus the only pinnipeds potentially found
2 in Cape Cod Bay would be the true seals. Five species of seals have been observed in the Gulf
3 of Maine. These include harbor seals (*Phoca vitulina*), gray seals (*Halichoerus grypus*), harp
4 seals (*P. groenlandica*), hooded seals (*Cystophora cristata*), and ringed seals (*P. hispida*)
5 (Provincetown Center for Coastal Studies 2006b). Both the gray seal and the harbor seal are
6 commonly observed in Cape Cod Bay (Short and Michelin 2006).

7
8 There are no known occurrences of PNPS operations affecting any marine mammals.

9 10 **2.2.5.3.7 Federally Listed Protected Marine Species**

11
12 This section provides information on marine aquatic species that are protected by Federal and
13 State laws. Protected aquatic species that occur in freshwater habitats on the mainland, as well
14 as birds that forage in the marine environment, are discussed as terrestrial resources in Section
15 2.2.6. Protected marine species include those that are Federally protected under the ESA, and
16 managed by the U.S. Fish and Wildlife Service (FWS) and/or the NMFS. Also included are
17 marine species listed as endangered, threatened, or special concern species by the
18 Commonwealth of Massachusetts. Eleven Federally and/or State-listed marine species could
19 occur in Cape Cod Bay in the vicinity of PNPS, including five whales, four sea turtles, and two
20 fishes (NMFS 2006c; NHESP 2006). These listed marine aquatic species that have the
21 potential to occur in the vicinity of the PNPS site are presented in Table 2-4.

22
23 Four listed species of sea turtle may occur in Cape Cod Bay: loggerhead (*Caretta caretta*),
24 Kemp's ridley (*Lepidochelys kempii*), leatherback (*Dermochelys coriacea*), and green (*Chelonia*
25 *mydas*) turtles. The leatherback and Kemp's ridley turtles are listed as endangered. The green
26 turtle is listed as endangered in its breeding populations in Florida and threatened in other areas
27 of the U.S. The loggerhead turtle is listed as threatened.

Table 2-4. Marine Threatened or Endangered Species

Scientific Name	Common Name	Federal Status	Massachusetts Status
TURTLES			
<i>Caretta caretta</i>	loggerhead turtle	Threatened	Threatened
<i>Chelonia mydas</i>	green turtle	Threatened (endangered in FL)	Threatened
<i>Dermochelys coriacea</i>	leatherback turtle	Endangered	Endangered
<i>Lepidochelys kempii</i>	Kemp's ridley turtle	Endangered	Endangered
WHALES			
<i>Balaenoptera borealis</i>	sei whale	Endangered	Endangered
<i>Balaenoptera physalus</i>	fin whale	Endangered	Endangered
<i>Eubalaena glacialis</i>	North Atlantic right whale	Endangered	Endangered
<i>Megaptera novaengliae</i>	humpback whale	Endangered	Endangered
<i>Physeter catadon</i>	sperm whale	Endangered	Endangered
FISH			
<i>Acipenser brevirostrum</i>	shortnose sturgeon	Endangered	Endangered
<i>Acipenser oxyrinchus</i>	Atlantic sturgeon	not listed	Endangered

Source: FWS 2006b

Sea turtles are only rarely found along the Massachusetts coast, and are primarily limited to individual juvenile "wanderers" (Prescott, 2000 in, Entergy 2006a). Many sea turtle species migrate north in summer months, and may be found in Cape Cod Bay. Loggerhead turtles inhabit neritic habitats in nearshore coastal areas, including bays, sounds, and estuaries in Massachusetts (NMFS 2006d). Kemp's ridley turtles can live in water temperatures as low as 11°C and may be present in New England waters from June 1 to November 30, when water temperatures exceed 16°C (NMFS 2006c). Leatherback turtles are expected to be present in New England waters in the summer months (NMFS 2006c). Green sea turtles are expected to be present in New England waters only sporadically (NMFS 2006c).

In late fall and winter, sea turtles still present in the bay may become cold-stunned and wash ashore (Entergy 2006). This typically includes fewer than 20 sea turtles in any given year. The largest incident recorded was in the winter of 1999 to 2000, when a total of 277 sea turtles were found on Cape Cod beaches (Entergy 2006). In 2003, the total number of turtles found stranded was 89 (Mass Audubon 2003 in Entergy 2006a). Records have been maintained on

1 turtle strandings in Massachusetts for 25 years, and in that time, only one sea turtle has
2 stranded in the Plymouth area (Entergy 2006a). This incident occurred in November 2003,
3 when a small (approximately 50 pounds) loggerhead turtle was stranded on Priscilla Beach
4 approximately 0.63 mi south of PNPS (Prescott 2005, in Entergy 2006a).

5
6 Six different species of great whales migrate along the Massachusetts coast, with the largest
7 number sighted in the spring on Stellwagen Bank off of the tip of Cape Cod (Entergy 2006a).
8 The most common species seen in this area are minke (*Balaenoptera acutorostrata*), fin, and
9 humpback whales (Entergy 2006a). Of the six species, three endangered great whale species
10 are found seasonally in New England waters and have been documented in Cape Cod Bay: the
11 North Atlantic right whale (*Eubalaena glacialis*), humpback whale, and fin whale. In addition,
12 two other endangered species, the sei whale (*B. borealis*) and sperm whale (*Physter catodon*),
13 are known to migrate in New England waters off of the coast of Massachusetts.

14
15 Right whales may be found in Massachusetts and Cape Cod Bays throughout the year (Brown
16 et al. 2002, in Short and Michelin 2006), and Cape Cod Bay has been designated as critical
17 habitat for the species (Entergy 2006a). Right whales have been documented in the nearshore
18 waters of Massachusetts from December through June, and are likely to be present in Cape
19 Cod Bay from December 15 to April 15 (NMFS 2006c). North Atlantic right whales are the most
20 critically endangered whale species in the Atlantic with population estimates of approximately
21 300 individuals. Humpback whales may be found off of the coast of Massachusetts during the
22 period from March 15 to November 30 (NMFS 2006c). Humpback whales are documented in
23 the Stellwagen Bank area from mid April to November, with a peak abundance in May and June
24 (CeTap 1982, in Short and Michelin 2006). Fin whales are the most frequently sighted
25 endangered whale species found in Massachusetts and Cape Cod Bays (EPA 1993 in, Short
26 and Michelin 2006). Sei whales are only rarely sighted in Massachusetts and Cape Cod Bays
27 (EPA 1993, in Short and Michelin 2006). Sperm whales may be seasonally present in New
28 England waters, but are typically found in deeper offshore waters (NMFS 2006c).

29
30 Although these species have been documented in Cape Cod Bay and/or coastal Massachusetts
31 waters, no whales have been observed in the shallow waters off PNPS or in the intake and
32 discharge canal areas by Boston Edison or Entergy biologists since biological monitoring began
33 in the late 1960s (Entergy 2006a). Two species of fish are State-listed as endangered in
34 Massachusetts: the shortnose sturgeon (*Acipenser brevirostrum*) and the Atlantic sturgeon (*A.*
35 *oxyrinchus*). The shortnose sturgeon is also Federally listed as endangered by the FWS. The
36 shortnose sturgeon is much smaller than the Atlantic sturgeon, rarely exceeding 3 ft in length. It
37 is often confused with the Atlantic sturgeon, but the two species can be distinguished by
38 comparing the widths of the mouth. The shortnose sturgeon has a much wider mouth than the
39 Atlantic sturgeon. The shortnose sturgeon is amphidromous, which indicates that the fish
40 spawns in freshwater, but regularly enters marine and freshwater habitats during its lifespan.
41 The shortnose sturgeon spawns in fast-flowing, rocky rivers; in April and May. There are three

1 known shortnose sturgeon populations in Massachusetts: one in the Merrimack River in
2 northeastern Massachusetts and two in the Connecticut River in the western portion of the
3 state. There are no known occurrences of the shortnose sturgeon in Plymouth or the
4 surrounding area (NHESP 2006).

5
6 The Atlantic sturgeon is a very large anadromous fish that averages 6 to 9 ft in length, but can
7 exceed a length of 13 ft and a weight of 800 pounds. Spawning occurs generally in rocky, fast-
8 flowing rivers in May and June, slightly later than the shortnose sturgeon. Populations of
9 Atlantic sturgeon have been documented in the Merrimack and Taunton Rivers in eastern
10 Massachusetts; however, none have been observed in the Plymouth area (NHESP 2006).

11 12 **2.2.6 Terrestrial and Freshwater Aquatic Resources**

13
14 The PNPS site is located within and near the western border of the Atlantic Coastal Pine
15 Barrens ecoregion, which extends in Massachusetts from Plymouth to the tip of Cape Cod and
16 the islands of Martha's Vineyard and Nantucket. The site is in an area of transition between this
17 ecoregion and the Northeastern Coastal Zone ecoregion, which extends to the north and west
18 and has a more irregular topography that includes hills and concentrations of glacial lakes. The
19 coarse-grained, nutrient-poor soils of the area currently support temperate mixed broadleaf and
20 coniferous forests dominated by oak and pine, similar to the forests that existed in the area
21 historically (EPA 2006a). Thirteen sub-ecoregions have been delineated within Massachusetts.
22 The PNPS site is within the Cape Cod/Long Island sub-ecoregion, which is characterized by
23 terminal glacial moraines and outwash plains, coastal deposits, elevations less than 200 ft, a
24 moderate maritime climate, and typical vegetation of stunted oak and pine forests (Swain and
25 Kearsley 2001).

26
27 The vegetation communities that occur in the Massachusetts sub-ecoregions have been
28 classified into 105 community types (Swain and Kearsley 2001). These natural communities
29 have been mapped by the Massachusetts Office of Geographic and Environmental Information
30 using interpretation of aerial photography flown in the spring of 1999 and 2000 in conjunction
31 with field information from local ecologists and community information from the NHESP of the
32 Massachusetts Division of Fisheries and Wildlife (MDFW). The community maps are available
33 online from the Massachusetts Geographic Information System (MassGIS 2006). These natural
34 community maps of the site and vicinity provide information on a local scale about the
35 vegetation communities and, indirectly, the animals they support, which may include both
36 common and rare species.

37
38 Among the natural communities monitored and mapped by the NHESP are vernal pools, which
39 are small, shallow ponds that are seasonally to semi-permanently flooded basin depressions
40 characterized by annual or semi-annual periods of dryness and a lack of fish. NHESP has a
41 program to identify potential vernal pools and to certify, based on official guidelines, those

1 shown by field data to function as vernal pools (MassGIS 2006). Review of the data layer for
2 certified vernal pools indicated there are none present within the PNPS site or along the
3 transmission line ROW.
4

5 **2.2.6.1 Description of Site Terrestrial and Freshwater Aquatic Environments**

6

7 An aerial photograph of the PNPS facility and its environs is shown in Figure 2-3. The
8 approximately 140-ac PNPS site includes a central developed area that contains the generating
9 facilities, switchyard, warehouses, office buildings, and parking lots. Prior to construction of
10 PNPS, the developed area was occupied by a private estate. The surrounding areas to the
11 north, west, and south are mainly undeveloped and wooded. The western shoreline of Cape
12 Cod Bay forms the northern and eastern boundaries of the site. From the shoreline to the most
13 inland boundary of the site along Rocky Hill Road (approximately in bands that parallel the
14 shoreline), at least six natural community types occur: coastal beach, marine intertidal rocky
15 shore, maritime erosional cliff, maritime shrubland, maritime oak-holly forest, and coastal forest.
16 The maritime shrubland, maritime forest, and coastal forest communities grade into each other
17 and into more upland forests (Swain and Kearsley 2001; MassGIS 2006).
18

19 A coastal beach community occurs in the intertidal zone along the shoreline north and south of
20 the developed area of the site. The beach substrate is sand, gravel, and scattered rocks, which
21 supports only sparse, non-vascular plants (algae) in this high-energy environment affected by
22 waves and tides. An area of marine intertidal rocky shore community, which also supports
23 algae and lacks vascular plants, occurs along a portion of the intake embayment shoreline
24 (Swain and Kearsley 2001; MassGIS 2006). The riprap covering the man-made banks of the
25 intake embayment, the breakwaters, and the discharge canal provides similar habitat. An area
26 of sandy beach also occurs at the western end of the intake embayment.
27

28 Along the shoreline to the north and south of the developed areas, bluffs and cliffs rise 10 to 40
29 ft above the beach. In the northern segment of the shoreline, the cliffs immediately above the
30 beach have been classified as a maritime erosional cliff community. The unconsolidated cliff
31 face is eroding and is within the salt spray zone. Consequently, the vegetation of this
32 community is very sparse but may include poison ivy (*Toxicodendron radicans*), Virginia creeper
33 (*Parthenocissus quinquefolia*), bayberry (*Myrica pennsylvanica*), sweet fern (*Comptonia*
34 *peregrina*), and greenbrier (*Smilax rotundifolia*) (Swain and Kearsley 2001; MassGIS 2006).
35

36 Located inland and above the beach, bluffs, and cliffs along the entire undeveloped shoreline of
37 the site, is a narrow zone of maritime shrubland community. This community receives storm
38 salt spray and is dominated by dense patches of shrubs consisting of species such as black
39 huckleberry (*Gaylussacia baccata*), bayberry, red cedar (*Juniperus virginiana*), black cherry
40 (*Prunus serotina*), beach plum (*P. maritima*), chokeberry (*Aronia melanocarpa*), lowbush
41 blueberry (*Vaccinium angustifolium*), and bearberry (*Arctostaphylos uva-ursi*). Also, greenbrier

Plant and the Environment

1 and poison ivy often grow in dense patches or cover other plants (Swain and Kearsley 2001;
2 MassGIS 2006).

3
4 The maritime shrubland develops a tree canopy as it transitions inland into a maritime oak-holly
5 forest community, which is a mixed deciduous/evergreen forest within the coastal salt spray
6 zone behind the bluffs. The trees in this community tend to be short relative to interior forests
7 [i.e., less than 10 m (30 ft) tall] with tops that are sculpted by winds and salt spray. Common
8 overstory species include the scarlet oak (*Quercus coccinea*), black oak (*Q. velutina*), other
9 oaks (*Q. spp.*), American holly (*Ilex opaca*), sassafras (*Sassafras albidum*), black gum (*Nyssa*
10 *sylvatica*), black cherry, and red maple (*Acer rubrum*). The pitch pine (*Pinus rigida*) and red
11 cedar also occur in this community. Vines such as greenbrier and poison ivy, Virginia creeper
12 and/or grape (*Vitis aestivalis*) may be dense, especially near openings. Shrubs include
13 bayberry, winged sumac (*Rhus copallinum*), and sweet pepperbush (*Clethra alnifolia*). The
14 herbaceous layer is highly variable and may include grasses and sedges (Swain and Kearsley
15 2001; MassGIS 2006).

16
17 Moving inland, the trees increase in height, and the forest transitions to a coastal forest
18 community that covers the majority of the wooded area of the site and is dominated by mixed
19 oaks. The coastal forest is sheltered from direct daily maritime influences because it is not in
20 the daily salt spray zone, but it receives wind and salt during storms. The climate in which this
21 community occurs is moderated by being near the ocean, with warmer winters and cooler
22 summers, as well as more fog and precipitation, than more inland areas. Historically, fire was
23 often an important factor in coastal forests. The dominant oaks in this community are scarlet
24 oak and black oak. Other trees in this community include white oak (*Q. alba*), chestnut oak (*Q.*
25 *prinus*), shagbark hickory (*Carya ovata*), red maple, sassafras, gray birch (*Betula populifolia*),
26 beech (*Fagus grandifolia*), black cherry, quaking aspen (*Populus tremuloides*), white pine (*P.*
27 *strobus*), and pitch pine (MassGIS 2006; Swain and Kearsley 2001; AEC 1974). Although its
28 natural range is well to the south, the black locust (*Robinia pseudoacacia*) also is present in site
29 forests as a result of its historical planting as a source for fence posts and its subsequent
30 escape from cultivation (AEC 1974). The dense understory includes a low shrub heath layer
31 dominated by lowbush blueberries (*Vaccinium pallidum*) and black huckleberry. Other shrubs
32 present include arrowwood (*Viburnum dentatum*), sweet pepperbush, staghorn sumac (*R.*
33 *typhina*), and winged sumac. The herbaceous layer is typically sparse, with bracken fern
34 (*Pteridium aquilinum*), wintergreen (*Gaultheria procumbens*) and wild sarsaparilla (*Aralia*
35 *nudicaulis*) often present, as well as little blue-stem grass (*Schizachyrium scoparius*) and
36 bearberry beneath canopy openings. Common vines in this community include poison ivy,
37 Virginia creeper, grape, and greenbriers (Entergy 2002; MassGIS 2006; Swain and Kearsley
38 2001; AEC 1974).

39
40 Isolated forested wetlands are present at several locations on the site, principally south and
41 southeast of the developed area. The dominant species in the canopy of these moist areas is

1 the red maple, with greenbrier, cattail (*Typha latifolia*), rush (*Juncus* spp.), and bulrush (*Scirpus*
2 *cyperinus*) in the understory. A small, seasonal wetland also is located in a depression within
3 the mixed oak forest at the northern end of the site. Non-native invasive plants that occur on
4 the site include Japanese honeysuckle (*Lonicera japonica*) and multiflora rose (*Rosa multiflora*)
5 (AEC 1974).

6
7 Entergy also owns over 1530 ac of undeveloped land located predominantly across Rocky Hill
8 Road south of the 140-ac PNPS site (Figure 2-3). The majority of this property (the Entergy
9 Woodlands) has been placed in a forest land trust and is being managed under a Forest
10 Management Plan (Entergy 2002) approved by the Massachusetts Department of
11 Environmental Management (MA DEM 2003). This Entergy Woodlands property encompasses
12 the northern end of the Pine Hills, a north-south oriented ridge of low hills approximately 4 mi
13 long (AEC 1972). The area is characterized by sandy to fairly rocky, well-drained soils and flat
14 to steeply sloped, wooded terrain. Typical forest in the area is dominated by pitch pine and
15 mixed oaks, with a component of white pine that is slowly recovering from repeated forest fires
16 in the past. Typical plant species include those listed above for the onsite forest. Historically,
17 much of the area was cleared for agriculture. Although the forest has regenerated, there are
18 several remaining abandoned fields in varying stages of succession to forest. There also are
19 several small, seasonal wetlands on the property (Entergy 2002).

20
21 Wildlife species in the vicinity of PNPS are typical of those found in eastern Massachusetts.
22 The predominant habitats at the site are those provided by the shoreline and the forested
23 uplands and wetlands. Many wildlife species are highly mobile, moving between and utilizing
24 habitats provided by multiple vegetation communities. In addition, many non-resident birds
25 migrate along the coastline and, as a result, briefly utilize site habitats for food and shelter
26 during migration.

27
28 Wildlife that utilize the shoreline habitat at the site primarily are birds, many of which are
29 migratory and occur in the area in either summer or winter. Birds that may use the shoreline
30 habitats at the site include shorebirds such as the willet (*Catoptrophorus semipalmatus*), dunlin
31 (*Calidris alpina*), purple sandpiper (*C. maritima*), piping plover (*Charadrius melodus*), and
32 sanderling (*Calidris alba*); waterfowl such as the great cormorant (*Phalacrocorax carbo*), brant
33 (*Branta bernicla*), and sea ducks, including the common eider (*Somateria mollissima*), king eider
34 (*S. spectabilis*), oldsquaw (*Clangula hyemalis*), harlequin duck (*Histrionicus histrionicus*), white-
35 winged scoter (*Melanitta deglandi*), black scoter (*M. nigra*), and surf scoter
36 (*M. pespicillata*); wading birds such as the black-crowned night heron (*Nycticorax nycticorax*)
37 and snowy egret (*Egretta thula*); and seabirds such as the herring gull (*Larus argentatus*), ring-
38 billed gull (*L. delawarensis*), and greater black-backed gull (*L. marinus*) (Peterson 1980). A
39 marine mammal that may occur here is the harbor seal, which potentially may utilize the rocky
40 shoreline habitat of the site for basking. Wildlife that utilize the shrub and forest habitats at the
41 site include birds, mammals, reptiles, and amphibians. Birds that occur in site forests include

Plant and the Environment

1 both migratory species and permanent residents that remain throughout the year. Migratory
2 species that forage and breed in forest habitats such as those at the site include the broad-
3 winged hawk (*Buteo platypterus*), gray catbird (*Dumetella carolinensis*), wood thrush (*Hylocichla*
4 *mustelina*), red-eyed vireo (*Vireo olivaceus*), black-and-white warbler (*Mniotilta varia*), yellow
5 warbler (*Dendroica petechia*), American redstart (*Setophaga ruticilla*), common yellowthroat
6 (*Geothlypis trichas*), ovenbird (*Seiurus aurocapillus*), and scarlet tanager (*Piranga olivacea*).
7 Resident species that may breed in forest habitats on the site and forage there throughout the
8 year include the red-tailed hawk (*B. jamaicensis*), sharp-shinned hawk (*Accipiter striatus*),
9 screech owl (*Otus asio*), great-horned owl (*Bubo virginianus*), ruffed grouse (*Bonasa umbellus*),
10 wild turkey (*Meleagris gallopavo*), cardinal (*Cardinalis cardinalis*), black-capped chickadee
11 (*Parus atricapillus*), swamp sparrow (*Melospiza georgiana*), American robin (*Turdus*
12 *migratorius*), cedar waxwing (*Bombocilla cedrorum*), downy woodpecker (*Picoides pubescens*),
13 American crow (*Corvus brachyrhynchos*), blue jay (*Cyanocitta cristata*), and dark-eyed junco
14 (*Junco hyemalis*) (Peterson 1980; Entergy 2006a).

15
16 Mammals likely to occur in the terrestrial forest, shrubland, and/or wetland habitats at the site
17 include the white-tailed deer (*Odocoileus virginianus*), raccoon (*Procyon lotor*), opossum
18 (*Didelphis virginiana*), striped skunk (*Mephitis mephitis*), New England cottontail (*Sylvilagus*
19 *transitionalis*), gray squirrel (*Sciurus carolinensis*), woodchuck (*Marmota monax*), white-footed
20 mouse (*Peromyscus leucopus*), and woodland vole (*Microtus pinetorum*) (AEC 1972;
21 AEC 1974; Entergy 2006a; Whitaker 1980). Reptiles that commonly occur in these habitat
22 types include the eastern hognose snake (*Heterodon platirhinos*), eastern garter snake
23 (*Thamnophis sirtalis*), northern black racer (*Coluber constrictor*), northern ringneck snake
24 (*Diadophis punctatus*), and eastern box turtle (*Terrapene carolina*). Amphibians likely to occur
25 in these habitats at the site include the American toad (*Bufo americanus*), Fowler's toad (*B.*
26 *woodhousii*), spotted salamander (*Ambystoma maculatum*), and redback salamander
27 (*Plethodon cinereus*) (AEC 1974; Conant and Collins 1998; Entergy 2006a).

28 29 **Transmission Line ROW**

30
31 Section 2.1.7 describes the two 345-kV transmission lines that connect PNPS to the electrical
32 transmission system. The two lines share a single 300-ft-wide transmission line ROW that
33 connects the PNPS switchyard with the power grid at the Snake Hill Road substation
34 approximately 7 mi to the southwest (Entergy 2006a; AEC 1972). Within the PNPS site
35 property, the transmission line ROW extends southeast from the switchyard, then turns south
36 and crosses Rocky Hill Road before reaching the station access road. This onsite segment of
37 the ROW passes through the coastal forest community and crosses the wooded deciduous
38 wetland community located south of the main parking lot. After crossing Rocky Hill Road, the
39 ROW enters the Entergy Woodlands property. It extends approximately 1 mi south within the
40 woodland before turning south-southwest along the southeastern boundary of the property for
41 another 2/3 mi. The ROW then turns farther west, leaves the Entergy Woodlands, and crosses

1 the Pine Hills as it continues approximately southwest over 5 mi to the Snake Hill Road
2 substation. Entergy does not own, operate, or maintain the PNPS-to-Snake Hill Road
3 transmission lines or ROW. The lines and ROWs are owned and maintained by NSTAR Electric
4 and Gas Corporation, which provides electricity and natural gas to businesses and residents in
5 eastern Massachusetts (Entergy 2006a; NSTAR 2006).

6
7 The transmission line ROW does not cross any state or federal parks, wildlife refuges, or wildlife
8 management areas (Entergy 2006a), nor does it cross any major lakes, ponds, or streams.
9 Approximately 1.3 mi of the corridor at its southern end are within Myles Standish State Forest.
10 The largest water feature traversed by the corridor is a medium-sized creek (approximately 8 ft
11 wide and 1 ft deep) next to Old Sandwich Road. Dense riparian vegetation, including shrubs
12 and small trees, is present beneath the transmission lines in the low-lying floodplain along the
13 stream in this area. The predominant vegetation community through which the corridor passes
14 is dry upland forest dominated by mixed oaks and pitch pine. This community supports the
15 typical inland forest species of plants and animals discussed earlier.

16
17 NSTAR maintains the transmission line ROW in accordance with a Vegetation Management
18 Plan (NSTAR 2006) approved by the Massachusetts Department of Agricultural Resources and
19 the NHESP. Under this plan, NSTAR maintains the PNPS ROW from the station to the Snake
20 Hill Road substation, as well as the rest of their system, using an integrated vegetation
21 management program. This program integrates the selective use of herbicides approved in
22 Massachusetts for use in sensitive areas with the use of cultural methods (i.e., selective
23 mechanical removal of targeted vegetation by hand cutting or mowing) and biological methods
24 (i.e., encouraging development of stable communities of low-growing plants) to restore and
25 maintain habitat and control invasive species in the transmission corridor. Herbicides are used
26 to manage vegetation by foliar treatment (spraying diluted herbicide on the foliage and stems of
27 targeted vegetation), low pressure basal treatment (applying herbicides, diluted in mineral oil to
28 the lower 12 to 18 in. of the main stem of the target plants) and cut stump treatments (applying
29 herbicides to newly cut surfaces of mechanically cut stumps). Additionally, tree growth
30 regulators are utilized to slow or regulate the growth of a tree, which minimizes clearance
31 pruning and/or tree removal (NSTAR 2006). The program encourages the development of
32 natural communities of low-growing woody shrubs and herbaceous plants while avoiding
33 adverse environmental impacts and controlling tall-growing trees and undesirable shrub species
34 that would interfere with operation of the transmission lines (NSTAR 2006). NSTAR's
35 environmental personnel review work plans with maintenance crews and consult with local town
36 conservation committees to ensure that wetland areas and sensitive plant communities are
37 protected prior to conducting vegetation management (Entergy 2006a).

38 39 **2.2.6.2 Rare Terrestrial and Freshwater Aquatic Species**

40
41 Rare species include those Federally listed as endangered or threatened, or proposed for

Plant and the Environment

1 Federal listing, as well as those listed as endangered, threatened, or special concern species by
2 the Commonwealth of Massachusetts. Determination of listing status and protection of
3 Federally listed terrestrial and freshwater aquatic species are within the jurisdiction of the FWS.
4 The NHESP of the MDFW maintains a listing of rare species occurrences by town. PNPS and
5 its transmission corridor are within the Town of Plymouth. Occurrences of 77 rare species listed
6 by the FWS and/or the Commonwealth of Massachusetts have been recorded in the Town of
7 Plymouth and are presented in Table 2-5. A subset of these species occurs or has the potential
8 to occur on the PNPS site or in the transmission line ROW. The names of these species are
9 indicated in bold in Table 2-5.

10
11 The Federally listed species identified by FWS (FWS 2006a) as potentially occurring in the
12 PNPS vicinity were the piping plover (*Charadrius melodus*), roseate tern (*Sterna dougallii*), bald
13 eagle (*Haliaeetus leucocephalus*), and northern red-bellied cooter (*Pseudemys rubriventris*),
14 which was formerly known as the Plymouth redbelly turtle (*Pseudemys rubriventris bangsi*).
15

16 The piping plover is a small, stocky shorebird that is Federally listed as threatened in areas
17 outside the Great Lakes watershed and is State-listed as threatened in Massachusetts. The
18 Atlantic Coast population of the piping plover nests from Newfoundland south to North Carolina
19 and winters from North Carolina to Florida, the Gulf of Mexico, and the West Indies. Other
20 populations nest along rivers of the northern Great Plains and along the shores of the Great
21 Lakes. In Massachusetts, the piping plover requires coastal beaches for nesting that are sandy,
22 relatively flat, and free of vegetation. Their population has declined significantly over the past
23 50 years, due principally to habitat loss from development and beach disturbance (NHESP
24 1990). The piping plover is known to occur along Plymouth Beach just north of PNPS (FWS
25 2006), and it may move through the PNPS site while foraging along the shoreline and during
26 northward migration in spring or southward migration in late summer (NHESP 1990).
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Table 2-5 Federally Listed Terrestrial and Freshwater Aquatic Species
Potentially Occurring in the Vicinity of PNPS and the
Associated Transmission Line ROW

	Scientific Name^(a)	Common Name^(a)	Federal Status^(b)	State Status^(c)
5	<u>Mammals</u>			
6	<i>Synaptomys cooperi</i>	southern bog lemming		SC
7	<u>Birds</u>			
8	<i>Ammodramus savannarum</i>	grasshopper sparrow		T
9	<i>Bartramia longicauda</i>	upland sandpiper		E
10	<i>Charadrius melodus</i>	piping plover	(PS ¹ : LT)	T
11	<i>Gavia immer</i>	common loon		SC
12	<i>Haliaeetus leucocephalus</i>	bald eagle	(PS ² : LT, PDL)	E
13	<i>Ixobrychus exilis</i>	least bittern		E
14	<i>Parula americana</i>	northern parula		T
15	<i>Pooecetes gramineus</i>	vesper sparrow		T
16	<i>Sterna antillarum</i>	least tern		SC
17	<i>Sterna dougallii</i>	roseate tern	(PS ³ : LE)	E
18	<i>Sterna hirundo</i>	common tern		SC
19	<i>Sterna paradisaea</i>	Arctic tern		SC
20	<i>Tyto alba</i>	barn owl		SC
21	<u>Reptiles</u>			
22	<i>Pseudemys rubriventris</i>	northern red-bellied cooter	LE ⁴	E
23	<i>Terrapene carolina</i>	eastern box turtle		SC
24	<u>Amphibians</u>			
25	<i>Hemidactylium scutatum</i>	four-toed salamander		SC
26	<u>Fish</u>			
27	<i>Lampetra appendix</i>	American brook lamprey		T
28	<i>Notropis bifrenatus</i>	bridle shiner		SC
29	<u>Insects</u>			
30	<i>Cicindela purpurea</i>	purple tiger beetle		SC
31	<i>Abagrotis nefascia</i>	coastal heathland cutworm		SC
32	<i>Acronicta albarufa</i>	barrens daggermoth		T

Table 2-5. (contd)

Scientific Name	Common Name	Federal Status ^(b)	State Status ^(c)
<i>Apamea inebriata</i>	drunk apamea moth		SC
<i>Callophrys irus</i>	frosted elfin		SC
<i>Catocala herodias gerhardi</i>	Gerhard's underwing moth		SC
<i>Catocala pretiosa pretiosa</i>	precious underwing moth		E
<i>Chaetagnalea cerata</i>	wax sallow moth		SC
<i>Cicinnus melsheimeri</i>	Melsheimer's sack bearer		T
<i>Cingilia catenaria</i>	chain dot geometer		SC
<i>Erynnis persius persius</i>	Persius duskywing		E
<i>Hemaris gracilis</i>	slender clearwing sphinx moth		SC
<i>Hemileuca maia</i>	barrens buckmoth		SC
<i>Hypomecis buchholzaria</i>	Buchholz's gray		E
<i>Itame</i> sp.	pine barrens itame		SC
<i>Lithophane viridipallens</i>	pale green pinion moth		SC
<i>Metarranthis pilosaria</i>	coastal swamp metarranthis moth		SC
<i>Papaipema sulphurata</i>	water-willow stem borer		T
<i>Psectraglaea carnosa</i>	pink sallow		SC
<i>Zale</i> sp.	pine barrens zale		SC
<i>Zanclognatha martha</i>	pine barrens zanclognatha		T
<i>Anax longipes</i>	comet darner		SC
<i>Enallagma daeckii</i>	attenuated bluet		SC
<i>Enallagma laterale</i>	New England bluet		SC
<i>Enallagma pictum</i>	scarlet bluet		T
<i>Enallagma recurvatum</i>	pine barrens bluet		T
Mussels			
<i>Alasmidonta heterodon</i>	dwarf wedgemussel	LE	E
<i>Alasmidonta undulata</i>	triangle floater		SC
<i>Leptodea ochracea</i>	tidewater mucket		SC
<i>Ligumia nasuta</i>	eastern pondmussel		SC
<i>Strophitus undulatus</i>	creeper		SC

Table 2-5. (contd)

Scientific Name	Common Name	Federal Status ^(b)	State Status ^(c)
<u>Vascular Plants</u>			
<i>Calamagrostis pickeringii</i>	reed bentgrass		E
<i>Carex striata</i>	Walter's sedge		E
<i>Conioselinum chinense</i>	hemlock parsley		SC
<i>Corema conradii</i>	broom crowberry		SC
<i>Dichanthelium wrightianum</i>	Wright's panic-grass		SC
<i>Eupatorium leucolepis</i> var. <i>novae-angliae</i>	New England boneset		E
<i>Helianthemum dumosum</i>	bushy rockrose		SC
<i>Isoetes acadensis</i>	Acadian quillwort		E
<i>Lachnanthes carolina</i>	redroot		SC
<i>Liatris scariosa</i> var. <i>novae-angliae</i>	New England blazing star		SC
<i>Linum intercursum</i>	sandplain flax		SC
<i>Lipocarpa micrantha</i>	dwarf bulrush		T
<i>Mertensia maritima</i>	oysterleaf		E
<i>Myriophyllum pinnatum</i>	pinnate water-milfoil		SC
<i>Ophioglossum pusillum</i>	adder's-tongue fern		T
<i>Polygonum puritanorum</i>	pondshore knotweed		SC
<i>Potamogeton confervoides</i>	algae-like pondweed		T
<i>Rhynchospora inundata</i>	inundated horned-sedge		T
<i>Rhynchospora nitens</i>	short-beaked bald-sedge		T
<i>Rhynchospora scirpoides</i>	long-beaked bald-sedge		SC
<i>Rhynchospora torreyana</i>	Torrey's beak-sedge		E
<i>Sabatia kennedyana</i>	Plymouth gentian		SC
<i>Sagittaria teres</i>	terete arrowhead		SC
<i>Spartina cynosuroides</i>	salt reedgrass		T
<i>Sphenopholis pensylvanica</i>	swamp oats		T
<i>Utricularia resupinata</i>	resupinate bladderwort		T
<i>Utricularia subulata</i>	subulate bladderwort		SC

Table 2-5. (contd)

^(a) Species names in **bold** indicate those with a greater potential to occur on the PNPS site or transmission line ROW based on the possible presence of suitable habitat.

^(b)LE: Listed endangered; LT: Listed threatened

PDL: Proposed for delisting

(PS): Partial status: listing status in only a portion of the species's range, as specified:

¹ Piping plover status in Great Lakes region is endangered; populations elsewhere are threatened

² Bald eagle status is threatened in the conterminous (lower 48) U.S.

³ Roseate tern status is endangered for the northeast U.S. nesting population; status is threatened elsewhere in the Western Hemisphere

⁴ Status applies to population 1.

^(c) E: Endangered

T: Threatened

SC: Special concern

Sources: NHESP (2006a) and FWS (2006b)

The roseate tern is a pale gray seabird with a black cap and underparts tinged with pink. Its northeastern U.S. nesting population is Federally listed as endangered, and it is State-listed as endangered in Massachusetts. The northeastern population breeds from Nova Scotia to Long Island and winters from the Caribbean to the coast of South America. The roseate tern nests in Massachusetts on coastal beaches, islands, and inshore beaches. It prefers dense herbaceous cover such as beach grass and seaside goldenrod, and it is a colonial nester that is always found with the common tern (*Sterna paradisaea*). The northeastern U.S. population has declined precipitously, approximately 70 percent since 1935, due to factors such as alteration of nesting habitats, displacement from nesting areas by gulls, erosion, flooding, and human predation on their wintering grounds (NHESP 1988). The roseate tern is known to occur along Plymouth Beach just north of PNPS (FWS 2006), and it may pass through the PNPS site during northward migration in late spring or southward migration in early fall (NHESP 1988).

The bald eagle is Federally listed as threatened in the lower 48 states but has been proposed for delisting. It is State-listed as endangered in Massachusetts. The bald eagle occurs in Massachusetts primarily in winter, but nesting also occurs in certain areas near the coast or large inland water bodies. Bald eagle populations declined due to habitat loss, human predation, and the eggshell-thinning effects of organochlorine pesticides in the food web. With regulatory protection and the banning of organochlorine pesticide use, bald eagle populations have increased, and the eagle's Federal listing status was changed from endangered to threatened in 1995 (NHESP 1995a). As a result of continued improvement in the population, the eagle has been proposed for delisting by the FWS. Wintering bald eagles occasionally

1 occur in the area of PNPS (FWS 2006), and in 2005 juveniles and adults were observed at
2 Plimoth Plantation, approximately 2 mi southwest of PNPS (Entergy 2006a).

3
4 The Massachusetts population of the northern red-bellied cooter is both Federally and State-
5 listed as endangered. The Massachusetts population currently is considered a disjunct
6 population of the species, which is a freshwater aquatic turtle whose primary range extends
7 from New Jersey south to North Carolina and inland to West Virginia. The isolated
8 Massachusetts population formerly was considered a distinct subspecies, which is why it is
9 listed by the FWS as the Plymouth redbelly turtle. The endangered Massachusetts population
10 of the northern red-bellied cooter inhabits freshwater ponds that have abundant aquatic
11 vegetation. Sandy soil with an open canopy on land surrounding the ponds is required for
12 successful nesting (NHESP 1995b). In accordance with the ESA, the FWS has identified and
13 designated critical habitat for the red-bellied cooter (at 50 CFR 17.95) in the site vicinity. Critical
14 habitat is habitat that is considered essential to the conservation of the species and that may
15 require special management considerations or protection (FWS 1980). Approximately 1400 ft of
16 the transmission line ROW, near its southern end and adjacent to the boundary of Myles
17 Standish State Forest, crosses the southeastern tip of the area designated as critical habitat for
18 the red-bellied cooter. The ponds encompassed in this critical habitat area are located west of
19 the Jordan Road Tap-to-Snake Hill Road Substation segment of the transmission ROW.

20
21 In addition to the four Federally listed species discussed above, a fifth species that is both
22 Federally and State-listed as endangered and has the potential to occur in the Town of
23 Plymouth is the dwarf wedgemussel (*Alasmidonta heterodon*). This mussel inhabits well-
24 oxygenated rivers and streams with sand, muddy sand, and gravel bottoms, slow to moderate
25 currents, and little silt deposition. Such habitats do not occur on the PNPS site or in the
26 transmission line ROW. In addition, the dwarf wedgemussel may no longer exist in the state.
27 The last known Massachusetts population was extirpated by 1988 (NHESP 1991). Therefore,
28 this species is not considered to have the potential to occur in the study area.

29
30 There are approximately 73 additional species within the Town of Plymouth that are State-listed
31 as endangered, threatened, or of special concern in Massachusetts (Table 2-5). Approximately
32 22 of the State-listed species (names bolded in the table) potentially could utilize habitats
33 available on the PNPS site or the transmission line ROW based on their preferred habitat
34 characteristics; however, their presence has not been confirmed. The Massachusetts NHESP
35 has mapped Priority Habitats for State-Protected Rare Species based on occurrence and
36 population records maintained in the NHESP database, and it also has mapped Estimated
37 Habitats for Rare Wildlife for use with the Massachusetts Wetland Protection Act Regulations
38 (310 CMR 10) (NHESP 2005).

39
40 No priority habitats have been mapped within the PNPS site for species currently listed as rare
41 by the Commonwealth of Massachusetts. An area of priority habitat for a previously State-listed

1 species of special concern, the spotted turtle (*Clemmys guttata*), was mapped in the northern
2 end of the PNPS property. This area also was designated as an Estimated Habitat for Rare
3 Wildlife. However, the spotted turtle was deleted from the State list of rare species in May 2006
4 based on occurrence records that have demonstrated the turtle to be more common and
5 widespread in Massachusetts than previously known and on the significant areas of habitat that
6 have been protected since its listing in 1986 (NHESP 2006b). Consequently, there currently are
7 no state-listed rare species with designated habitat on the PNPS site. The transmission line
8 ROW does not cross any Priority Habitats for State-Protected Rare Species or Estimated
9 Habitats for Rare Wildlife (NHESP 2005).

10 11 **2.2.7 Radiological Impacts**

12
13 A radiological environmental monitoring program (REMP) has been conducted around the
14 PNPS site since August 1968 (AEC 1974). Licensed operations at PNPS began in 1972. The
15 REMP is conducted to monitor the radiation and radioactivity released to the environment as a
16 result of PNPS operation. This program includes the collection, analysis, and evaluation of data
17 in order to assess the radiological impact of PNPS on the environment and on the general
18 public (Entergy 2006a).

19
20 The results of measurements of radiological releases and environmental monitoring are
21 summarized in two annual reports: the PNPS Radiological Environmental Monitoring Program
22 Report (Entergy 2006b) and the PNPS Radioactive Effluent and Waste Disposal (REWD)
23 Report (Entergy 2006c). The Offsite Dose Calculation Manual (ODCM) specifies the limits for
24 all radiological releases (Entergy 2003c). These limits are designed to meet Federal standards
25 and requirements for all radiological releases including ambient radiation.

26
27 The REMP consists of taking radiation measurements and collecting samples from the
28 environment at a variety of locations surrounding the PNPS site, analyzing them for radioactivity
29 content, and interpreting the results. Sampling locations are chosen based on meteorological
30 factors, pre-operational planning, and results of land-use surveys. A number of locations in
31 areas unlikely to be affected by plant operations are selected as controls. With emphasis on the
32 critical radiation exposure pathways to humans, samples from the aquatic, atmospheric, and
33 terrestrial environments are collected. These samples include, but are not limited to: air, soil,
34 seawater, shellfish, lobster, fishes, cranberries, vegetables, and forage.

35
36 Thermoluminescent dosimeters are placed in the environment to measure gamma radiation
37 levels. The thermoluminescent dosimeters are processed and the environmental samples are
38 analyzed to measure the very low levels of radiation and radioactivity present in the
39 environment as a result of the PNPS operation and other natural and man-made sources
40 (Entergy 2006b). Results from the 5-year period 2001 through 2005 indicate that the radiation
41 and radioactivity in the environmental media monitored around the plant are well within

1 applicable regulatory limits and are not significantly higher than pre-operational levels (Entergy
2 2002a, 2003a, 2004a, 2005a, 2006b).

3
4 In addition to monitoring radioactivity in environmental media, Entergy annually assesses doses
5 to the maximally-exposed individuals from gaseous and liquid effluents based on actual liquid
6 and gaseous effluent release data (Entergy 2006c). Calculations are performed at several
7 locations using the plant effluent release data, onsite meteorological data, and appropriate
8 pathways identified in the ODCM (Entergy 2003). A summary of the calculated maximum doses
9 to individuals in the vicinity of PNPS from liquid and gaseous effluents for 2005 follows:

- 10
11 • No liquid effluents containing radioactivity were discharged during the calendar year 2005,
12 so there is no associated contribution to radiation dose (Entergy 2006c).
- 13
14 • The maximum total body dose from noble gases in gaseous effluents was 0.075 mrem from
15 gamma radiation, which is 0.75 percent of the 10 mrem gamma dose design objective
16 specified in 10 CFR 50, Appendix I, and 1.6 mrem from beta radiation, which is 8.0 percent
17 of the 20 mrem beta dose design objective (Entergy 2006c).
- 18
19 • The critical organ dose from gaseous effluents because of iodines, tritium, and particulates
20 with half-lives greater than 8 days was 3.2 mrem, which is 21 percent of the 15 mrem dose
21 design objective (Entergy 2006c).
- 22
23 • As a result of current water management practices that emphasize reprocessing and reuse
24 rather than release, PNPS had liquid radioactive effluent releases in some years and some
25 years it had none. For example, while liquid radioactive waste releases were reported for
26 each year from 2001 through 2003, there were no liquid effluent releases made during 2004
27 or 2005. During this 5-year period, the maximum annual total body dose from liquid effluents
28 occurred in 2003. It was 0.003 mrem, which is 0.1 percent of the 3 mrem design objective
29 specified in 10 CFR 50, Appendix I. The maximum critical organ dose during this period
30 also occurred in 2003. It was 0.008 mrem, which is 0.08 percent of the 10 mrem design
31 objective specified in 10 CFR 50, Appendix I.

32
33 In all cases, doses were well below the limits as defined in the ODCM and confirm that PNPS is
34 operating in compliance with 10 CFR Part 50 Appendix I, 10 CFR Part 20, and 40 CFR Part
35 190.

36
37 No significant changes to the radioactive effluent releases or exposures from PNPS operations
38 during the license renewal term are expected, and therefore, the impacts to the environment are
39 not expected to change.

1 **2.2.8 Socioeconomic Factors**

2
3 **2.2.8.1 Housing**

4
5 Approximately 80 percent of the permanent PNPS work force resides in Plymouth (63 percent)
6 and Barnstable (19.5 percent) counties in southeastern Massachusetts, which is the fastest
7 growing region in the state (Entergy 2006a). PNPS employs approximately 700 personnel,
8 including Entergy employees normally on-site (or at off-site training facilities) and contractor
9 employees. During refueling and maintenance outages, typically lasting 30 days, there are an
10 additional 900 workers on site. Maintenance outages usually occur every 24 months. There
11 are no plans to add additional employees at the site. The residences of the PNPS employees
12 are shown in Table 2-6 by State and county and, for Plymouth and Barnstable counties, by city
13 or town in Table 2-6.

14
15 Data on total housing units in the region are shown by county for 1990 and 2000 in Table 2-7
16 together with the numbers of occupied units, and vacant units available for sale or rent. The
17 Massachusetts counties shown had a total of 1,377,360 housing units in 2000, an increase of
18 7.1 percent since 1990. Occupied units in the region totaled 1,278,641 units in 2000, an
19 increase of 10 percent since 1990. The number of vacant units for sale or rent in 2000 was
20 22,421, a decline of 44 percent over the number of vacant units for sale or rent in 1990. In the
21 context of the scale of southeastern Massachusetts' housing market, however, accommodating
22 the plant's approximately 700 employees has not been a problem; they would represent only
23 0.05 percent of the occupied units in 2000. Accommodating the additional plant workers during
24 the periods of biennial maintenance outages, when an additional 900 workers are on site, is
25 facilitated by the region's extensive seasonal accommodations, as well as the 22,421 units in
26 year 2000 that were available as vacant for sale and rent.

Table 2-6. Pilgrim Nuclear Power Station Permanent Employee
Residence Information by County and Town/City

County and Town/City	PNPS Employees
PLYMOUTH COUNTY (MASSACHUSETTS)	
Abington	3
Bridgewater	9
Brockton	5
Carver	25
Duxbury	19
East Bridgewater	5
Halifax	10
Hanover	9
Hanson	5
Hingham	7
Kingston	21
Lakeville	2
Marion	1
Marshfield	27
Middleboro	13
Norwell	3
Pembroke	18
Plymouth	223
Plympton	2
Rochester	8
Rockland	3
Scituate	6
Wareham	14
West Bridgewater	1
Whitman	5
Total	444
BARNSTABLE COUNTY (MASSACHUSETTS)	
Barnstable	21
Bourne	25
Brewster	1
Chatham	1
Dennis	6
Falmouth	9
Harwich	4
Mashpee	13
Sandwich	53
Yarmouth	4
Total	137

Table 2-6. (contd)

County and Town/City	PNPS Employees
OTHER COUNTIES	
Norfolk (Massachusetts)	57
Bristol (Massachusetts)	43
Middlesex (Massachusetts)	6
Suffolk (Massachusetts)	6
Worcester (Massachusetts)	3
Providence (Rhode Island)	3
New London (Connecticut)	1
Manatee (Florida)	1
Cheshire (New Hampshire)	1
Oswego (New York)	1
Total	122

Source: Entergy 2006a

Table 2-7. Housing Units and Housing Units Vacant (Available) by County During 1990 and 2000

	1990	2000	Approximate Percentage Change
Barnstable County			
Housing Units	135,192	147,083	8.8
Occupied Units	77,586	94,822	22.2
Vacant Units	5,675	2,712	-52.2
Plymouth County			
Housing Units	168,555	181,524	7.7
Occupied Units	149,519	168,361	12.6
Vacant Units	5,229	2,436	-53.4

Sources: USBC, 1990 and 2000

1 **2.2.8.2 Public Services**

2
3 **2.2.8.2.1 Water Supply**

4
5 Most of the PNPS employees reside in Plymouth and Barnstable counties; with almost one-third
6 residing in the Town of Plymouth. With the exception of Scituate, Abington-Rockland (which
7 obtain their drinking water from both groundwater and surface water), and Brockton (which
8 obtains its drinking water from surface water only), all of the communities in Plymouth County,
9 including the Town of Plymouth, obtain their municipal water supply from groundwater sources
10 (Entergy 2006a). Table 2-8 provides public water supply information for selected Plymouth
11 County water systems, including average consumption and authorized withdrawal volume for
12 the year 2003. Average daily consumption rates exceed the authorized withdrawal limits
13 (capacities) for two of the water systems listed on Table 2-8. Those communities purchase
14 water from communities with excess capacity to meet the residual demand. Overall, the region
15 has excess capacity and has been able to meet total demand (MDEP 2004). In the Town of
16 Plymouth, the Plymouth-Carver aquifer has sufficient water for existing and projected demand
17 (Town of Plymouth 2006a).

18
19 **Table 2-8.** Selected Plymouth County Public Water Supply Systems and Capacities in 2003

20
21

Water System	Average Consumption (mgd)	Authorized Withdrawal Volume (Capacity mgd)
Duxbury Water Department	1.35	1.85
Halifax Water Department	0.49	0.68
Kingston Water Department	1.39	1.56
Marshfield Water Department	2.90	3.3
Middleborough Water Department	1.53	3.03
Pembroke Water Division	1.33	1.26
Plymouth Water Division	4.61	6.36
Plymouth Water Co.	0.26	0.22

22 Sources: MDEP 2004 and Entergy 2005c

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Plant and the Environment

Groundwater is the only source of drinking water for most of the communities in Barnstable County (Cape Cod Commission 2003). Table 2-9 provides public water supply information, including average consumption and authorized withdrawal volume for the year 2003, for Barnstable County water systems serving the areas where the majority of the PNPS employees that live in Barnstable County reside. Three of the water systems had average consumption levels slightly in excess of authorized withdrawals. The water systems can buy or sell water to each other in order to meet demand (MDEP 2004). To ensure a sustainable supply of high-quality drinking water, the Cape Cod Commission has identified potential public water supply areas and minimum performance standards designed to protect those areas (Cape Cod Commission 2003).

Table 2-9. Barnstable County Public Water Supply Systems and Capacities in 2003

Water System	Average Consumption (mgd)	Authorized Withdrawal Volume (Capacity mgd)
Barnstable Fire District	0.54	0.66
Barnstable Water Company	2.57	3.42
Bourne Water District	1.17	1.40
Buzzards Bay Water District	0.46	0.53
COMM Water Department	2.74	3.57
Cotuit Water Department	0.49	0.48
Mashpee Water Department	1.26	1.30
North Sagamore Water District	0.51	0.48
Sandwich Water District	1.67	2.64
South Sagamore Water District	0.10	0.09

Sources: MDEP 2004 and Entergy 2005c

2.2.8.2.2 Education

Public school systems in Plymouth County are organized by township, with 27 separate school districts in the county. The Town of Plymouth Public Schools serve over 8800 students (Town of Plymouth 2004c) and rely on a 2004 operating budget of over \$70.9 million in expenditures (Town of Plymouth 2004c). School population projections provided by the town indicate a growth by 2010 of 130 students (to 8930 or 1.5 percent over 2004 levels) and to 9413 in 2020 (a growth of 613 or 7 percent over 2004 levels) (Urbanomics 2006).

2.2.8.2.3 Transportation

Figures 2-1 and 2-2 show the PNPS site and highways within a 50-mi radius and a 6-mi radius of PNPS. At the larger regional scale, the major highways serving PNPS are:

- (1) Route 3, a four-lane divided highway that generally parallels the coast from Boston to Cape Cod;
- (2) I-495, an outer ring road for Boston that extends southeast towards Cape Cod; and
- (3) Route 44, much of which has recently been improved to four lanes, that extends west from Plymouth to I-495.

Local road access to PNPS is via Rocky Hill Road or Power House Road (formerly known as Edison Access Road). These are both two-lane paved roads with the latter owned and maintained by Entergy. Rocky Hill Road intersects with Route 3A approximately 1.5 mi west of PNPS, and Power House Road intersects with Route 3A approximately 1.5 mi south of PNPS and 2.5 mi east of the Rocky Hill Road intersection with Route 3A.

Route 3A generally parallels the coast in the Town of Plymouth, providing access to both Rocky Hill Road and Power House Road from downtown Plymouth. Route 3A also connects with Route 3 near downtown Plymouth, and again close to the boundary with Barnstable County and Cape Cod. Route 3 is the major north-south highway in the Town of Plymouth and is used by the PNPS employees traveling south from the towns of Marshfield, Duxbury, Kingston and Pembroke. Employees traveling north to PNPS would likely use either Route 3A to Power House Road or Route 3 to Clark Road/Beaver Dam Road, which intersects Route 3A approximately one-quarter mi east of Power House Road. Employees traveling east to PNPS would use Route 44 to Routes 3 or 3A.

The level of service determination for the intersection of Route 3A and Beaver Dam Road/White Horse Road is C, which describes operations with moderate delay (Vanasse & Associates 2001, in Entergy 2006a). Table 2-10 provides available daily traffic counts for roads in the vicinity of PNPS from the Massachusetts Highway Department.

Old Colony Planning Council (OCPC), at the request of the Town of Plymouth Department of Public Works, recently conducted a traffic study of Rocky Hill Road (OCPC 2006b). This road generally follows the coastline and serves residences both east and west of PNPS. The study was initiated because of safety concerns of residents: specifically, several sharp curves, changes in grade, and limited sight distances, especially in the segment west of PNPS.

Table 2-10. Traffic Counts for Roads in the Vicinity of PNPS

Route No.	Route Location	Estimated Average Daily Traffic Volume	Year
3	North of Clark Road*	30,500	1992
3A	North of Beaver Dam Road	14,400	2003
3A	South of Rocky Hill Road	13,000	1995
3A	South of Route 44	12,700	1998
44	East of Route 3	17,677	1990

Source: Entergy 2006a

* Beaver Dam Road is the continuation of Clark Road north of the intersection with Sandwich Road.

The road is narrow (25 ft), with two 12-ft lanes, without shoulders and with limited (2 to 2.5 ft) width for pedestrians. Traffic volumes counted in August 2005 indicate higher volumes at the western end of the road near its intersection with Route 3A. Here, average 24-hour volumes were 4372 vehicles with an a.m. peak of 274 per hour and p.m. peak of 354 per hour. Volumes east of PNPS are much lower, with a 24-hour average of 2360 vehicles, an a.m. peak of 154, and p.m. peak of 198. The OCPC traffic study notes that the road has adequate capacity for the highest volumes recorded. (OCPC cites the Institute of Transportation Engineers, *Transportation Planning Handbook*, that in excess of 10,000 vehicles per arterial lane usually indicates a need for more capacity.)

The study notes that average speeds exceed the posted 30 miles per hour and that several locations have substandard sight distances. The report makes several recommendations, including: speed warning signs at the curve in the vicinity of 209 to 222 Rocky Hill Road; constructing or widening shoulders; speed humps; and an increase in police speed enforcement. The report makes no mention of PNPS as a specific factor in its safety analysis. Truck traffic accessing the plant is directed by Entergy to use Power House Lane rather than Rocky Hill Road.

2.2.8.3 Off-site Land Use

PNPS is located in the Town of Plymouth. Current land use surrounding PNPS is predominantly residential, with the population concentrated toward Cape Cod Bay (See Figure 2-3). The communities of Priscilla Beach and White Horse Beach are located along the shoreline directly to the southeast of the site; they are in the Town of Plymouth R-20SL/Small

1 Lot Residential zone^(a). The Bay Shore Drive neighborhood along the shoreline to the northwest
2 is zoned R-25/ Residential^(a). The nearest population centers are Manomet to the southeast
3 (approximately 0.5 mi) and Plymouth to the west (approximately 2 mi). Low density residential
4 development and areas of vacant land/open space are located south of the PNPS site, inland
5 from the shoreline. This area is the northern part of the Pine Hills, a north-south oriented ridge
6 of low hills that contain the highest elevations in the town. The current zoning scheme in the
7 Town of Plymouth is designed to guide growth in keeping with the land use objectives
8 presented in the Master Plan (Town of Plymouth 2006a). Based on the zoning currently in
9 place, the future land uses planned for the areas surrounding the site are large lot and medium
10 lot residential, including the Entergy woodlands property, which is zoned for large lot residential
11 development. Future land use for the PNPS site itself is industrial.
12

13 The Town of Plymouth has the largest land area of the 26 towns and one city that make up
14 Plymouth County; it is also the largest town in the state, as well as the oldest (incorporated in
15 1620). The area within the vicinity of PNPS (i.e., within a 6-mi radius of the site) is located
16 entirely in Plymouth County and almost completely in the Town of Plymouth. Plymouth Town
17 has 65,920 ac of land. Based on 2004 land use data provided in the Master Plan (Town of
18 Plymouth 2006a), 29 percent of Plymouth Town is developed: 21 percent is residential, just over
19 4 percent is commercial and industrial, and 4 percent is occupied by nonprofit uses. Seventy-
20 one percent of Plymouth Town is undeveloped. Publicly owned property and protected open
21 space occupy 36 percent of the town. Myles Standish State Forest, a 12,500-ac recreation area
22 owned by the Commonwealth of Massachusetts, represents approximately half of the publicly
23 owned property in Plymouth. Properties privately held in Chapter 61, 61A, and 61B uses
24 (currently utilized for forestry, agriculture, and outdoor recreation, respectively) occupy 23
25 percent of Plymouth. Almost all of the agricultural land in the town is used for cranberry
26 production. Nearly 12 percent of land in the town is vacant.
27

28 Land use in Plymouth Town is regulated by the town, primarily through zoning and preservation
29 incentives. The Town of Plymouth Master Plan (Town of Plymouth 2006a) provides a vision for
30 the future and a framework for both preservation and growth. The characteristics identified by
31 local residents as most important to preserve are small town character, natural resources,
32 historic heritage, and open space. The Master Plan encourages smart growth, which
33 emphasizes development within or near growth areas (primarily “village centers”) and away
34 from preservation areas that Plymouth intends to protect for environmental, scenic, cultural,
35 recreational, and fiscal reasons. Plymouth has implemented village center zoning in which the
36 existing mixed uses of a village (residential, commercial, and civic) are preserved and new
37 construction encouraged that is compatible with the village setting. Six village centers have

(a) The R-20SL zoning district has a minimum lot size of 20,000 ft² (Small Lot Residential). The R-25 district has a minimum lot size of 25,000 ft² (Medium Lot Residential) (Town of Plymouth 2004c).

Plant and the Environment

1 been identified in the town; PNPS lies between the Plymouth Center and Manomet Village
2 Centers.

3
4 Approximately 80 percent of the permanent PNPS work force resides in Plymouth County (63
5 percent) and Barnstable County (19.5 percent) in southeastern Massachusetts, which is the
6 fastest growing region in the state (Entergy 2006a). Sprawl, in the form of large-lot, low-density
7 residential development that consumes open space and costs more in town services than it
8 returns in property taxes, is a critical issue facing towns in southeastern Massachusetts. In the
9 Town of Plymouth, for example, most of the new housing constructed since 1980 has been
10 single family homes, of which 58 percent have been built outside the villages and 82 percent
11 have been built in large lot zoning districts. Average land consumption per single family unit
12 has almost doubled from an average lot size of 0.6 to 1.0 ac. In Fiscal Year (FY) 2001, the
13 average cost to service a single family home in the town's rural areas exceeded \$8600, more
14 than double the cost of servicing a higher density home in the older village centers (Town of
15 Plymouth, 2006a). In Barnstable County, more than 15,000 ac of open land (nearly 6 percent of
16 the land on Cape Cod) was converted to development during the 1990s and the number of
17 housing units increased by approximately 17,000 (Cape Cod Commission, 2003).

18
19 Vision 2020 is a partnership for southeastern Massachusetts, which includes Plymouth County
20 as well as neighboring Bristol County and southern Norfolk County. It is a regional growth
21 management initiative addressing the rapid growth and change occurring in the area between
22 Boston, Cape Cod, and Rhode Island (OCPC 2000). Vision 2020 is charged with preparing an
23 overall growth and development strategy for southeastern Massachusetts. The project identifies
24 strategies and incentives to (1) encourage compact development and minimize sprawl; (2)
25 preserve and enhance farmland, natural resources and open space; (3) protect historical
26 resources; and (4) encourage economic development that is beneficial to the region.

27 28 **2.2.8.3.1 Plymouth County**

29
30 Plymouth County occupies an area of 661 square mi and is located in the Boston-Cambridge-
31 Quincy, Massachusetts-New Hampshire metropolitan area (USCB 2006b). Land use in the
32 county is primarily forest (51 percent) and residential (22 percent). Agriculture and open land
33 each occupy 8 percent of the county land area. Industrial and commercial (3 percent) are minor
34 land uses. Table 2-11 provides the acreage and percent of total for each land use category in
35 Plymouth County.

Table 2-11. Land Use in Plymouth County, 1999

Land Use	Acres	Percent of Total
Residential	96,467	21.9
Commercial	5,892	1.3
Industrial	7,706	1.7
Recreation	7,108	1.6
Transportation	5,069	1.2
Agriculture	37,454	8.5
Forest	223,861	50.8
Open Land	37,423	8.5
Water	19,756	4.5
Total	440,735	100

Source: MEOEA 2003

Control of land use in Plymouth County rests with the individual towns, which have zoning authority for the lands within their boundaries. Old Colony Planning Council (OCPC) is the regional planning agency responsible for overall coordination of planning in 11 of the communities in Plymouth County, including the Town of Plymouth. The Council was formed in response to a growing need of local communities to be able to address the many issues that cross over local boundaries such as air quality, water supply and quality, transportation, and economic development. The Regional Land Use and Transportation Policy Plan published in October 2000 (OCPC 2000) provides regional land use policies designed to guide future growth into priority development areas; encourage compact, mixed-use community centers; protect outlying areas more suitable to natural resource protection, agricultural, open space and recreation uses, and water supply protection; and increase housing diversity.

In the late 1990s, the Massachusetts Executive Office of Environmental Affairs developed build-out analyses for all the towns and cities in the state, which projected the additional housing units and commercial and industrial space that would be built if the community were to fully develop its land. The build-out study for the Town of Plymouth estimates that 29,043 developable acres are available as of 1999, which represents 44 percent of the total town land area. The study projects a doubling of residential units (from 21,250 to 41,147) and population (from 51,701 to 105,424) at build-out (Town of Plymouth 2006a).

2.2.8.3.2 Barnstable County

Barnstable County, which comprises the towns of Cape Cod, has a separate Regional Policy Plan that is both a planning and a regulatory document (Cape Cod Commission 2003). The Regional Policy Plan develops a growth policy for Cape Cod, identifies key resources of regional importance, and provides the framework for town local comprehensive planning efforts. Its purpose is to guide development on Cape Cod and protect its resources. The Regional Policy Plan is required by the Cape Cod Commission Act of 1990, which calls for an update to the plan every 5 years.

Barnstable County has a land area of 396 square mi and is located in the Barnstable Town, Massachusetts metropolitan area (USCB 2006a). The county, located southeast of and adjacent to Plymouth County, includes the 15 coastal towns that make up the Cape Cod peninsula. The major land uses in Barnstable County are forest (40 percent), residential (29 percent), and open land (16 percent). The remaining 15 percent of the county is occupied by water (5 percent) and other land uses. Table 2-12 identifies the acres in each land use category in Barnstable County and the percent of the total land area that each category occupies.

Table 2-12. Land Use in Barnstable County, 1999

Land Use	Acres	Percent of Total
Residential	78,049	29.4
Commercial	4,756	1.8
Industrial	3,308	1.2
Recreation	9,344	3.5
Transportation	4,753	1.8
Agriculture	4,195	1.6
Forest	106,250	40.0
Open Land	41,569	15.6
Water	13,492	5.1
Total	265,717	100

Source: MEOEA 2003

1 Barnstable County has a county legislative body with the power to enact ordinances. The
2 county is the regional government for Cape Cod (Barnstable County 2006). The Cape Cod
3 Commission, a department of the county, is the regional planning and land use regulatory
4 agency for Barnstable County. The Commission was established in response to an
5 unprecedented growth boom in the 1980s. The Commission's purpose is to prepare and
6 oversee implementation of a regional land use policy plan for all of Cape Cod, review and
7 regulate Developments of Regional Impact, and recommend designation of certain areas as
8 Districts of Critical Planning Concern. Barnstable County adopted the latest update of the Cape
9 Cod Commission's Regional Policy Plan in 2002, which was revised in 2003 (Cape Cod
10 Commission 2003). The Regional Policy Plan includes broad goals that set the direction for the
11 future of the county as well as more detailed Minimum Performance Standards that future
12 development on Cape Cod is required to meet. As in Plymouth County, the towns in Barnstable
13 County guide land use through local zoning bylaws. The Regional Policy Plan provides a
14 growth policy in which development is redirected toward existing village centers and other
15 developed areas and away from outlying areas in order to preserve open space, natural
16 resources, and scenic landscapes.

17
18 As of 2000, Barnstable County has 76,973 ac available for development, approximately 31
19 percent of the land on Cape Cod. A build-out analysis conducted in 2000 by the Cape Cod
20 Commission and the Massachusetts Executive Office of Environmental Affairs determined that
21 Barnstable County could add 37,000 housing units and at least 50,000 people at build-out,
22 which would likely be reached within 30 years (Cape Cod Commission 2003).

23 24 **2.2.8.4 Visual Aesthetics and Noise**

25
26 The PNPS plant structures can be seen from Cape Cod Bay, from approximately north-
27 northwest to southeast. Most visible is the 330-ft-tall main stack, with its alternating white and
28 red stripes and aviation lights. For boaters on the bay, the stack serves a useful navigational
29 purpose as a notable landmark. From the land side, PNPS is relatively well screened by natural
30 vegetation from viewers on Rocky Hill Road, the closest public thoroughfare. Motorists traveling
31 on Rocky Hill Road pass two former entrance gates and the main entrance drive to the plant at
32 Power House Road. Overhead transmission lines pass over local roads on their way to connect
33 to the regional grid. Viewers from other vantage spots, such as Priscilla and White Horse
34 Beaches, would see only the plant's stack.

1 **2.2.8.5 Demography**

2
3 **2.2.8.5.1 Regional Population**

4
5 U.S. Census Bureau (USCB) year 2000 data and geographic information system (GIS) software
6 (ArcView®) were used to determine the demographic characteristics in the vicinity of PNPS
7 (USCB 2002). Census data reveal that approximately 285,547 people live within 20 mi of
8 PNPS, with a population density of 422 persons per square mi within 20 mi of PNPS and,
9 applying the GEIS sparseness index, falls into the least sparse category, Category 4 (having
10 greater than or equal to 120 persons per square mile within 20 mi). This calculation corrects for
11 the area within the radius that is water (Entergy 2006a).

12
13 USCB data indicate approximately 4,629,116 people live within 50 mi of PNPS. This equates to
14 a population density of 1167 persons per square mi within 50 mi. Applying the GEIS proximity
15 index, PNPS is classified as Category 4 proximity (having greater than or equal to 190 persons
16 per square mi within 50 mi). According to the GEIS sparseness and proximity matrix, PNPS
17 ranks of sparseness Category 4 and proximity Category 4 result in the conclusion that PNPS is
18 located in a "high" population area. All or parts of 15 counties (Figure 2-1) and the cities of
19 Boston, Massachusetts, and Providence, Rhode Island, are located within 50 mi of PNPS.

20
21 In 2000, Plymouth County and Barnstable County had a combined total population of 695,052
22 (USCB 2006a, USCB 2006b). Plymouth County extends to metropolitan Boston and comprises
23 26 towns and one city. Barnstable County is made up of 15 towns on Cape Cod. From 1970 to
24 2000, Plymouth County had an average annual growth rate of 1.4 percent and Barnstable
25 County had an average annual growth rate of 4.3 percent. Both Plymouth and Barnstable
26 counties have been growing at a rate faster than that of Massachusetts as a whole. From 1970
27 to 2000, Massachusetts's average annual population growth rate was 0.39 percent
28 (Entergy 2006a).

29
30 Table 2-13 shows estimated populations and annual growth rates through 2020 for the two
31 counties with the greatest potential to be socioeconomically affected by license renewal
32 activities. The proposed license renewal term is through 2032; however, the Massachusetts
33 Institute for Social and Economic Research (MISER) projections extend only through 2020.
34 Plymouth, while representing the larger of the two counties in terms of population, is projected
35 to grow at a much slower rate than Barnstable over the period to 2020. Plymouth is projected to
36 grow a total of 16.5 percent over 2000 to 2030, compared to Barnstable's 50.6 percent.

Table 2-13. Population Growth in Plymouth and Barnstable Counties - 1980 to 2020

	Plymouth County		Barnstable County	
	Population	Annual Growth Percent ^(a)	Population	Annual Growth Percent ^(a)
1970 ¹	333,314	-	96,656	-
1980 ¹	405,437	2.16	147,925	5.3
1990 ¹	435,276	0.7	186,605	2.6
2000 ¹	472,822.	0.9	222,230	1.9
2010 ²	496,053	0.5	257,844	1.6
2020 ²	517,644	0.4	299,035	1.6
2030 ³	551,005	0.6	334,766	1.2

(a) Annual percent growth rate is calculated over the previous decade.

Sources: (1) USCB 1995, (2) MISER 2003, (3) Entergy 2006a

2.2.8.5.2 Transient Population

Coastal areas of Plymouth and Barnstable counties experience major increases in their summer populations because of the area's attraction as a vacation destination. This is reflected in the number of "vacant for seasonal use" housing units reported in the U.S. Census. For Barnstable County the 2000 Census reports 47,610 units vacant for seasonal use (91 percent of all vacant units and 32.4 percent of all housing units). In Plymouth County, vacant for seasonal use units in 2000 totaled 8865 (67 percent of all vacant units or 4.9 percent of all housing units). In addition, there are numerous hotels, motels and guest houses that serve the tourist/vacation population. The Town Manager of Plymouth reported that the summer population of the town increased to approximately 86,000, from a year-round population of 55,000, i.e., a 56 percent increase (Sylvia 2006). Other indicators of significant seasonal activity are the number of registered boats in Plymouth harbor. The statistics for 2004 indicate that there were 655 moorings in the harbor, 5000 visiting boats that logged in, and an estimated 11,000 boats launched at the boat ramp (Town of Plymouth 2004c).

2.2.8.5.3 Minority and Low-Income Populations

Executive Order 12898 (59 FR 7629), *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, refers to a Federal policy that requires Federal agencies to identify and address, as appropriate, disproportionately high and adverse

1 human health or environmental effects of its actions on minority and low-income populations.
2 Although the Executive Order is not mandatory for independent agencies, the NRC has
3 voluntarily committed to undertake environmental justice reviews and in 2004, the Commission
4 issued a final *Policy Statement on the Treatment of Environmental Justice Matters in NRC*
5 *Regulatory and Licensing Actions* (NRC 2004a).

6
7 The guidance requires determining the existence of minority and low-income populations within
8 50-mi radius of the site and the use of the state as the geographic area for comparative
9 analysis. According to the guidance, a qualified minority population exists in a census block
10 group (a USCB-designated area smaller than a census tract), if the percentage of each minority
11 and aggregated minority category within the census block group exceeds the corresponding
12 percentage of minorities in the state of which it is a part by 20 percentage points, or the
13 corresponding percentage of minorities within the census block group is at least 50 percent. A
14 qualified low-income population exists if the percentage of low-income population within a
15 census block group exceeds the corresponding percentage of low-income population in the
16 state of which it is a part by 20 percent, or if the corresponding percentage of low-income
17 population within a census block group is at least 50 percent.

18
19 Using the ArcView® GIS software to combine USCB Topologically Integrated Geographic
20 Encoding and Referencing System (TIGER) line data with USCB 2000 census data to
21 determine minority and low-income characteristics (at the block-group level) within the 50-mi
22 radius of the PNPS site, it was determined that the 50-mi radius includes 3863 block groups in a
23 two-state area, with the largest portion of that area (89 percent) located in Massachusetts and a
24 smaller portion (11 percent) in Rhode Island.

25 26 **2.2.8.5.4 Minority Populations**

27
28 The NRC Environmental Justice guidance defines a "minority" population as the racial
29 categories: American Indian or Alaskan Native, Asian, Native Hawaiian or Pacific Islander,
30 Black races, other races, more than 2 races, and the aggregate of all minority races.
31 Hispanic ethnicity is also defined as a minority population category (NRC 2004b, in Entergy
32 2006a). Hispanic ethnicity is not defined by the USCB as a racial category and, therefore, it is
33 possible to have both white Hispanics and non-white Hispanics (e.g. Black Hispanic, Asian
34 Hispanic). For the purposes of aggregation, a minority population that combines both minority
35 races and Hispanic ethnicity can be defined as all non-white and multiple races plus white
36 Hispanics.

37
38 Using 2000 census data, the percentage of the total population in Massachusetts and Rhode
39 Island that belong to each minority category was determined (Table 2-14). This information was
40 then used to calculate minimum thresholds for each minority category. Any block group with a

1 minority category percentage that exceeded the minimum threshold listed in Table 2-14 was
2 defined as a "minority population."
3

4 The percent of the population in each minority category was calculated in each of the 3863
5 block groups within 50 mi of PNPS, and compared to the corresponding geographic area's
6 minority threshold percentages to determine if a minority population exists. The number of block
7 groups that exceeded minority thresholds is summarized in Table 2-15. The location of the
8 aggregated minority populations within 50 mi of PNPS is shown in Figure 2-11.
9

10 Based on the "more than 20 percent" criterion, a Native Hawaiian or other Pacific Islander
11 minority population exists in one block group in Suffolk County, Massachusetts. Black minority
12 populations exist in 261 block groups, with 233 of the block groups in Massachusetts and 28 in
13 Rhode Island. Other minority race populations exist in 135 block groups, with 77 occurring in
14 Massachusetts and 58 in Rhode Island. No block groups exceeded the minimum threshold for
15 more than 2 races. The aggregate of minority racial populations exist in 595 block groups, with
16 475 of the block groups occurring in Massachusetts and 120 in Rhode Island.
17

18 Minority populations based on Hispanic ethnicity occur in 240 block groups, with 145 of them in
19 Massachusetts and 95 in Rhode Island. Minority populations composed of the aggregate of
20 minority races and Hispanic ethnicity populations exist in 651 block groups, with 514 of the
21 block groups occurring in Massachusetts and 137 in Rhode Island. The locations of these
22 minority populations are shown in Figure 2-12.
23

24 Overall, no minority populations were identified within a 6-mi radius of PNPS. The nearest
25 minority population within a 50-mi radius was in west-central Plymouth County near the
26 community of Brockton where several minority thresholds were exceeded. These populations
27 are approximately 25 mi west of the PNPS site. Other minority populations within 50 mi of
28 PNPS were typically clustered in or near the Boston, Massachusetts and Providence, Rhode
29 Island areas.
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Table 2-14. Percentage of Minority and Low-income Individuals in the 50-mile Radius Study Area and Threshold Criteria for Identifying Minority and Low-income Populations at the Block Group Level. (Source: Entergy 2006f)

State	American Indian Alaska Native	Asian	Native Hawaiian or Other Pacific Islanders	Black Races	Other Races	More than 2 Races	Aggregate of Minority Races	Hispanic Ethnicity	Aggregate of Minority Races and Hispanic Ethnicity	Low-income Population (Individuals)	Low-income Population (Households)
MA	0.2	3.8	0.0	5.4	3.7	2.3	15.5	6.8	18.1	9.3	9.8
RI	0.5	2.3	0.1	4.5	5.0	2.7	15.0	8.7	18.1	11.9	12.4
Minority and low-income population threshold criteria											
MA	20.2	23.8	20.0	25.4	23.7	22.3	35.5	26.8	38.1	29.3	29.8
RI	20.5	22.3	20.1	24.5	25.0	22.7	35.0	28.7	38.1	31.9	32.4
Source: Entergy 2006f											

Table 2-15. Block Groups Exceeding Thresholds for Minority and Low-income Populations in Counties Within a 50-mile Radius of PNPS.

State	County	Number of Block Groups within 50-mile Radius	American Indian Alaska Native	Asian	Native Hawaiian or Other Pacific Islander	Black Races	Other Races	More than 2 Races	Aggregate of Minority Races	Hispanic Ethnicity	Aggregate of Minority Races and Hispanic Ethnicity	Low-income Population (Individuals)	Low-income Population (Households)
MA	Barnstable	198	0	0	0	0	0	0	0	0	0	1	0
MA	Bristol	417	0	1	0	0	11	0	22	6	26	34	34
MA	Dukes	20	1	0	0	0	0	0	1	0	1	0	0
MA	Essex	317	0	0	0	1	5	0	33	25	36	12	10
MA	Middlesex	761	0	11	0	14	2	0	52	8	67	9	7
MA	Nantucket	4	0	0	0	0	0	0	0	0	0	0	0
MA	Norfolk	473	0	14	0	5	0	0	20	0	18	3	2
MA	Plymouth	366	0	0	0	17	8	0	43	0	45	11	11
MA	Suffolk	630	0	28	1	196	51	0	304	106	321	120	115
MA	Worcester	18	0	0	0	0	0	0	0	0	0	0	0
RI	Bristol	41	0	0	0	0	0	0	0	0	0	0	0
RI	Kent	83	0	0	0	0	0	0	0	0	0	1	0
RI	Newport	60	0	0	0	1	0	0	2	0	2	1	1
RI	Providence	471	0	3	0	27	58	0	118	95	135	77	73
RI	Washington	4	0	0	0	0	0	0	0	0	0	0	0
	Total	3863	1	57	1	261	135	0	595	595	651	269	253
Minority and low-income thresholds													
MA		3204	20.2	23.8	20.0	25.4	23.7	22.3	35.5	35.5	38.1	29.3	29.8
RI		659	20.5	22.3	20.1	24.5	25.0	22.7	35.0	35.0	38.1	31.9	32.4
Source: Entergy 2006f													

Plant and the Environment

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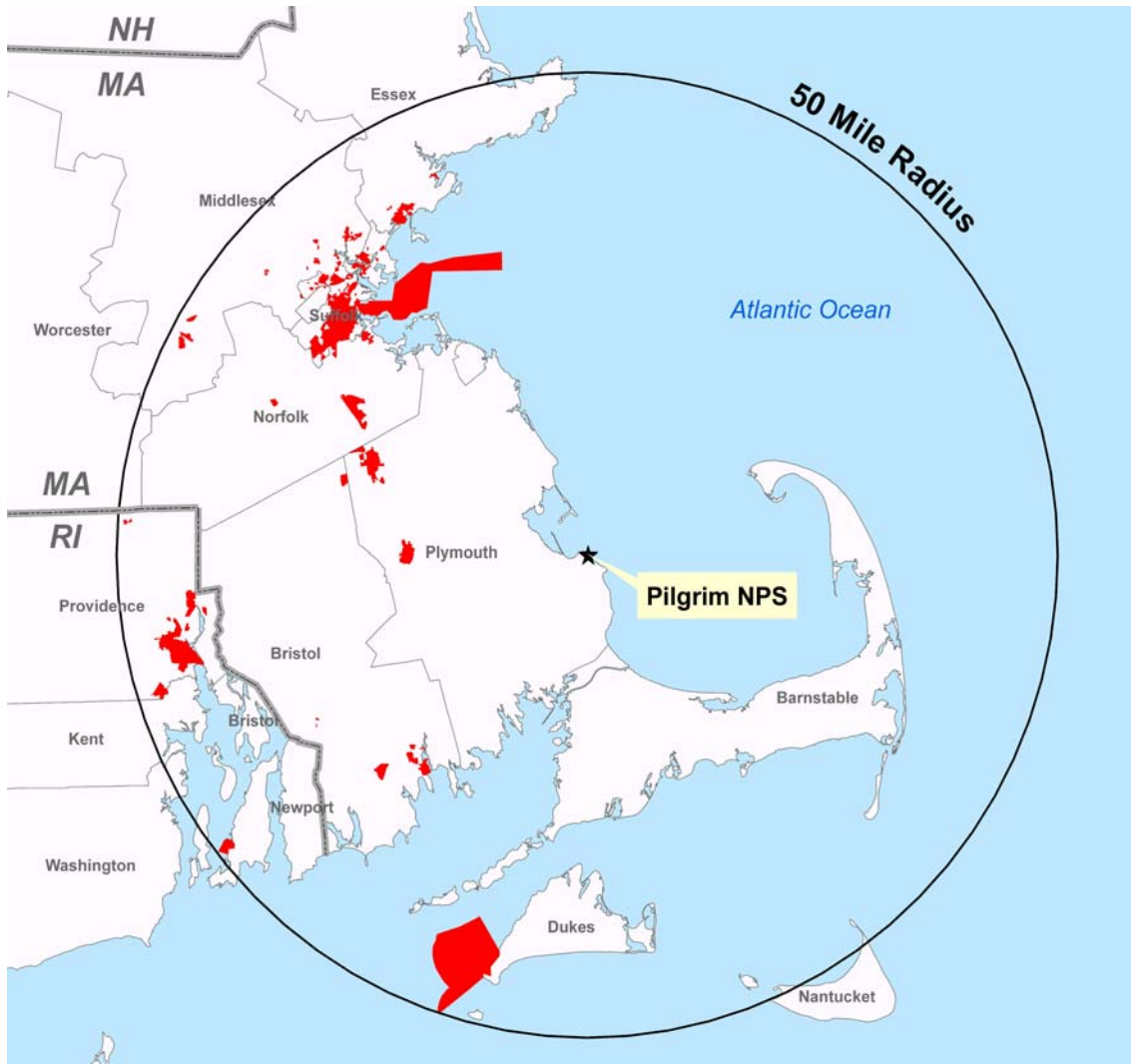


Figure 2-11. Aggregate of Minority Races Population Map (Source: Entergy 2006a)

2.2.8.5.5 Low-Income Populations

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2
3 NRC guidance defines “low-income” by using USCB statistical poverty thresholds for the year
4 1999 (NRC 2004b). Low-income populations within the 50-mi radius of PNPS were identified
5 using information on both the number of individuals and number of households below the
6 poverty level in Massachusetts and Rhode Island and block groups within the environmental
7 impact site (50-mi radius). The USCB values for the number of individuals and households
8 below the poverty level in Massachusetts was 9.3 percent and 9.8 percent, respectively
9 (Table 2-14). The number of individuals and households below the poverty level in Rhode
10 Island was 11.9 percent and 12.4 percent, respectively.

11
12 The low-income populations within the 50-mi radius were identified using the “greater than 20
13 percent” criterion (Table 2-14). The number and percentage of block groups that exceeded
14 these thresholds are included in Table 2-15. The locations of these low income populations are
15 shown in Figure 2-12.

16
17 Low-income “individual” populations exist in 190 block groups in Massachusetts and 79 in
18 Rhode Island. Low-income populations based on the number of “households” exist in 179 block
19 groups in Massachusetts and 74 block groups in Rhode Island.

20
21 No low-income populations were identified within a 6-mi radius of PNPS. The nearest low-
22 income population occurring within a 50-mi radius was in northwest Plymouth County in
23 Brockton where thresholds for both low-income individuals and households were exceeded.
24 These populations are approximately 25 mi northwest of the PNPS site. Other low-income
25 populations within 50 mi of PNPS were clustered near Boston and in Bristol County, near the
26 communities of Fall River and New Bedford, Massachusetts and in Providence County, Rhode
27 Island.

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Figure 2-12. Low-Income Population Map (Source: Entergy 2006a)

2.2.8.6 Economy

2.2.8.6.1 Employment

The 10-mi radius surrounding PNPS mostly includes the town of Plymouth; however, small sections of the towns of Carver, Kingston, Plympton, Duxbury and Marshfield are also within this radius. Employment trends data provided by the OCPC is shown in Table 2-16. (The OCPC region includes Plymouth, Kingston and Plympton, among other towns as it extends to the northeast, but does not include Carver, Duxbury and Marshfield.) Plymouth is seen to have increased its employment by 19 percent over the 1990s, greater than the OCPC total employment increase of 11.4 percent over the period.

Services are by far the largest industry sector in Plymouth, accounting for 38 percent of employment in 2000, followed by Trade (22 percent) and Government (16 percent). In the OCPC region, Trade dominates with 32 percent, followed by Services (28 percent) and Government (15.5 percent). Employment projections by OCPC see employment in Plymouth increasing to 22,810 by 2025, a 19 percent growth over employment in 2000. The OCPC region is expected to grow at a similar rate of 19.8 percent over the period.

Table 2-16. Employment Trends: Number of Employees by Industry Sector 1990 and 2000

Industry/ Year	Plymouth		Kingston		Plympton		OCPC Region	
	1990	2000	1990	2000	1990	2000	1990	2000
Agriculture	253	190	22	53	7	30	864	1,096
Government	2416	3,041	506	531	Conf.	99	16,883	19,274
Construction	562	702	93	187	38	45	6,158	6,197
Manufacturing	1,856	1,500	232	287	273	12	14,622	12,740
TCPU	1,551	1,480	806	95	Conf.	Conf.	7,619	6,618
Trade	3,890	4,225	2,413	3,060	35	29	35,993	39,940
FIRE	1,023	472	116	146	Conf.	8	4,746	3,296
Services	4,503	7,279	468	959	45	36	24,436	34,578
Total Jobs	16,054	19,100	4,656	5,318	398	267	111,321	123,978

Source: OCPC 2006a

TCPU: Transportation, Communications, and Public Utilities.

FIRE: Finance, Insurance and Real Estate.

Conf.: Data suppressed due to confidentiality.

Plant and the Environment

1 The OCPC report *Keeping Our Region Competitive* (OCPC 2006a) provides data on large
2 employers in the region. In Plymouth, it cites two large manufacturing employers and one
3 hospital:

- 4
- 5 • Pixley-Richards, Inc. (plastic molds) with 200 estimated employees;
- 6 • Tech-Etch (shielding products) with 130 estimated employees; and
- 7 • Jordan Hospital with 800 estimated employees.
- 8

9 The only other large employer noted in the OCPC report among the nearby towns is L. Knife &
10 Son, a wholesale liquor distributor in Kingston with 500 estimated employees. Interviews with
11 local officials indicated that government was often the largest local employer, although officials
12 from the following towns also noted: Independence Mall and R.S. Means (cost estimating) in
13 Kingston; Battelle (engineers) in Duxbury; and two supermarkets, two retail stores, and several
14 restaurants in Marshfield.

15
16 Another industry of some note to the coastal towns is commercial and recreational fishing and
17 boating. The mooring data from Plymouth's Harbor Master was noted under Section 2.2.8.5.2,
18 Transient Populations, with 655 moorings in the harbor, 5000 visiting boats logged in, and an
19 estimated 11,000 boats launched at the boat ramp. The Harbor Master also reports: 50 fishing
20 boats and 14 charter boats using Plymouth wharves; 712 shell fishing permits; and that
21 Plymouth has one of the State's top five lobster landings (Town of Plymouth 2004c). In
22 addition, active draggers, gill-netters and other commercial boats work from the harbor. Other
23 important recreational activities include whale watching, party fishing and sport fishing boats.
24 Similar commercial and recreational activities occur in the Towns of Kingston, Duxbury, and
25 Marshfield including: shell fishing, aquaculture farming, lobstering, charter boats, and
26 recreational marinas.

27 28 **2.2.8.6.2 Migrant Farm Labor**

29
30 Although agriculture is not a large employment sector in the region, interviews with Plymouth
31 town officials and those of surrounding towns indicated that the extensive cranberry bogs in the
32 area were among the largest cranberry producers in the country. This agricultural activity is
33 particularly significant in Plymouth and Carver, where several hundred seasonal workers were
34 likely to be hired each year, in addition to the 200 to 300 workers at three processing plants in
35 Carver, which operate 6 to 9 months a year^(a).

(a) Employment estimates obtained during interview with Town of Carver officials on May 4, 2006.

2.2.8.6.3 Taxes

PNPS pays annual property taxes to the Town of Plymouth. Taxes fund the Town of Plymouth's operations, the school system, public works, the Town General Fund, and the police and fire departments (MA DOR 2002 in Entergy 2006a).

In 1998, the Commonwealth of Massachusetts deregulated its utility industry. As a result, the Massachusetts legislature changed property tax assessment methodologies for utilities from net book value to fair market value. In 1999, Boston Edison Company sold PNPS to Entergy Corporation for significantly less than the assessed values at that time. Consequently, property taxes paid to the Town of Plymouth for PNPS have declined from pre-1999 payments. Boston Edison's parent, NSTAR, retained ownership of all transmission functions and facilities and continues to pay property taxes to the Town of Plymouth for those facilities. As part of the utility industry, the transmission facilities are also subject to the new property tax assessment methodologies, with the effect that NSTAR will pay reduced property taxes to the Town of Plymouth.

In FY 2004 (ending June 30, 2004), the Town of Plymouth collected \$86.4 million in property taxes, of which \$72.2 million were from real estate taxes (Town of Plymouth 2004c). Total town revenues in that year were \$126.96 million, implying that real estate taxes accounted for 57.7 percent of total town revenues.

Entergy paid \$1.58 million in property taxes (real and personal property) in the Town's FY 2001 and \$1.34 million for FY 2006. Additional data on Entergy's property tax payments from the "Top Ten Property Taxpayers" in Plymouth over the years 2000-2006 are shown in Table 2-17. Boston Edison's payments are also shown, although these are for all its transmission facilities, etc., not only those associated with the PNPS transmission lines.

Subsequent to the state's deregulation law and Entergy's purchase of PNPS, the Town of Plymouth and Entergy agreed to payments in lieu of taxes (PILOT) of \$1 million annually with the potential for payments to increase should Entergy make capital improvements or substantial additions to the plant. The agreement takes effect in FY2007 and continues through 2012, and would be renegotiated in the event of license renewal (Entergy 2006a). In addition, in order to ameliorate the deregulation impacts on the Town of Plymouth's revenues, the Massachusetts legislature required NSTAR to make PILOT payments to the Town of Plymouth until the end of PNPS' current license in 2012. NSTAR payments have been reduced from over \$15 million in 2001 to \$12 million in 2006, and thereafter will decline to \$1 million in 2007 and continue at that level through 2012. This is a significant reduction from the \$15 million in tax revenues previously received by the town from Boston Edison Company.

Plant and the Environment

1 Until 1999, PNPS' property taxes provided approximately 22 percent of the Town of Plymouth's
2 total property tax revenues. In FY2007, PNPS is expected to pay only about 2 percent of the
3 total property taxes received by the Town of Plymouth.
4

5 **Table 2-17.** PNPS Contributions to Town of Plymouth Property Tax Revenues
6

7	Year	Town of Plymouth Total Property Tax Revenues (\$millions)	Property Tax Paid by Entergy		Property Tax Paid by Boston Edison/NSTAR*	
			(\$millions)	Percent of Total Property Taxes (%)	(\$millions)	Percent of Total Property Taxes (%)
8	2000	71.83	-	-	15.35	21.37
9	2001	75.17	1.58	2.10	15.28	20.34
10	2002	76.38	2.01	2.63	13.03	17.05
11	2003	78.71	1.59	2.03	13.03	16.56
12	2004	86.57	1.53	1.77	13.03	15.05
13	2005	87.54	1.40	1.60	13.03	14.88
14	2006	93.48	1.34	1.43	12.03	12.87

15 Source: Town of Plymouth 2006b

16 *NSTAR, the parent company of Boston Edison, retained ownership of all transmission functions and facilities and
17 continues to pay property taxes to the Town of Plymouth.
18

19 **2.2.9 Historic and Archaeological Resources** 20

21
22 This section presents a brief summary of the region's cultural background and a description of
23 known historic and archaeological resources at the PNPS site and its immediate vicinity. The
24 information presented was collected from area repositories, the Massachusetts Historical
25 Commission (MHC), and the applicant's Environmental Report (Entergy 2006).
26

27 **2.2.9.1 Cultural Background** 28

29 Native Americans first settled in southern New England following the recession of the Wisconsin
30 glacier approximately 10,000 years before present. Little information is available concerning the
31 population or subsistence strategies of these earliest groups, perhaps because the earliest sites
32 have been inundated by gradually rising sea levels or destroyed by development (Anderson and
33 Gillam 2000). Over the following several thousand years prehistoric people in this region

1 gradually adapted to a slowly warming environment, although environmental change was
2 periodically more abrupt (McWeeney 1999 in ENSR 2000). As the environment changed, so did
3 the available resource base and the tool kit utilized to exploit those resources. During the most
4 recent portion of prehistory, beginning a few thousand years before the present, indigenous
5 populations began to settle in semi-permanent villages based in part on agriculture and fishing
6 and to use pottery for both food preparation and storage.

7
8 Historically attested groups such as the Wampanoag inhabited the region at the time of
9 European contact during the 17th century. Documentary evidence indicates that the 17th
10 century Wampanoag would spend the warmer months of the year living along the coast to fish
11 and grow a variety of crops and the winter months inland where hunting and gathering would be
12 more abundant (Hasenstab 1999). Contact with Europeans led to a dramatic population
13 decrease due to lack of immunity to disease and later political conflicts and war led to additional
14 depopulation and displacement.

15
16 Among the separatists leaving England seeking religious autonomy during the 17th century was
17 a group, eventually known as the Pilgrims, which ultimately established a colony in Plymouth,
18 Massachusetts, a few miles northwest of PNPS in 1620. These colonists initially found survival
19 very difficult and were famously assisted by members of the Wampanoag. Additional groups
20 settled the region swelling the population to 7000 by the time Plymouth joined the Province of
21 Massachusetts Bay in 1691.

22
23 During the 18th and 19th centuries regional populations dramatically increased. The primary
24 economic engines of the region were agriculture and maritime-industries, which were replaced
25 by tourism during the 20th century.

26 27 **2.2.9.2 Historic and Archaeological Resources at the PNPS Site**

28 29 **2.2.9.2.1 Previously Identified Resources**

30
31 The MHC houses the state's archaeological site files and information on historic resources such
32 as buildings and houses, including available information concerning the National or State
33 Register eligibility status of these resources. The NRC staff visited the MHC and collected site
34 files on five archaeological sites located within or nearby the PNPS property. The first of these
35 sites, listed as Manomet Site (MHC No. 19-PL-68), is described as being located "left of [the]
36 access road to PNPS off Route 3a" (Turner 1976), apparently at the edge of the wetland area
37 immediately south of the station (Figure 2-13). No additional information was provided on this
38 site except that it was prehistoric and was investigated in 1972 by Dr. James Deetz of Brown
39 University. The second of these sites, listed as Forges Field P4 (MHC No. 19-PL-816),

1 consisted of two prehistoric artifacts collected from the ground surface within "highly disturbed
2 powerline corridor" (Donahue-Putnam 1997), several thousand feet southwest of PNPS. The
3 remaining three sites were discovered within a mile of the transmission line ROW, southwest of
4 PNPS, and were also prehistoric.

5
6 A review of the MHC files to identify above-ground cultural resources in Plymouth County
7 revealed 109 resources listed on the National Register of Historic Places (Entergy 2006a).
8 Within the Town of Plymouth there are 21 historic locations listed on the National Register
9 and/or State Register of Historic Places (Entergy 2006a). None of these sites are located within
10 the boundaries of the PNPS site or the associated transmission line ROW.

11
12 In 1972, in advance of construction of the station, an archaeological survey was conducted of
13 the 517-ac parcel of land on which the PNPS facility and the Jordan Road transmission line
14 were proposed (AEC 1974). This survey was conducted by the Archaeological Research
15 Department of Plimoth Plantation and the Brown University Department of Anthropology. This
16 survey identified a total of 25 archaeological sites: 24 historic sites and one prehistoric site.
17 The 24 historic sites were determined to not be significant and no further work was
18 recommended. The one prehistoric site was the subject of a more intensive investigation, which
19 concluded that the site was not eligible for listing (AEC 1974). This more intensive
20 archaeological survey, conducted by the two previously mentioned groups in collaboration with
21 the Massachusetts Archaeological Society, further concluded that the land around the proposed
22 power station site showed no evidence of prehistoric occupation. It appears that this prehistoric
23 site is Manomet Site (MHC No. 19-PL-68), described above. A search at the MHC and the
24 Massachusetts Archaeological Society failed to locate any documentation of the 1972 surveys.

25 26 **2.2.9.2.2 Results of Walkover Survey**

27
28 The NRC staff performed an informal walkover survey of the PNPS property during the site
29 audit, including the power block area, the recreation area, the Entergy Woodlands area, and a
30 portion of the transmission line ROW. During this walkover it was observed that the power
31 block area has been extensively disturbed and graded while much of the recreation area,
32 woodlands, and transmission ROW appear to have been only minimally disturbed. All of the
33 buildings and structures that comprise the station have been constructed since the early 1970s.
34 A surface scattering of late 19th century to early 20th century domestic refuse such as bottles
35 and ceramics was observed on the east side of the access road to the recreation area. The
36 topography in the vicinity of these remains suggests gravel or sand mining and the area may
37 have also been used as a dump site. NRC staff examined two potential historic resources in the
38 woodlands area: a concrete and cinder block house foundation, apparently dating to the early
39 20th century; and a granite quarrying site (Benjamin 2006).

1 **2.2.9.2.3 Potential Archaeological Resources**

2
3 Due to disturbances associated with site preparation and construction of the station, the power
4 lock area has no potential for archaeological resources. There is the potential for
5 archaeological resources to be present in the recreation area, the woodlands area, and within
6 the transmission line corridor. These areas appear to have been only minimally disturbed and
7 are comprised of landforms that may have been attractive during prehistory for varied resource
8 exploitation. A review of historic maps dating from 1879 (Walker 1879), 1895 (USGenNet.org
9 2006), and 1903 (Richards 1903) show very sparse development in the recreation area, the
10 woodlands area, and within the transmission line corridor, but there is the potential for the
11 presence of historic resources, particularly in light of the resources observed in the recreation
12 area and woodlands area during the walkover described above.

13
14 **2.2.10 Related Federal Project Activities and Consultations**

15
16 The NRC staff reviewed the possibility that activities of other Federal agencies might impact the
17 renewal of the OL for PNPS. Any such activities could result in cumulative environmental
18 impacts and the possible need for the Federal agency to become a cooperating agency for
19 preparation of this SEIS.

20
21 The NRC staff has reviewed local Federally owned facilities and Federally permitted industrial
22 facilities in the local area near Plymouth and Cape Cod Bay, and has determined that there are
23 no Federal project activities that would make it desirable for another Federal agency to become
24 a cooperating agency for preparing this SEIS. Proposed Federal projects in the local area
25 include dredging for the Plymouth Harbor Federal Navigation Project by the U.S. Army Corps of
26 Engineers (ACE 2006). Pending applications for Federal permits in the area include the filling
27 of 26 acres within Plymouth Bay by the Town of Plymouth, the construction of a pile-supported,
28 fixed pier and floating docks in the Federal anchorage in Plymouth Harbor, dredging to
29 reestablish the entrance to Ellisville Harbor in Plymouth, and the ability to retain and maintain
30 the Cordage Park Marina in Plymouth Bay (ACE 2006). The Mirant Canal Station power plant
31 in Sandwich, on Cape Cod Canal, is the nearest power facility that extracts and discharges
32 cooling water under a Federally issued NPDES permit (EPA 2006b).

33
34 An additional Federal action in the area is the proposed implementation of NMFS's Ship Strike
35 Reduction Strategy to reduce vessel strikes to the endangered North Atlantic right whale.
36 Implementation of this strategy would involve establishment of a Seasonal Management Area in
37 Cape Cod Bay in the winter and spring, routing measures in Cape Cod Bay to deflect major
38 vessel traffic away from right whale aggregations, and the establishment of as-needed Dynamic
39 Management Areas when whales are sighted (NOAA 2006).

40
41 NRC is required under Section 102(c) of the National Environmental Policy Act of 1969, as
42 amended, to consult with and obtain the comments of any Federal agency that has jurisdiction

1 by law or special expertise with respect to any environmental impact involved. NRC is
2 consulting with the EPA, NMFS, and the FWS. Consultation correspondence is included in
3 Appendix E. The EPA and NMFS submitted written comments during the scoping process; their
4 comments are addressed in this SEIS.
5

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3.0 Environmental Impacts of Refurbishment

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

- (1) The environmental impacts associated with the issue have been determined to apply either to all plants or, for some issues, to plants having a specific type of cooling system or other specified plant or site characteristics.
- (2) A single significance level (i.e., SMALL, MODERATE, or LARGE) has been assigned to the impacts (except for collective off-site radiological impacts from the fuel cycle and from high-level waste and spent fuel disposal).
- (3) Mitigation of adverse impacts associated with the issue has been considered in the analysis, and it has been determined that additional plant-specific mitigation measures are likely not to be sufficiently beneficial to warrant implementation.

For issues that meet the three Category 1 criteria, no additional plant-specific analysis is required in this draft Supplemental Environmental Impact Statement unless new and significant information is identified.

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

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

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

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

Environmental Impacts of Refurbishment

Table 3-1. Category 1 Issues for Refurbishment Evaluation

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

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

The potential environmental effects of refurbishment actions would be identified, and the analysis would be summarized within this section, if such actions were planned. Entergy Nuclear Operations, Inc. (Entergy) indicated that it has performed an evaluation of structures and components pursuant to Title 10 of the Code of Federal Regulations (CFR), Part 54, Section 54.21 to identify activities that are necessary to continue operation of PNPS during the requested 20-year period of extended operation. These activities include replacement of certain components as well as new inspection activities, and are described in the Environmental Report (Entergy 2006).

Table 3-2. Category 2 Issues for Refurbishment Evaluation

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Sections	10 CFR 51.53 (c)(3)(ii) Subparagraph
TERRESTRIAL RESOURCES		
Refurbishment impacts	3.6	E
THREATENED OR ENDANGERED SPECIES (FOR ALL PLANTS)		
Threatened or endangered species	3.9	E
AIR QUALITY		
Air quality during refurbishment (nonattainment and maintenance areas)	3.3	F
SOCIOECONOMICS		
Housing impacts	3.7.2	I
Public services: public utilities	3.7.4.5	I
Public services, education (refurbishment)	3.7.4.1	I
Offsite land use (refurbishment)	3.7.5	I
Public services, transportation	3.7.4.2	J
Historic and archaeological resources	3.7.7	K
ENVIRONMENTAL JUSTICE		
Environmental justice	Not addressed ^(a)	Not addressed ^(a)
(a) Guidance related to environmental justice was not in place at the time the GEIS and the associated revision to 10 CFR Part 51 were prepared. If an applicant plans to undertake refurbishment activities for license renewal, environmental justice must be addressed in the applicant's environmental report and the staff's environmental impact statement. The Commission issued a <i>Final Policy Statement on the Treatment of Environmental Justice Matters in NRC Regulatory and Licensing Actions</i> in 2004 (NRC 2004).		

However, Entergy stated that the replacement of these components and the additional inspection activities are within the bounds of normal plant component replacement and inspections; therefore, they are not expected to affect the environment outside the bounds of plant operations as evaluated in the final environmental statement (AEC 1972). In addition, Entergy's evaluation of structures and components as required by 10 CFR 54.21 did not identify any major plant refurbishment activities or modifications necessary to support the continued operation of PNPS beyond the end of the existing operating licenses. Therefore, refurbishment is not considered in this draft Supplemental Environmental Impact Statement.

3.1 References

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

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

Atomic Energy Commission (AEC). 1972. *Final Environmental Statement Related to Operation of Pilgrim Nuclear Power Station, Boston Edison Company*. Dockets No. 50-293, Washington, D.C.

Entergy Nuclear Operations, Inc. (Entergy). 2006. *Applicant’s Environmental Report – Operating License Renewal Stage, Pilgrim Nuclear Power Station*. Docket No. 50-293, Plymouth, Massachusetts.

Nuclear Regulatory Commission (NRC). 1996. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*. NUREG-1437, Volumes 1 and 2, Washington, D.C.

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

Nuclear Regulatory Commission (NRC). 2004. “Policy Statement on the Treatment of Environmental Justice Matters in NRC Regulatory and Licensing Actions,” Final. *Federal Register*. Volume 69, No. 163, pp. 52040-52048. August 24, 2004.

4.0 Environmental Impacts of Operation

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

- (1) The environmental impacts associated with the issue have been determined to apply either to all plants or, for some issues, to plants having a specific type of cooling system or other specified plant or site characteristics.
- (2) A single significance level (i.e., SMALL, MODERATE, or LARGE) has been assigned to the impacts (except for collective off-site radiological impacts from the fuel cycle and from high-level waste and spent fuel disposal).
- (3) Mitigation of adverse impacts associated with the issue has been considered in the analysis, and it has been determined that additional plant-specific mitigation measures are likely not to be sufficiently beneficial to warrant implementation.

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

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

This chapter addresses the issues related to operation during the renewal term that are listed in Table B-1 of Title 10 of the Code of Federal Regulations (CFR) Part 51, Subpart A, Appendix B and are applicable to Pilgrim Nuclear Power Station (PNPS). Section 4.1 addresses issues applicable to the PNPS cooling system. Section 4.2 addresses issues related to transmission lines and onsite land use. Section 4.3 addresses the radiological impacts of normal operation, and Section 4.4 addresses issues related to the socioeconomic impacts of normal operation during the renewal term. Section 4.5 addresses issues related to groundwater use and quality, while Section 4.6 discusses the impacts of renewal-term operations on threatened and endangered species. Section 4.7 addresses potential new information that was raised during the scoping period and Section 4.8 discusses cumulative impacts. The results of the evaluation of environmental issues related to operation during the renewal term are summarized in Section 4.9. Finally, Section 4.10 lists the references for Chapter 4. Category 1 and Category 2

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

1 issues that are not applicable to PNPS because they are related to plant design features or site
 2 characteristics not found at PNPS are listed in Appendix F.
 3

4 **4.1 Cooling System**

5
 6 Category 1 issues in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, that are applicable to
 7 PNPS cooling system operation during the renewal term are listed in Table 4-1. Entergy
 8 Nuclear Operations, Inc. (Entergy) stated in its Environmental Report (ER) (Entergy 2006a) that
 9 it is not aware of any new and significant information associated with the renewal of the PNPS
 10 operating license (OL). The U.S. Nuclear Regulatory Commission (NRC) staff has not identified
 11 any new and significant information during its independent review of the Entergy ER, the staff's
 12 site visit, the scoping process, or evaluation of other available information. For all of the
 13 Category 1 issues, the staff concluded in the GEIS that the impacts would be SMALL, and
 14 additional plant-specific mitigation measures are not likely to be sufficiently beneficial to be
 15 warranted.
 16
 17

18 **Table 4-1. Category 1 Issues Applicable to the Operation of the PNPS**
 19 **Cooling System During the Renewal Term**
 20

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Sections
SURFACE WATER QUALITY, HYDROLOGY, AND USE (FOR ALL PLANTS)	
Altered current patterns at intake and discharge structures	4.2.1.2.1
Altered salinity gradients	4.2.1.2.2
Temperature effects on sediment transport capacity	4.2.1.2.3
Scouring caused by discharged cooling water	4.2.1.2.3
Discharge of chlorine or other biocides	4.2.1.2.4
Discharge of other metals in wastewater	4.2.1.2.4
Water use conflicts (plants with once-through cooling systems)	4.2.1.3

Table 4-1. (contd)

AQUATIC ECOLOGY (FOR ALL PLANTS)	
Accumulation of contaminants in sediments or biota	4.2.1.2.4
Entrainment of phytoplankton and zooplankton	4.2.2.1.1
Cold shock	4.2.2.1.5
Thermal plume barrier to migrating fish	4.2.2.1.6
Distribution of aquatic organisms	4.2.2.1.6
Gas supersaturation (gas bubble disease)	4.2.2.1.8
Low dissolved oxygen in the discharge	4.2.2.1.9
Losses from predation, parasitism, and disease among organisms exposed to sublethal stresses	4.2.2.1.10
Stimulation of nuisance organisms	4.2.2.1.11
Human Health	
Noise	4.3.7

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

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

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

The staff has not identified any new and significant information during its independent review of the PNPS ER, the site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there would be no impacts of altered current patterns at intake and discharge structures during the renewal term beyond those discussed in the GEIS.

Environmental Impacts of Operation

- 1 • Altered salinity gradients. Based on information in the GEIS, the Commission found
2 that:

3
4 Salinity gradients have not been found to be a problem at operating nuclear power
5 plants and are not expected to be a problem during the license renewal term.
6

7 The staff has not identified any new and significant information during its independent
8 review of the PNPS ER, the site visit, the scoping process, or its evaluation of other
9 available information. Therefore, the staff concludes that there would be no impacts of
10 altered salinity gradients during the renewal term beyond those discussed in the GEIS.
11

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

14
15 These effects have not been found to be a problem at operating nuclear power
16 plants and are not expected to be a problem during the license renewal term.
17

18 The staff has not identified any new and significant information during its independent
19 review of the PNPS ER, the site visit, the scoping process, or its evaluation of other
20 available information. Therefore, the staff concludes that there would be no impacts of
21 temperature effects on sediment transport capacity during the renewal term beyond those
22 discussed in the GEIS.
23

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

26
27 Scouring has not been found to be a problem at most operating nuclear power
28 plants and has caused only localized effects at a few plants. It is not expected to be
29 a problem during the license renewal term.
30

31 The staff has not identified any new and significant information during its independent
32 review of the PNPS ER, the site visit, the scoping process, its review of monitoring
33 programs, or its evaluation of other available information. Therefore, the staff concludes
34 that there would be no impacts regarding sediment transportation due to scouring caused by
35 discharged cooling water during the renewal term beyond those discussed in the GEIS.
36

37 Scouring affects submerged aquatic vegetation in the immediate vicinity of the discharge at
38 PNPS. Such minor, localized effects of scouring are discussed in Section 4.1.3.

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

3
4 Effects are not a concern among regulatory and resource agencies, and are not
5 expected to be a problem during the license renewal term.
6

7 The staff has not identified any new and significant information during its independent
8 review of the PNPS ER, the site visit, the scoping process, or its evaluation of other
9 available information including the National Pollutant Discharge Elimination System
10 (NPDES) permit for PNPS, or discussion with the U.S. Environmental Protection Agency
11 (EPA) NPDES compliance office. To evaluate the potential impacts to water quality, the
12 staff evaluated the discharge data presented in the applicant's April 2005 to March 2006
13 monthly Discharge Monitoring Reports (DMRs) for the PNPS facility. During this time
14 period, an effluent limitation was outside of the permit requirement on three occasions. One
15 exceedence was for total suspended solids. On one occasion in January 2006 and another
16 in February 2006, there was a problem with the screenwash dechlorination system (outfall
17 003) in which chlorine was detected in the screenwash sluiceway. In each instance, one of
18 the dechlorination pumps was not pumping adequately. One pump was repaired and the
19 other replaced, and the system was restored to normal operation. Although exceedences of
20 the chlorine permit limits have been observed at PNPS, the staff has determined that there
21 would be no significant impacts of discharge of chlorine or other biocides during the renewal
22 term beyond those discussed in the GEIS.
23

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

26
27 These discharges have not been found to be a problem at operating nuclear power
28 plants with cooling-tower-based heat dissipation systems and have been
29 satisfactorily mitigated at other plants. They are not expected to be a problem
30 during the license renewal term.
31

32 The staff has not identified any new and significant information during its independent
33 review of the PNPS ER, the site visit, the scoping process, or its evaluation of other
34 available information including the NPDES permit for PNPS. Therefore, the staff concludes
35 that there would be no impacts of discharges of other metals in wastewater during the
36 renewal term beyond those discussed in the GEIS.
37
38
39
40
41
42

Environmental Impacts of Operation

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

3
4 These conflicts have not been found to be a problem at operating nuclear power
5 plants with once-through heat dissipation systems.
6

7 The staff has not identified any new and significant information during its independent
8 review of the PNPS ER, the site visit, the scoping process, or its evaluation of other
9 available information. Therefore, the staff concludes that there would be no impacts of
10 water-use conflicts for plants with once-through cooling systems during the renewal term
11 beyond those discussed in the GEIS.
12

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

15
16 Accumulation of contaminants has been a concern at a few nuclear power plants
17 but has been satisfactorily mitigated by replacing copper alloy condenser tubes with
18 those of another metal. It is not expected to be a problem during the license renewal
19 term.
20

21 The staff has not identified any new and significant information during its independent
22 review of the PNPS ER, the site visit, the scoping process, or its evaluation of available
23 information. Therefore, the staff concludes that there would be no impacts of accumulation
24 of contaminants in sediments or biota during the renewal term beyond those discussed in
25 the GEIS.
26

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

29
30 Entrainment of phytoplankton and zooplankton has not been found to be a problem
31 at operating nuclear power plants and is not expected to be a problem during the
32 license renewal term.
33

34 The staff has not identified any new and significant information during its independent
35 review of the PNPS ER, the site visit, the scoping process, its review of monitoring
36 programs, or its evaluation of other available information. Therefore, the staff concludes
37 that there would be no impacts of entrainment of phytoplankton and zooplankton during the
38 renewal term beyond those discussed in the GEIS.
39
40
41
42

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

2
3 Cold shock has been satisfactorily mitigated at operating nuclear plants with once-
4 through cooling systems, has not endangered fish populations or been found to be
5 a problem at operating nuclear power plants with cooling towers or cooling ponds,
6 and is not expected to be a problem during the license renewal term.
7

8 The staff has not identified any new and significant information during its independent
9 review of the PNPS ER, the site visit, the scoping process, or its evaluation of other
10 available information. Therefore, the staff concludes that there would be no impacts of cold
11 shock during the renewal term beyond those discussed in the GEIS.
12

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

15
16 Thermal plumes have not been found to be a problem at operating nuclear power
17 plants and are not expected to be a problem during the license renewal term.
18

19 The staff has not identified any new and significant information during its independent
20 review of the PNPS ER, the site visit, the scoping process, or its evaluation of other
21 available information. Therefore, the staff concludes that there would be no impacts of
22 thermal plume barriers to migrating fish during the renewal term beyond those discussed in
23 the GEIS.
24

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

27
28 Thermal discharge may have localized effects but is not expected to affect the
29 larger geographical distribution of aquatic organisms.
30

31 The staff has not identified any new and significant information during its independent
32 review of the PNPS ER, the site visit, the scoping process, its review of monitoring
33 programs, or its evaluation of other available information. Therefore, the staff concludes
34 that there would be no impacts on distribution of aquatic organisms during the renewal term
35 beyond those discussed in the GEIS.
36
37
38
39
40
41
42

Environmental Impacts of Operation

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

3
4 Gas supersaturation was a concern at a small number of operating nuclear power
5 plants with once-through cooling systems but has been satisfactorily mitigated. It
6 has not been found to be a problem at operating nuclear power plants with cooling
7 towers or cooling ponds and is not expected to be a problem during the license
8 renewal term.

9
10 Several incidents of gas bubble disease occurred at PNPS in the mid 1970s (Lawton et al.,
11 1986). In response to these incidents, a fish barrier net was installed in the discharge canal
12 to lessen the magnitude of the mortality events, should supersaturated conditions occur in
13 the discharge. There have been no additional incidents of gas bubble disease since that
14 time and the fish barrier net has been removed from the discharge canal and is currently
15 stored on site.

16
17 The staff has not identified any new and significant information during its independent
18 review of the PNPS ER, the site visit, the scoping process, its review of monitoring
19 programs, or its evaluation of other available information. Therefore, the staff concludes
20 that there would be no impacts of gas supersaturation during the renewal term beyond those
21 discussed in the GEIS.

- 22
23 • Low dissolved oxygen in the discharge. Based on information in the GEIS, the
24 Commission found that:

25
26 Low dissolved oxygen has been a concern at one nuclear power plant with a once-
27 through cooling system but has been effectively mitigated. It has not been found to
28 be a problem at operating nuclear power plants with cooling towers or cooling
29 ponds and is not expected to be a problem during the license renewal term.

30
31 The staff has not identified any new and significant information during its independent
32 review of the PNPS ER, the site visit, the scoping process, its review of monitoring
33 programs, or its evaluation of other available information. Therefore, the staff concludes
34 that there would be no impacts of low dissolved oxygen during the renewal term beyond
35 those discussed in the GEIS.

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

4
5 These types of losses have not been found to be a problem at operating nuclear
6 power plants and are not expected to be a problem during the license renewal term.
7

8 The staff has not identified any new and significant information during its independent
9 review of the PNPS ER, the site visit, the scoping process, or its evaluation of other
10 available information. Therefore, the staff concludes that there would be no impacts of
11 losses from predation, parasitism, and disease among organisms exposed to sub-lethal
12 stresses during the renewal term beyond those discussed in the GEIS.
13

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

16
17 Stimulation of nuisance organisms has been satisfactorily mitigated at the single
18 nuclear power plant with a once-through cooling system where previously it was a
19 problem. It has not been found to be a problem at operating nuclear power plants
20 with cooling towers or cooling ponds and is not expected to be a problem during the
21 license renewal term.
22

23 The staff has not identified any new and significant information during its independent
24 review of the PNPS ER, the site visit, the scoping process, or its evaluation of other
25 available information. Therefore, the staff concludes that there would be no impacts of
26 stimulation of nuisance organisms during the renewal term beyond those discussed in the
27 GEIS.
28

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

30
31 Noise has not been found to be a problem at operating plants and is not expected to be
32 a problem at any plant during the license renewal term.
33

34 The staff has not identified any new and significant information during its independent
35 review of the PNPS ER, the site visit, the scoping process, or its evaluation of other
36 available information. Therefore, the staff concludes that there would be no impacts of
37 noise during the license renewal term beyond those discussed in the GEIS.
38

39 The Category 2 issues related to cooling system operation during the renewal term that are
40 applicable to PNPS are discussed in the sections that follow, and are listed in Table 4-2.
41 Additionally, PNPS operations are not expected to affect any marine mammals.
42

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

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Sections	10 CFR 51.53(c)(3)(ii) Subparagraph	SEIS Section
AQUATIC ECOLOGY (FOR PLANTS WITH ONCE-THROUGH AND COOLING POND HEAT-DISSIPATION SYSTEMS)			
Entrainment of fish and shellfish in early life stages	4.2.2.1.2	B	4.1.2
Impingement of fish and shellfish	4.2.2.1.3	B	4.1.3
Heat shock	4.2.2.1.4	B	4.1.4

4.1.1 Entrainment of Fish and Shellfish in Early Life Stages

For plants with once-through cooling systems such as PNPS, entrainment of fish and shellfish in early life stages into nuclear power plant cooling water systems is considered a Category 2 issue, thus requiring a site specific assessment for the license renewal review. The staff reviewed the PNPS ER, visited the site, consulted with Federal and State resource agencies, and reviewed the applicant's existing NPDES permit and existing literature related to fish and shellfish populations of Cape Cod Bay, with particular regard to entrainment studies conducted at the PNPS.

Section 316(b) of the Clean Water Act (CWA) (common name for the Federal Water Pollution Control Act) requires that the location, design, construction, and capacity of cooling water intake structures reflect the best technology available for minimizing adverse environmental impacts (33 USC 1326). Entrainment of fish and shellfish into the cooling water system is a potential adverse environmental impact that could be minimized by use of the best available technology.

On July 9, 2004, EPA published a final rule in the *Federal Register* (69 FR 41575 [EPA 2004]) addressing cooling water intake structures at existing power plants whose flow levels exceed a minimum threshold value of 50 million gallons per day. The rule is Phase II in EPA's development of 316(b) regulations that establish national categorical requirements applicable to the location, design, construction, and capacity of cooling water intake structures at existing facilities that exceed the threshold value for water withdrawals. The national requirements, which are implemented through NPDES permits, minimize the adverse environmental impacts associated with the continued use of the intake systems. Licensees are required to demonstrate compliance with the Phase II requirements at the time of renewal of their NPDES permit. Licensees may be required as part of the NPDES renewal to alter the intake structure, redesign the cooling system, modify station operation, or take other mitigative measures as a result of this regulation. Performance standards are designed to significantly reduce entrainment and impingement losses due to plant operation. Any site-specific mitigation would

1 result in less impact due to continued plant operation. Entergy is currently conducting a
2 Comprehensive Demonstration Study (CDS) as part of the 316(b) evaluation. This study is due
3 to the EPA by January 2008.

4 5 **4.1.1.1 Environmental Monitoring** 6

7 The potential impacts to the marine environment have been actively monitored since the station
8 first went on line in 1972. The majority of the monitoring program has been conducted in
9 response to the environmental monitoring and permitting requirements of the facility's NPDES
10 permit from the EPA and Massachusetts Department of Environmental Protection (MDEP). As
11 of the writing of this Supplemental Environmental Impact Statement (SEIS), a total of 67 semi-
12 annual reports has been developed by the owners of PNPS addressing all aspects of the
13 nearshore environment surrounding PNPS, including impingement, entrainment, marine
14 fisheries, plankton, aquatic plants, the benthic community, temperature and oceanographic
15 studies, and mitigation strategies. The 316 demonstration report (ENSR 2000) contains a
16 detailed overview of the studies that were performed through 1999.

17
18 Marine algal studies were conducted periodically from the mid 1970s, up through the late 1990s,
19 primarily to evaluate impacts of the thermal discharge on algal species, in particular Irish moss
20 (*Chondrus crispus*). Studies of the benthic fauna, including the American lobster (*Homarus*
21 *americanus*), were conducted from the early 1970s up through the late 1980s, while plankton
22 studies were conducted primarily in the mid 1970s. Several temperature and oceanographic
23 studies have also been conducted by the applicant throughout the operating history of PNPS.
24 Thermal plume studies have included dye studies, boat-based thermal plume surveys, and
25 aerial infrared surveys. These studies were used as input to develop a thermal plume model.
26 Several studies of the current structure and velocities in the immediate area surrounding PNPS
27 have also been conducted by the applicant, universities, and Federal government agencies
28 (ENSR 2000).

29
30 Monitoring of marine fisheries in the area surrounding PNPS has taken place since the early
31 1970s. Many of these studies were performed by the Massachusetts Division of Marine
32 Fisheries (MDMF) and have included overflights of the nearshore environment; diving surveys;
33 sampling including bottom trawling, gill netting, and haul seining; and recreational creel surveys
34 (ENSR 2000). In addition, several species-specific studies have been performed to evaluate
35 impacts to winter flounder (*Pseudopleuronectes americanus*), cunner (*Tautoglabrus*
36 *adspersus*), and rainbow smelt (*Osmerus mordax*).

37
38 For the past 11 years, annual area-swept surveys have been conducted to assess the
39 population status of the winter flounder stock in northwestern Cape Cod Bay, as this species is
40 very important to commercial and recreational fishermen in the area, and the waters around
41 PNPS serve as a spawning, nursery, and feeding grounds (MRI 2005a). The studies were
42 initially conducted by the MDMF. More recently, the work has been conducted by Marine

Environmental Impacts of Operation

1 Research, Inc. (MRI) under contract to PNPS. The target approach for each of these surveys
2 is at least 84 tows, of at least 30 minutes in duration (MRI 2005a).

3
4 For the 2005 sampling event, 75 tows were completed between mid April and early May,
5 resulting in a total catch of 4206 winter flounder. Population size (expressed as instantaneous
6 absolute abundance) was determined using an area/density approach. After accounting for
7 efficiency of the sampling gear, estimates of winter flounder abundance in the study area were
8 approximately 126,000 adults and 230,000 total winter flounder (MRI 2005a). The abundance
9 estimates in 2005 were less than 50 percent of the 1995-2004 time series data (MRI 2005a).

10
11 Larval transport studies were conducted in 2000, 2002, and 2004 for the purposes of
12 determining the flux of winter flounder larvae moving along the coast and the flux of winter
13 flounder larvae entering PNPS through entrainment (ENSR and MRI 2005). The studies have
14 consisted of larval sampling at five offshore locations in Cape Cod Bay and the entrainment
15 sampling in the discharge canal. Water velocity measurements were also conducted at various
16 locations to correlate larval density with water movements. Sampling was conducted from late
17 May through late June (ENSR and MRI 2005).

18
19 Results from the most recent entrainment sampling conducted in 2004 indicate that PNPS likely
20 entrains a small percentage (<2 percent) of stages 1, 2, and 3 winter flounder larvae (ENSR and
21 MRI 2005). Results for stage 4 winter flounder larvae were mixed, with one of the surveys
22 indicating a 20 percent entrainment rate and the other survey indicating less than 1 percent
23 entrainment, although the authors emphasized that the higher rate may have been a result of
24 some methodological difficulties such as lost sampling gear, resulting in no sample collection
25 from several survey locations (ENSR and MRI 2005).

26
27 Of the four separate surveys conducted in 2002, one showed a 4 percent entrainment rate, one
28 was at less than 1 percent, and the entrainment rate for the other two surveys could not be
29 calculated due to the fact that no stage 4 larvae were collected in the open water stations
30 (ENSR and MRI 2002). Two of the surveys also showed relatively high entrainment rates for
31 stage 3 larvae (26 percent and 3 percent), whereas the remainder of the larval stages had less
32 than 1 percent entrainment rate (ENSR and MRI 2002).

33
34 In 2000, entrainment rates up to 5 percent were observed for stage 4 winter flounder larvae
35 while the entrainment rates for all other larvae were less than 1 percent (ENSR and MRI 2000).
36 The 2000 and 2002 reports state that the periodic high entrainment rates observed for stages 3
37 and 4 larvae were likely due to difficulties in collecting the stages 3 and 4 larvae, as these larval
38 stages generally are associated with the bottom sediments (ENSR and MRI 2000, 2002).

39
40 According to the authors, the results of the 2004 study were similar to those of 2000 and 2002
41 and that overall there appeared to be a consistent net flow of water and winter flounder larvae to
42 the south in near shore waters off PNPS. They also concluded that less than 0.1 percent of the

1 net volumetric flow of water in Cape Cod Bay passes through PNPS and the amount of winter
2 flounder larvae in northwest Cape Cod Bay entrained by PNPS is estimated at less than 1
3 percent of the net larval transport (ENSR and MRI 2005).

4
5 Through the early years of operation of the PNPS, cunner have had relatively high entrainment
6 rates based on comparisons to other species entrained at PNPS. A tagging study was initiated
7 in 1990 to evaluate the absolute abundance of this species in the PNPS area, as the near shore
8 waters around the plant serve as spawning, nursery, and adult feeding grounds. The data,
9 although not conclusive, indicated that the PNPS has a minor effect on recruitment success to
10 the local population (Lawton et al. 2000a).

11
12 Rainbow smelt have periodically had high impingement rates throughout the history of PNPS
13 based on comparison to other species impinged at the plant. After a large impingement event in
14 1978, a study was initiated to obtain site-specific population data in order to assess impacts on
15 the local smelt population. This study was focused on the Jones River, which is the principal
16 spawning ground for smelt in the Plymouth area. This study evaluated egg production,
17 population structure and size, as well as the degree of parasitic infestations on the stock.
18 Based on this study, the spawning stock abundance was calculated to be 4.18×10^6 adult smelt
19 in 1981. Comparison of these population data to impingement data at PNPS indicated that
20 PNPS had reduced the Jones River spawning population by less than 1 percent (Lawton et al.
21 1990). The Jones River spawning run along with other runs in the western North Atlantic have
22 been depressed for many years. According to the MDMF, the Jones River population is still at
23 depressed levels (Chase 2006).

24 25 **4.1.1.2 Entrainment Monitoring**

26
27 Entrainment sampling was initiated in 1974 and was initially conducted twice per month from
28 January to February and from October to December and conducted weekly from March through
29 September. During these events, sampling was conducted in triplicate. Beginning in 1994, the
30 sampling program was modified to focus on better temporal coverage. During the January to
31 February and October to December time periods, samples are collected every other week on
32 three separate days for a total of approximately six samples per month. During the March
33 through September time frame, three separate samples have been collected every week for a
34 total of approximately 12 samples per month (Normandeau Associates 2006a).

35
36 Entrainment sampling is usually conducted concurrently with the impingement sampling.
37 Entrainment sampling is conducted by suspending a 60-centimeter (cm) (2-ft) diameter plankton
38 net (with flowmeter) in the discharge canal approximately 30 meters (m) (98 ft) from the
39 headwall. Typically a standard mesh of 0.333 millimeters (mm) (0.013 inches [in.]) is used, with
40 the exception of the late March through late May time period, when a 0.202-mm (.007-in.) mesh
41 is used to capture early stage larval winter flounder. The sampling period typically ranges from
42 8 to 30 minutes depending upon the tide; the higher tide requiring a longer interval due to lower

Environmental Impacts of Operation

1 discharge stream velocities. The target is to sample a minimum quantity of 100 m³ (3531 ft³) of
2 water. Upon termination of the sampling period, samples are preserved in 10 percent formalin
3 prior to laboratory identification and enumeration (Normandeau Associates 2006a).

4
5 Approximately 60 different fish species have been collected over the last 30 years of
6 entrainment monitoring at PNPS (Normandeau Associates 2006a). Additionally, Irish moss
7 (*Chondrus crispus*) spores have been identified in entrainment samples. In this area of Cape
8 Cod Bay, there are three primary spawning seasons: winter to early spring, late spring to early
9 summer, and late summer to autumn.

10
11 Many of the species that spawn during the winter to early spring period have demersal,
12 adhesive eggs that are not normally entrained, and as a result, more species are typically
13 represented by larvae than by eggs during this time period (Normandeau Associates 2006a).
14 During the 2005 winter to early spring season (generally January to April), egg collections are
15 dominated by Atlantic cod (*Gadus morhua*), while larvae collections are dominated by the sand
16 lance (*Ammodytes americanus*) (Normandeau Associates 2006a). In 2004, the sand lance also
17 dominated the larvae collection while the egg collection was dominated by American plaice
18 (*Hippoglossoides platessoides*), followed by Atlantic cod (MRI 2005b).

19
20 The late spring to early summer season is typically the most active reproductive period among
21 the temperate fishes in the PNPS area (Normandeau Associates 2006a). In both the 2004 and
22 2005 late spring to early summer seasons (May to July), the egg species were dominated by
23 tautog, cunner, and yellowtail flounder (*Pleuronectes ferruginea*), while the larvae were
24 dominated by winter flounder (MRI 2005a; Normandeau Associates 2006a).

25
26 The late summer to early autumn season in the PNPS area typically shows a decline in overall
27 ichthyoplankton density and number of species collected (Normandeau Associates, 2006a).
28 The 2004 and 2005 late summer to early autumn seasons (August to December) are dominated
29 by tautog, cunner, and yellowtail flounder eggs, closely followed by fourspot flounder
30 (*Paralichthys oblongus*) and windowpane flounder (*Scophthalmus auquosus*) eggs (MRI 2005b;
31 Normandeau Associates 2006a). In 2005, the larval collections were dominated by fourbeard
32 rockling (*Enchelyopus cimbrius*), whereas in 2004 larval collections were dominated by cunner
33 with the fourbeard rockling showing a much lower entrainment percentage than in 2004 (MRI
34 2005b; Normandeau Associates 2006a).

35
36 According to Entergy (2006), ichthyoplankton densities obtained in 2005 are consistent with the
37 data from the 1975 to 2004 time series, with the exception of Atlantic cod and Atlantic mackerel
38 (*Scomber scombrus*) eggs and larval winter flounder and rock gunnel (*Pholis gunnellus*). Both
39 the Atlantic cod eggs and larval winter flounder abundance estimates appear to have increasing
40 long term trends, whereas Atlantic mackerel eggs and larval rock gunnel appear to be relatively
41 low compared to historic data (Normandeau Associates 2006a).

42

1 Periodically through the life of the plant, there have been periods when the rate of entrainment
2 is significantly elevated. Reporting of these “significant” events is required by the facility
3 NPDES permit. Identification of these events was thought to be necessary so that it could be
4 determined whether high ichthyoplankton entrainment rates were being caused by conditions in
5 the vicinity of Rocky Point that are attributable to operation of PNPS, or whether they were
6 attributable to naturally occurring high population levels in the bay (i.e., during spawning
7 season) (Normandeau Associates 2006a). These high entrainment events can contribute a
8 significant percentage of the overall annual entrainment numbers for certain species. For
9 example, during the 2005 sampling season, there were 54 separate high entrainment events, as
10 defined by comparison to historical data sets. These included a total of 12 species of eggs and
11 larvae, including American plaice, Atlantic menhaden (*Brevoortia tyrannus*), Atlantic herring
12 (*Clupea harengus*), sand lance, seasnail (*Liparis atlanticus*), winter flounder, radiated shanny
13 (*Ulcaria subbifurcata*), cunner, fourbeard rockling, tautog, Atlantic mackerel, and red hake
14 (*Urophycis chuss*) (Normandeau Associates 2006a).

15
16 Table 4-3 presents ichthyoplankton entrainment data for six species of fish that are of concern
17 in this area (cunner, Atlantic mackerel, Atlantic menhaden, Atlantic herring, Atlantic cod, and
18 winter flounder). As can be seen from these data, there is a high level of variability in the
19 degree of entrainment from year to year. This is also true of many of the other species of fish
20 entrained at PNPS (Normandeau Associates 2006a).

21
22 Cunner larval abundance as of 2005 continues to be below the 1981 to 2004 time series
23 average; however, no overall trends in the entrainment collections are apparent (Normandeau
24 Associates 2006a). There were high entrainment densities of Atlantic mackerel eggs from the
25 mid 1980s to mid 1990s but no clear trends are apparent over the last decade (Normandeau
26 Associates 2006a). Abundance indices of mackerel larvae in the entrainment collections have
27 dropped since 1995 (Normandeau Associates 2006a).

28
29 For the Atlantic menhaden, the abundance index of eggs entrained at PNPS appears to have
30 dropped, but there is a significant amount of variability (Normandeau Associates 2006a).
31 Abundance of larval menhaden has varied significantly over the last few years with 2004 having
32 the lowest abundance on record and 2005 having a relatively high abundance (compared to the
33 last 5 years) (Normandeau Associates, 2006a). The overall stock appears to be healthy
34 (ASMFC 2006). No trends are apparent in Atlantic herring larvae entrainment data
35 (Normandeau Associates 2006a). However, the overall stock appears to be healthy (ASMFC
36 2006). For Atlantic cod, there are no clear trends in the abundance index of eggs and larvae.
37 However, there has been an increase in stock biomass and spawning biomass observed since
38 the late 1990s (Normandeau Associates 2006a).

39
40 For winter flounder, larval abundance in 2005 was slightly lower than the 1981 to 2004 time
41 series data (Normandeau Associates 2006a), while the number of eggs entrained in 2005 was
42 almost identical to that entrained in 2004 but significantly less than the quantities entrained in

Environmental Impacts of Operation

1 2003 and in the 1991 to 2000 time series average (Normandeau Associates 2006a).

2
3 In addition to ichthyoplankton, periodically American lobster larvae are also entrained at PNPS.
4 In 2005, 32 lobster larvae were found in the entrainment samples. This is the highest number of
5 lobster larvae collected in a single year. In fact, up until 2005, only 46 larvae had been
6 collected at PNPS since monitoring began in 1974 (Normandeau Associates 2006a). Apparent
7 causes of the high entrainment for lobsters in 2005 are unclear, but could be due to the
8 implementation of a security zone around the plant and hence a reduction in lobster fishing
9 pressure (Normandeau Associates 2006a).

10 11 **4.1.1.3 Assessment of Entrainment Impact**

12
13 To evaluate the impact of these entrainment losses, the NRC staff conducted an independent
14 analysis and evaluated the conclusions of the 316 demonstration report (ENSR 2000), the
15 PNPS ER (Entergy 2006a), recent monitoring reports developed by PNPS as required by the
16 NPDES permit, and other reports regarding the status of fish stocks in New England. NRC staff
17 also consulted with Federal and State resource agencies that issue permits required for
18 operation of PNPS (EPA, Massachusetts Coastal Zone Management Office), or that have
19 responsibility for biological resources potentially affected by operation of PNPS (MDMF,
20 National Marine Fisheries Service [NMFS]) (Earth Tech 2006a, Earth Tech 2006b).

21
22 The 316 demonstration report concludes that impingement and entrainment have caused no
23 adverse impacts to any representative important species population or to the integrity of the
24 aquatic ecosystem of Cape Cod Bay (ENSR 2000). However, EPA Region 1, in discussions
25 with the NRC staff, indicated that there was some debate over the conclusions of the report.
26 The 316 demonstration report evaluated impacts on essential fish habitat (EFH) and
27 representative important species including:
28

Table 4-3. Number of Eggs and Larvae Entrained for Six Species of Fish at PNPS from 1980 to 2005

		Winter Flounder					Cunner				
		Number of Larvae Entrained					Number of Larvae Entrained				
Year	Number of Eggs Entrained	Stage 1	Stage 2	Stage 3	Stage 4	Total Larvae Entrained	Number of Eggs Entrained	Stage 1	Stage 2	Stage 3	Total Larvae Entrained
1980	3,513,717	8,694,456	12,714,822	7,317,129	0	28,726,407	3,257,891,776	76,282,260	40,480,032	4,229,248	120,991,540
1981	9,674,954	7,606,942	19,133,121	3,073,126	43,304	29,856,493	6,576,294,915	316,245,739	256,567,950	3,508,876	576,322,565
1982	7,001,776	2,706,834	6,724,795	11,583,134	425,011	21,439,774	2,010,779,150	6,351,445	3,187,760	597,356	10,136,561
1983	1,305,735	1,933,453	2,246,172	7,558,534	260,350	11,998,509	5,895,329,347	10,961,646	27,571,530	3,955,802	42,488,978
1984	341,424	248,082	0	7,570,145	516,247	8,334,474	1,766,764,864	0	176,682	1,029,352	1,206,034
1985	32,717,535	1,039,001	2,312,789	8,025,452	130,786	11,508,028	2,021,886,071	17,182,039	20,392,615	2,307,617	39882271
1986	5,118,035	5,397,403	5,783,669	3,963,747	77,005	15,221,824	1,493,653,289	4,419,092	22,197,318	297,368	26,913,778
1987	20,857,334	0	437,608	3,088,405	0	3,526,013	4,465,564,080	40,247,222	314,474	248,738	40,810,434
1988	3,494,771	1,995,968	1,656,376	15,079,960	511,009	19,243,313	1,539,089,318	2,290,972	2,624,077	2,461,452	7,376,501
1989	6,423,987	1,668,823	5,755,240	2,224,675	39,114	9,687,852	4,469,416,004	34,100,052	15,224,141	2,863,938	52,188,131
1990	48,501	643,683	1,155,404	6,846,718	33,002	8,678,807	1,336,048,112	65,705,970	62,378,298	44,014,528	172,098,796
1991	1,217,178	3,471,022	3,908,488	5,188,056	37,717	12,605,283	675,000,390	5,790,172	3,701,490	7,243,966	16,735,628
1992	4,124,308	873,660	876,914	7,034,690	26,192	8,811,456	2,174,661,078	0	1,186,819	1,605,055	2,791,874
1993	3,078,941	1,595,700	3,540,750	4,934,952	88,617	10,160,019	3,235,317,207	148,674	7,178,133	7,923,303	15,250,110
1994	2,530,707	1,034,617	6,433,716	13,060,373	172,606	20,701,312	1,558,253,667	0	5,545,977	4,440,095	9,986,072
1995	2,766,716	1,632,907	2,820,023	8,826,496	375,857	13,655,283	4,116,491,874	7,961,638	29,910,748	9,257,792	47,130,178
1996	4,896,687	504,810	5,818,499	11,329,855	995,127	18,648,291	2,807,124,109	3,765,455	8,094,509	5,558,849	17,418,813
1997	3,609,393	2,225,634	9,537,788	41,484,016	2,126,280	55,373,718	1,718,289,720	6,444,923	51,895,511	41,294,559	99,634,993
1998	1,035,001	3,111,891	20,282,772	58,546,916	4,904,482	86,846,061	4,341,664,826	104,908,332	211,248,501	54,060,618	370,217,451
1999	1,409,453	2,031,988	588,974	1,936,648	123,103	4,680,713	1,717,578,656	36,934,878	11,960,388	7,510,427	56,405,693
2000	1,693,672	33,482	170,475	5,391,088	0	5,595,045	1,349,685,330	22,411,361	39,293,994	1,388,620	63,093,975
2001	330,283	4,638,546	13,093,697	37,019,304	263,144	55,014,691	2,744,377,803	1,044,260	34,542,919	35,707,859	71,295,038
2002	28,637	1,389,319	6,911,151	14,802,848	1,232,865	24,336,183	580,954,607	537,068	4,771,751	10,257,985	15,566,804
2003	1,977,333	722,030	480,190	2,966,524	76,394	4,245,138	759,226,058	352,721	1,783,511	1,865,231	4,001,463
2004	246,468	159,859	10,431,901	49,597,823	1,988,421	62,178,004	1,452,433,321	462,728	7,927,232	8,369,181	16,759,141
2005	243,151	158,986	7,470,964	20,441,584	4,277,092	32,348,626	816,334,983	820,862	10,225,681	5,504,981	16,551,524

December 2006

4-17

Draft NUREG-1437, Supplement 29

Environmental Impacts of Operation

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Table 4-3. (contd)

Year	Atlantic Mackerel		Atlantic Menhaden		Atlantic Herring		Atlantic Cod	
	Total Number Entrained		Total Number Entrained		Total Number Entrained		Total Number Entrained	
	Eggs	Larvae	Eggs	Larvae	Eggs ^a	Larvae	Eggs	Larvae
1980	81,599,432	22,293,108	16,468,408	12,060,791	NA	1,068,466	20,388,850	1,450,522
1981	183,959,791	320,135,596	3,473,080	40,076,799	NA	2,471,492	11,620,588	2,173,076
1982	108,234,931	9,388,143	365,091,471	1,845,849	NA	732,857	2,582,984	222,721
1983	148,616,621	41,333,673	869,580	1,227,190	NA	5,880,315	9,349,728	142,136
1984	22,486,619	78,315	4,751,607	0	NA	468,840	11,726,579	587,054
1985	1,867,648,438	45,711,343	41,131,470	9,190,654	NA	1,580,435	5,071,151	1,441,442
1986	219,488,066	58,333,520	21,112,802	3,654,854	NA	1,811,101	2,788,767	1,035,987
1987	71,222,294	215,561	311,687	1,560,529	NA	5,142,045	5,623,282	122,579
1988	2,663,608,568	3,401,489	9,273,771	2,713,857	NA	639,089	2,747,034	254,239
1989	4,673,915,938	65,562,469	11,212,165	4,411,807	NA	911,487	3,395,726	119,436
1990	2,313,416,455	4,627,282	7,057,041	3,263,718	NA	2,079,483	2,406,536	1,566,291
1991	479,761,865	66,009,482	5,744,115	512,319	NA	1,280,273	3,668,649	239,746
1992	377,610,764	8,086,393	392,533	1,117,881	NA	3,970,208	2,819,673	469,713
1993	1,801,378,418	8,325,789	947,815,345	11,833,443	NA	2,098,952	1,268,748	446,489
1994	520,917,221	3,419,299	10,221,752	2,361,834	NA	16,351,765	3,119,312	1,904,519
1995	1,767,609,278	197,689,693	3,280,481	12,419,886	NA	43,247,883	2,549,370	602,594
1996	1,507,370,682	70,947,053	4,861,265	8,660,874	NA	9,265,826	8,542,922	2,369,255
1997	316,969,390	25,778,062	48,899,715	48,283,152	NA	24,445,056	1,800,711	1,101,118
1998	530,017,006	56,622,648	44,730,447	33,280,806	NA	4,026,783	4,971,621	735,301
1999	34,498,141	483,595	14,395,648	19,324,314	NA	11,379,446	1,932,894	464,125
2000	619,863,003	16,496,664	882,086	809,127	NA	12,306,502	18,525,824	325,095
2001	150,613,190	4,868,686	4,025,648	1,251,898	NA	4,062,977	6,869,977	4,215,642
2002	280,852,511	3,704,444	14,464,446	5,164,308	NA	3,468,890	4,698,000	1,299,393
2003	314,571,725	2,790,425	6,027,864	5,364,766	NA	1,045,853	7,032,420	2,114,930
2004	70,227,928	10,894,804	613,682	176,011	NA	4,722,708	5,231,113	1,550,052
2005	85,750,499	2,782,044	1,402,677	17,566,121	NA	9,860,824	14,966,375	950,164

(a) Data are not reported for entrainment of Atlantic Herring eggs, as this species is a riverine spawner

Source: Entergy 2006b

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Environmental Impacts of Operation

- 1 • Irish moss (*Chondrus crispus*)
- 2 • American lobster (*Homarus americanus*)
- 3 • Winter flounder (*Pseudopleuronectes*
- 4 *americanus*)
- 5 • Rainbow smelt (*Osmerus mordax*)
- 6 • Cunner (*Tautoglabrus adspersus*)
- 7 • Alewife (*Alosa pseudoharengus*)
- 8 • Atlantic silverside (*Menidia menidia*)
- 9 • Atlantic cod (*Gadus morhua*)
- 10 • Haddock (*Melanogrammus aeglefinus*)
- 11 • Pollock (*Pollachius virens*)
- 12 • Silver hake / whiting (*Merluccius bilinearis*)
- 13 • Red hake (*Urophycis chuss*)
- 14 • White hake (*Urophycis tenuis*)
- 15 • Yellowtail flounder (*Pleuronectes ferruginea*)
- 16 • Windowpane flounder (*Scopthalmus aquosus*)
- 17 • American plaice (*Hippoglossoides*
- 18 *platessoides*)
- Ocean pout (*Macrozoarces americanus*)
- Atlantic halibut (*Hippoglossus hippoglossus*)
- Atlantic sea scallop (*Placopecten*
- magellanicus*)
- Atlantic herring (*Clupea harengus*)
- Monkfish (*Lophius americanus*)
- Bluefish (*Pomatomus salatrix*)
- Longfin squid (*Loligo pealei*)
- Shortfin squid (*Illex illecebrosus*)
- Atlantic butterflyfish (*Peprilus triacanthus*)
- Atlantic mackerel (*Scomber scombrus*)
- Summer flounder (*Paralichthys dentatus*)
- Scup (*Stenotomus chrysops*)
- Surf clam (*Spisula solidissima*)
- Spiny dogfish (*Squalus acanthias*)
- Bluefin tuna (*Thunnus thynnus*)

19 With the exception of the winter flounder, the authors estimated that losses due to entrainment
20 from PNPS were less than 1 percent of the population for all of these species (ENSR 2000).

21
22 Since the publication of the 316 report in 2000, Entergy has continued to evaluate in detail the
23 effects of entrainment and impingement on six species: cunner, Atlantic mackerel, Atlantic
24 menhaden, Atlantic herring, Atlantic cod, and winter flounder. Entergy commonly uses the
25 equivalent adult procedure (Goodyear 1978) to evaluate effects of entrainment and
26 impingement on local fish populations. This methodology applies estimated survival rates to
27 eggs and larvae that have been lost to entrainment and impingement to estimate the number of
28 adult fish that might have been recruited to the local populations (Normandeau Associates
29 2006a). Winter flounder, herring, and cod were selected because they are commercially and
30 recreationally important in the area, and cunner, mackerel, and menhaden historically have had
31 high entrainment and impingement rates (Normandeau Associates 2006a).

32
33 For cunner, the numbers of equivalent adults has remained relatively steady over the last 4
34 years but has declined in comparison to historical data (Normandeau Associates 2006a). There
35 is no management of the cunner fishery; consequently, landings data and stock status
36 information are not available, but based on an analysis conducted by Normandeau (2006a), the
37 population numbers in the PNPS area appear to be high. The loss to the local population due
38 to entrainment and impingement by PNPS appears to be less than 1 percent (Normandeau
39 Associates 2006a).

40
41 Atlantic mackerel equivalent adult numbers tend to follow the same trend as cunner
42 (Normandeau Associates 2006a). The loss to the local population due to entrainment and
43 impingement by PNPS appears to be less than 1 percent (Normandeau Associates 2006a). As

Environmental Impacts of Operation

1 of the 1999 stock assessment, the spawning stock biomass (SSB) was believed to be at
2 historically high levels (Normandeau Associates 2006a). Based on the 2006 stock assessment,
3 the northwest Atlantic mackerel stock is considered to be healthy (NEFSC 2006).
4

5 For Atlantic menhaden, the most recent numbers are the highest on record; however, there is
6 significant variability in year-to-year trends (Normandeau Associates 2006a). The Atlantic
7 menhaden stock is considered to be healthy (ASMFC 2006), and based on the 2005 Pilgrim
8 monitoring data, the loss to the stock due to entrainment and impingement by PNPS appears to
9 be less than 1 percent (Normandeau Associates 2006a).
10

11 The number of Atlantic herring adults have also increased over the last several years following
12 very low numbers in 2003 (Normandeau Associates 2006a). The Atlantic herring stock is
13 considered to be healthy (ASMFC 2006), and based on the 2005 Pilgrim monitoring data, the
14 loss to the stock due to entrainment and impingement by PNPS appears to be significantly less
15 than 1 percent (Normandeau Associates 2006a).
16

17 Trends for Atlantic cod have shown significant increases in adult numbers over the last several
18 years (Normandeau Associates 2006a). This contrasts with recent stock assessments, which
19 have indicated that the stock is depressed (Fahay et. al. 1999). Normandeau (2006a)
20 concluded that the numbers of equivalent adults entrained and impinged at PNPS are low
21 relative to recent landings information for the Cape Cod Bay area.
22

23 The winter flounder is a species of significant commercial and recreational value in the area and
24 has been intensively studied at PNPS. The 316 demonstration report (ENSR 2000) utilized
25 three procedures, the Stone and Webster model, equivalent adult analysis, and the Risk
26 Analysis Management Alternative System (RAMAS) model, to evaluate the significance of
27 entrainment losses on the local population. The authors concluded that the conditional mortality
28 from entrainment is uncertain but is less than 5 percent (ENSR 2000).
29

30 Figure 4-1 presents the numbers of equivalent winter adult flounder estimated from entrainment
31 and impingement data at PNPS over the last 25 years. As can be seen from this figure, the loss
32 of adults from the local stock (due to entrainment and impingement) over the last two years are
33 the second and third highest levels observed at PNPS. This contrasts with near record low
34 levels observed in 1999, 2000, and 2003.
35

36 Comparison of the equivalent adult numbers to the area-swept population estimates may
37 provide an indication of effects on the local stock of winter flounder. Normandeau (2006a)
38 compared recent estimates of the loss of age 3 adults (age at which flounder become sexually
39 mature) using the equivalent adult method to the numbers of winter flounder in the area derived
40 from the area-swept population estimates. As can be seen from Table 4-4, losses from the local
41 stock due to entrainment and impingement at PNPS range from less than 0.5 percent to
42 approximately 12 percent.
43

1 An estimate of the potential loss of the 2003 year class due to entrainment and impingement will
2 be estimated upon conducting the 2006 area-swept surveys. However, an estimate of the
3 potential losses can be derived by comparing the equivalent adult loss to the average of the
4 numbers estimated by the area-swept surveys. Based on the 2005 data, there was a loss of
5 29,852 equivalent adult fish. Comparison of this estimate to the average area-swept estimate
6 for the last three years indicates a 16.4 percent take of the local population (Normandeau
7 Associates 2006a).

8
9 The loss estimates presented in Table 4-4 contrast with other estimates. For instance the
10 RAMAS model was also run as an alternative means of assessing effects to the local winter
11 flounder populations from entrainment and impingement. This analysis indicated that stock
12 reductions ranging from 2.3 to 5.2 percent might occur as a result of entrainment at PNPS
13 (Normandeau Associates 2006a).

14
15 Based on the larval transport studies described in Section 4.1.1.1, the amount of winter flounder
16 larvae (based on all four larval stages combined) in northwest Cape Cod Bay entrained by
17 PNPS is estimated at less than 1 percent of the net larval transport (ENSR and MRI 2005).
18 Estimates of loss due to entrainment of stages 3 and 4 larvae have ranged up to 20 percent of
19 the net larval transport for those stages; however, there were several methodological difficulties,
20 which impart a high degree of uncertainty to these estimates (ENSR and MRI 2005).

21
22 Geographical range of the local winter flounder population is a key consideration in evaluating
23 the extent of impacts of entrainment at PNPS. Winter flounder in the PNPS area are managed
24 as the Gulf of Maine stock complex; however, more localized populations may exist, as adults
25 express a high degree of spawning site fidelity and spawning populations can be highly
26 localized (Nitschke et al. 2000, Lawton et al. 1999a, Lawton et al. 2000b).

Figure 4-1. Equivalent Adult Summary of Entrained and Impinged Winter Flounder from PNPS (Source: Normandeau 2006a)

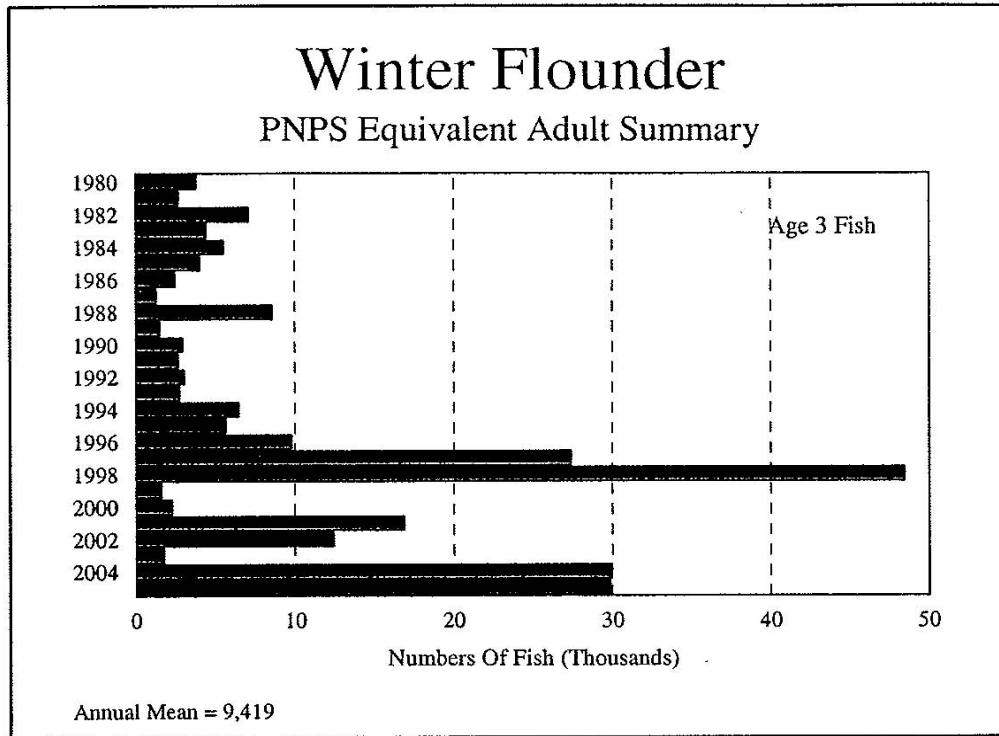


Table 4-4. Equivalent Adult Losses of Winter Flounder

Year	Predicted Numbers of Age 3 Adults Lost Due to Egg and Larval Entrainment and Impingement*	Estimated Numbers of Age 3 Adults in Western Cape Cod Bay**	Estimated Percent of Age 3 Adults Lost Due to Entrainment and Impingement
1997	27,398	464,176	5.9
1998	48,483	400,182	12.1
1999	1,615	476,263	0.3
2000	2,275	262,604	0.9
2001	16,883	157,532	10.7
2002	12,450	126,117	9.9

*Number of age 3 adults are predicted based on the equivalent adult approach.

**Estimates based on area-swept surveys.

Source: Normandeau 2006a

1 According to the Atlantic States Marine Fisheries Commission (ASMFC) (2006), the Gulf of
2 Maine winter flounder population is healthy. The 2003 Regional Stock Assessment noted that
3 recruitment to the stock has been near or above average since 1995 (NEFSC 2003). The 2005
4 stock assessment (NEFSC 2005) concluded that the stock is not overfished and overfishing is
5 not currently occurring, but also noted that there is considerable uncertainty in the current
6 estimates of fish mortality and SSB. This contrasts with data collected by MDMF and the NMFS
7 that indicate a sharp decline in stock abundance over the last several years (as measured by
8 catch per unit effort) (Figures 2-10 and 2-11).

9
10 The area-swept data for winter flounder (MRI 2005a), which are conducted in western Cape
11 Cod Bay in the waters surrounding PNPS, can provide an estimate of the status of local stocks.
12 As can be seen from Figure 2-9, the annual abundance estimates have steadily decreased from
13 2002. These data also track the NMFS and MDMF data noted above, perhaps suggesting that
14 the decline observed in Cape Cod Bay is not local to the PNPS area (MRI 2005a).

15
16 An independent analysis conducted by Szal (2005), a biologist with MDEP, calculated the
17 entrainment loss of adult winter flounder, using age 4 equivalent adults and local population
18 estimates from the area-swept surveys. The average loss of age 4 equivalent adults over the
19 10-year period ending in 2004 was approximately 6 percent. The maximum loss of age 4
20 equivalent adults over this time period was observed in 2004 and estimated to be 20 percent
21 (Szal 2005).

22
23 Stocks of rainbow smelt in Massachusetts are significantly depressed compared to historical
24 levels (Chase 2006). However, entrainment of rainbow smelt eggs is not expected to be a
25 significant concern at PNPS as rainbow smelt are riverine spawners and eggs spawned near
26 PNPS would not be viable due to ambient salinity levels surrounding PNPS (greater than lethal
27 tolerance levels) (ENSR 2000). Based on an analysis of data from the 1970s, entrainment of
28 smelt larvae at PNPS would account for significantly less than 1 percent of the local smelt
29 population (ENSR 2000). Even considering recent declines in the stock in the Plymouth–Jones
30 River area, the impacts of entrainment on rainbow smelt larvae would likely be minimal (ENSR
31 2000).

32 33 **4.1.1.4 Summary of Entrainment Impacts**

34
35 The staff concludes that the impact of entrainment on marine aquatic species other than the
36 local winter flounder population would be minor. However, due to the lack of recent information
37 describing the status of several local populations, it is difficult to quantify entrainment impacts.
38 Effects of entrainment on winter flounder likely affect only the local population. Historical data
39 have indicated no clear correlation between entrainment rates at PNPS and Gulf of Maine stock
40 trends. However, available data indicate that there are high levels of larval entrainment at
41 PNPS, with particular concern being the high larval entrainment rates for late-stage larvae
42 (stages 3 and 4). Based on the decline of the local population, the percentage take of the local

Environmental Impacts of Operation

1 population, and the considerable uncertainties in the stock status, the staff's conclusion is that
2 continued operation of PNPS would have a MODERATE impact on the local winter flounder
3 population due to entrainment over the course of the license renewal term. However, the staff
4 has concluded that continued operation of PNPS during the renewal term would have a SMALL
5 to MODERATE impact on the overall Gulf of Maine winter flounder stock as well as on all other
6 marine aquatic resources due to entrainment.

7
8 Due to the potential for impacts on marine aquatic resources in Cape Cod Bay over the course
9 of the license renewal term, additional mitigation measures may further reduce entrainment
10 impacts. Section 4.1.4 of this SEIS discusses the potential mitigation measures that may be
11 applicable to PNPS. Additionally, EPA's evaluation of the PNPS CDS would likely address any
12 applicable sight-specific mitigation measure that may reduce entrainment impacts.

13 14 **4.1.2 Impingement of Fish and Shellfish**

15
16 For plants with once-through cooling systems, such as PNPS, impingement of fish and shellfish
17 on traveling screens associated with nuclear power plant cooling water intakes is considered a
18 Category 2 issue, thus requiring a site-specific assessment for license renewal review. The
19 staff independently reviewed the PNPS ER, visited the site, consulted with Federal and State
20 resource agencies, and reviewed the applicant's existing NPDES permit and existing literature
21 related to fish and shellfish populations of Cape Cod Bay, with particular regard to impingement
22 studies conducted at PNPS.

23
24 Similar to EPA's Phase II performance standards for entrainment, performance standards also
25 are designed to significantly reduce impingement losses due to plant operation. Any site-
26 specific mitigation would result in less impact due to continued plant operation. PNPS is
27 currently conducting a CDS as part of the 316(b) evaluation. This study, which addresses both
28 entrainment and impingement, is due to EPA by January 2008.

29 30 **4.1.2.1 Impingement Monitoring**

31
32 Impingement sampling consists of monitoring three scheduled screen wash periods each week
33 throughout the year. The screens are not continuously turned. However, in general they are
34 turned for 8 hours prior to conducting the impingement sampling. If the screens were turned
35 prior to sampling, a 60-minute sample is obtained. If the screens were not turned prior to arrival
36 of the sampling crew, a 30-minute sample is scheduled (Normandeau Associates 2006b).
37 While the screens are turning, low and high pressure sprays continuously rinse debris and
38 organisms off the screens into a sluiceway, which is sampled by inserting a stainless steel
39 collection basket into the sluiceway entrance adjacent to the traveling screens. Fish are
40 considered to be alive if opercular movement is noted and there are no obvious signs of injury.

1 Living fauna are noted and measured for total length and then returned to the sluiceway. Dead
2 or injured specimens are preserved for later analysis in the lab (Normandeau Associates
3 2006b).

4
5 After being rinsed off of the screens and being washed into the east sluiceway, all debris and
6 organisms are diverted via a seamless concrete sluiceway into the intake embayment,
7 approximately 300 feet (ft) from the screens. A re-impingement study was attempted in the
8 early 1980s, but due to methodological difficulties, the study was never completed. During
9 storm events, a portion or all of the flow from the screens is diverted to the discharge canal via
10 the west sluiceway.

11
12 Impingement rates are calculated by dividing the number of individuals of a given species that
13 are collected by the number of hours in the collection period. If impingement rates of greater
14 than 20 fish per hour are noted, additional samples are collected. If impingement rates continue
15 to be elevated after the second sampling period then the plant operator is notified and advised
16 to leave the screens operating until further notice (Normandeau Associates 2006b).

17
18 Since 1980, a total of 73 species of fish has been collected in the impingement sampling
19 (Normandeau Associates 2006b). In 2005, impingement samples were collected for a total of
20 440 hours spread out over the entire year. Over 300,000 fish consisting of 38 species were
21 collected (Normandeau Associates 2006b). Atlantic menhaden, Atlantic silverside (*Menidia*
22 *menidia*), rainbow smelt, winter flounder, and Atlantic tomcod (*Microgadus tomcod*) accounted
23 for 98 percent of the annual total of impinged fish (Normandeau Associates 2006b). Atlantic
24 menhaden were the most dominant at 97 percent, followed by Atlantic silverside (3.8 percent),
25 rainbow smelt (1.3 percent) and winter flounder (1.2 percent) (Normandeau Associates 2006b).
26 Approximately 23,000 invertebrates representing 18 taxa were also collected. Sevenspine bay
27 shrimp (*Crangon septemspinosa*) was the dominant taxon, followed by cancer crabs (*Cancer*
28 spp.), and then American lobster (Normandeau Associates 2006b).

29
30 Atlantic menhaden impingement rates were significantly greater in 2005 than at any other time
31 in the history of the station, being impinged at a rate 25 times greater than the historical mean
32 (Table 4-5). Impingement rates for Atlantic silversides in 2005 were similar to the historical
33 mean. Winter flounder and rainbow smelt were impinged at rates of almost 3 times and 2 times,
34 respectively, of their historical means (Table 4-5). Impingement rates for winter flounder have
35 been steadily increasing since the late 1990s (Normandeau Associates 2006b). There was a
36 sharp drop in rainbow smelt impingement rates in 2000, but other than that, impingement
37 rates have remained at relatively consistent levels since the 1990s. Impingement data for the
38 Atlantic tomcod was approximately six times greater than the historical mean and is the second
39 highest impingement rate in the history of PNPS (Normandeau Associates 2006b).

Environmental Impacts of Operation

1 In 2005, there were 19 impingement events (greater than 20 fish per hour). In the majority of
2 these events, Atlantic menhaden and Atlantic silversides were the primary species impinged
3 (Normandeau Associates 2006b).

4
5 In 2005, survival of impinged organisms was higher during the 60-minute samples than during
6 the 30-minute samples. This trend is consistent with previous years (Normandeau Associates
7 2006b). Survival of the Atlantic menhaden was low during both the 60-minute samples (27
8 percent) and the 30-minute samples (18 percent). The Atlantic silverside had a much greater
9 difference in survival between the 60-minute samples and the 30-minute samples (62 percent
10 versus 15 percent). Winter flounder survival averaged 96 percent when collected during the 60-
11 minute samples, while survival was approximately 77 percent during the 30-minute samples.
12 There was also a significant difference for the rainbow smelt, with 53 percent survival based on
13 the 60-minute samples and no survival based on the 30-minute samples (Normandeau
14 Associates 2006b). Survival for the Atlantic tomcod ranges from 35 percent for the 30-minute
15 samples to 63 percent for the 60-minute samples.

16 17 **4.1.2.2 Assessment of Impingement Impact**

18
19 To evaluate the impact of these impingement losses, the NRC staff conducted an independent
20 analysis and evaluated the conclusions of the 316(b) demonstration report (ENSR 2000), the
21 PNPS ER (Entergy 2006a), and recent monitoring reports developed by PNPS in fulfillment of
22 NPDES permitting requirements. The 316 demonstration report concludes that impingement
23 caused no adverse impacts to any representative important species population or to the integrity
24 of the aquatic ecosystem of Cape Cod Bay (ENSR, 2000). However, EPA Region 1, in
25 discussions with NRC staff, indicated that there was some debate over the conclusions of the
26 report.

27
28 The 316 demonstration report evaluated impacts on representative important species and EFH.
29 With the exception of cunner and rainbow smelt, the authors estimated that losses due to
30 impingement from PNPS were less than 1 percent of the population for each of these species
31 (ENSR 2000). Atlantic menhaden and the Atlantic silverside have been the two most frequently
32 impinged organisms at PNPS (Table 4-5). Atlantic menhaden were impinged in record numbers
33 at PNPS in 2005, 25 times the long-term average (Table 4-5). Menhaden travel in dense
34 schools and juveniles and adults are frequently attracted to intake and discharge canals. Other
35 coastal New England power stations have noted the production of several large year classes of
36 Atlantic menhaden since 1999 (Normandeau Associates 2006b). In 2005, Atlantic silversides
37 were impinged at a rate equal to the long-term mean (Table 4-5).

38
39 Both of these species have been consistently collected at PNPS since the plant first went on
40 line. The Atlantic menhaden stock is considered to be healthy with stable stock size and high
41 biomass. Information on the stock status for the Atlantic silverside is not available; however, it
42 is a species with high levels of reproduction in near-coastal environments such as the area

1 surrounding PNPS. Atlantic tomcod is also a species that has been consistently collected at
2 PNPS since the plant first went on line, although it is typically impinged at rates much less than
3 that observed for the Atlantic silverside and Atlantic menhaden (Table 4-5). However, in 2005,
4 the impingement rate for the Atlantic tomcod increased by approximately 5 times its long-term
5 average (Table 4-5). Stock data are not available to evaluate the potential effects of Atlantic
6 tomcod impingement by PNPS; however, it is unlikely that PNPS is having a significant effect on
7 the Atlantic tomcod.

8
9 In 2005, winter flounder were impinged at a rate approximately 2.5 times the long-term mean of
10 917 fish (Table 4-5). Over the last decade, the numbers of winter flounder impinged at PNPS
11 have generally increased (Normandeau Associates 2006b). With the exception of 2005,
12 comparison of the number of impinged fish to the number of fish through the area swept surveys
13 indicates a loss to the local population of less than 1 percent. However, as discussed in Section
14 4.1.1, PNPS does have a detectable impact on the entrainment of winter flounder eggs and
15 larvae. Although the loss of winter flounder juveniles and adults through impingement may be
16 contributing to population declines, the level of impact is considered to be minimal when
17 compared to the potential entrainment impacts. For the cunner, impingement losses were
18 estimated to be less than 3 percent; however, as shown by Lawton et al. (2000a), population
19 numbers in the vicinity of PNPS are high. For the rainbow smelt, ENSR (2000) estimated that
20 based on the 1980 spawning run, there would be less than 1 percent impact to the local
21 population. Taking into account state-wide declines in the stock and the lack of any recent
22 information on the Jones River spawning run, they estimated that impacts due to PNPS
23 impingement could range up to 2.5 percent (ENSR 2000). The MDMF has recently initiated a
24 sampling program to determine the population indices of rainbow smelt monitoring runs in four
25 rivers, including the Jones River. Data collected to date indicate that the Jones River population
26 has a low degree of spawning activity. Recent data on population size are not available as only
27 the first year's data of a multi-year monitoring effort have been analyzed to date (Chase 2006).
28 Thus, considerable uncertainty exists regarding the potential impacts to rainbow smelt
29 populations in the area.

31 **4.1.2.3 Summary of Impingement Impacts**

32
33 Based on a review of the available information relative to potential impacts of the cooling water
34 intake system on the impingement of fish and shellfish, the staff concludes that impacts on
35 marine aquatic species other than the Jones River population of rainbow smelt would be minor.
36 However, due to the lack of recent information describing the status of several local populations,
37 it is difficult to quantify impingement impacts. Effects of impingement on rainbow smelt likely
38 affect only the Jones River population. Based on the decline of that population, the
39
40
41
42

Environmental Impacts of Operation

Table 4-5. Annual Extrapolated Totals for Typical Dominants Found on the PNPS Intake Screens, 1980-2005.

Species	Year																	Mean									
	1980	1981	1982	1983	1984 ¹	1985	1986	1987 ²	1988	1989	1990	1991	1992	1993	1994 ³	1995 ⁴	1996	1997	1998	1999 ⁵	2000	2001 ⁶	2002	2003 ⁷	2004	1990-2004	2005 ⁸
Atlantic silverside	191	90,449	2,626	1,586	245	4,417	702	1,298	940	2,838	4,761	2,955	2,381	9,872	36,498	13,085	16,615	6,303	6,773	8,377	25,665	4,987	4,430	23,149	13,107	11,378	11,590
Atlantic menhaden	226	0	171	522	11	1,491	953	0	177	2,020	3,155	1,117	32	46	58	1,560	2,168	1,329	1,423	42,686	34,354	3,599	53,304	119,041	10,431	11,194	277,601
Winter flounder	297	249	297	232	47	884	908	138	556	1,119	336	694	787	1,181	1,018	1,628	857	608	2,069	1,021	1,358	1,729	1,466	1,435	2,021	917	2,688
Blueback herring	46	230	251	754	34	791	63	7	222	207	1,194	298	110	295	269	1,244	2,462	424	134	530	5,919	229	943	1,968	2,046	828	646
Grubby	107	448	340	490	114	932	359	200	124	684	585	468	507	640	1,094	648	1,347	405	335	628	1,105	517	1,087	237	2,257	626	501
Rainbow smelt	814	236	634	1,224	29	189	1,909	1,070	370	886	387	372	317	8,302	9,464	2,191	3,728	1,978	1,656	875	13	879	335	532	1,092	1,579	2,840
Atlantic tomcod	63	76	221	276	157	389	174	57	1,578	433	291	159	104	329	153	260	466	72	40	302	323	278	168	19	304	268	1,518
Cunner	1,043	870	610	196	45	580	270	115	97	199	210	182	28	93	77	346	332	41	101	153	348	140	59	172	240	262	716
Atlantic herring	83	53	156	22	0	35	3,009	6	51	138	408	24,238	51	169	28	108	0	13	108	181	77	48	301	51	138	1,179	549
Alewife	99	201	262	83	88	807	261	26	464	149	1,480	250	247	1,021	123	39,884	216	317	158	610	2,443	1,618	334	438	145	2,069	265
Hakes (Red and White)	93	101	125	0	8	34	27	53	23	55	0	55	14	166	23	182	113	196	106	682	182	1,158	192	128	202	157	70
Winduppane	68	96	107	173	56	146	87	0	0	171	171	103	41	133	179	232	296	65	416	434	363	162	24	13	37	143	135
Tautog	0	69	18	41	11	83	26	113	82	159	52	175	93	275	50	73	488	172	129	119	157	92	289	46	14	113	39
Lumpfish	38	0	160	103	75	125	46	72	674	30	78	51	122	329	177	116	206	173	244	136	131	0	137	61	8	132	409
Annual totals for dominants	3,168	93,078	5,978	5,702	920	10,903	8,794	3,155	5,358	9,088	13,088	31,117	4,834	22,851	49,211	61,557	29,294	12,096	13,692	56,954	72,438	15,436	63,069	147,290	32,042	30,845	299,567
Percent of total for dominants	79%	98%	71%	87%	83%	87%	95%	83%	80%	88%	82%	97%	90%	95%	98%	98%	97%	85%	96%	98%	70%	99%	98%	82%	95%	89%	99%
Total all fish	4,030	95,336	8,411	6,558	1,112	12,499	9,259	3,782	6,675	10,289	15,939	32,080	5,397	24,105	50,439	62,616	30,264	14,230	14,303	58,318	103,986	15,656	64,606	179,608	33,591	34,523	302,883
Collection Time (hrs.)	687	574.8	687	763	1,042	465	806	527	525	618	919.5	930.3	774.0	673.5	737.4	607.7	416	455	575	375.5	507	430.1	494.4	714.1	638.3	638	440.5
Impingement Rate (fish/hour)	0.66	10.02	0.93	0.57	0.13	1.14	1.26	0.28	0.27	0.8	1.70	3.38	0.63	2.78	5.97	5.87	3.11	1.43	1.30	7.21	9.25	1.78	4.93	25.58	2.85	3.75	18.87

1 No CWS pumps were in operation April to August 1984.
 2 No CWS pumps were in operation August 1987.
 3 No CWS pumps were in operation 9 October - 14 November 1994.
 4 No CWS pumps were in operation 30 March - 15 May 1995.
 5 No CWS pumps were in operation 10 May - 10 June 1999.
 6 No CWS pumps were in operation 28 April - 9 May 2001.
 7 No CWS pumps were in operation 21 April - 11 May 2003.
 8 No CWS pumps were in operation 20 April - 8 May 2005.

Source: Normandeau 2006b.

1 uncertainty of the stocks status, impingement rates, and the low impingement survivability of
2 rainbow smelt, the staff's conclusion is that continued operation of PNPS would have a
3 MODERATE impact on the Jones River population due to impingement over the course of the
4 license renewal term. However, the staff has concluded continued operation of PNPS during
5 the renewal term would have SMALL to MODERATE impacts on other marine aquatic
6 resources due to impingement.

7
8 Due the uncertainty associated with local population abundance estimates and potential
9 impingement impacts on the local populations, implementation of mitigation measures may
10 further reduce impingement impacts. A discussion of potentially applicable mitigation measures
11 is presented in Section 4.1.4. Additionally, EPA's evaluation of the PNPS CDS would likely
12 address any applicable site specific mitigation measure that may reduce impingement impacts.

13 **4.1.3 Heat Shock**

14
15
16 For plants with once-through cooling systems, the effects of heat shock are listed as a Category
17 2 issue and require plant-specific evaluation for license renewal review. The NRC identified
18 impacts on fish and shellfish resources resulting from heat shock as a Category 2 issue
19 because of continuing concerns about thermal discharge effects and the possible need to
20 modify thermal discharges in the future in response to changing environmental conditions
21 (NRC 1996a). Information considered includes: 1) the type of cooling system (whether
22 once-through or closed-cycle) and (2) evidence of a CWA Section 316(a) variance or equivalent
23 State documentation. To perform this evaluation, the staff reviewed the ER, visited the PNPS
24 site, reviewed the facility's 316 demonstration report (ENSR 2000), and reviewed the applicant's
25 NPDES Permit.

26
27 Section 316(a) of the CWA establishes a process by which a discharger can demonstrate that
28 the established thermal discharge limitations are more stringent than necessary to protect
29 balanced, indigenous populations of fish and wildlife and obtain facility-specific thermal
30 discharge limits (33 USC 1326). The applicant has provided EPA with Section 316(a)
31 demonstrations that address compliance with the thermal effluent limitations of the NPDES
32 permit and environmental impacts of the thermal discharge. The NPDES permit (EPA 1994)
33 states that "the thermal plumes from the station: (1) shall not deleteriously interfere with the
34 natural movements, reproductive cycles, or migratory pathways of the indigenous populations
35 within the water body segment; and (2) shall have minimal contact with the surrounding
36 shorelines." In order to obtain information to assess compliance with these requirements, there
37 has been an extensive program of monitoring of the coastal environment near the PNPS site
38 since the beginning of design/construction in the late 1960s (EG&G 1995).

39
40 A combined Section 316(a) and (b) demonstration report for PNPS was submitted to EPA
41 Region 1 in 1975 and 1977 by the Boston Edison Company (Stone & Webster 1975, 1977), was
42 accepted by EPA, and was used in determining facility-specific NPDES discharge temperature

Environmental Impacts of Operation

1 limits (Entergy 2006a). That initial Section 316 demonstration was based on engineering,
2 hydrological, and ecological data from a 3-year pre-operational period (1969 to 1972) and a
3 5-year post-operational period (1972 to 1976). It predicted that station operations would not
4 result in long-term thermal impacts to the aquatic environment (ENSR 2000). Based on that
5 report and ongoing ecological monitoring programs, EPA has issued and renewed NPDES
6 permits for PNPS for over 30 years and has determined that thermal discharges from PNPS are
7 sufficiently protective of the aquatic community of Cape Cod Bay to satisfy alternative thermal
8 effluent limitations under Section 316(a) of the CWA (ENSR 2000, Entergy 2006a).

9
10 In recent years, EPA Region 1 has required all NPDES permittees affected by Section 316 to
11 submit new 316(a) and (b) demonstrations. A new 316 demonstration report for PNPS was
12 prepared in 2000 (ENSR 2000), which updated the previous report based on approximately 25
13 years of additional engineering, hydrological, and biological data related to PNPS operations
14 and conditions in the aquatic environment of western Cape Cod Bay. EPA Region 1 currently is
15 reviewing an Entergy application for renewal of the NPDES permit for PNPS, including the
16 newest combined 316 demonstration report (Entergy 2006). In the interim, Entergy has
17 continued biological monitoring. The Thermal Discharge Fish Surveillance Program involves
18 periodic visual inspections of the discharge canal during times of fish migration in order to
19 determine the presence of fish and their condition.

20
21 Previous investigations to characterize the extent of the thermal plume included studies that
22 focused on collecting ambient temperature measurements and studies that used the measured
23 temperature data to develop predictive models of temperature changes in the plume under a
24 variety of operating and ambient conditions. These investigations have characterized the
25 dimensions of the thermal plume and assessed biological impacts potentially associated with
26 the plume. Two of the most detailed thermal investigations at PNPS were a 1974 study by the
27 Massachusetts Institute of Technology, which focused on characterizing the plume based on
28 surface water temperature measurements (ENSR 2000), and a 1994 study by EG&G (1995),
29 which focused on bottom water temperature measurements to characterize the benthic thermal
30 plume and validate mathematical models to predict bottom plume characteristics (ENSR 2000).

31
32 The 1974 study, which included one-day temperature surveys in July, August, and November
33 1973, found that the thermal plume is largest during high tide, and that during high tide the
34 plume is detached from the bottom and is essentially confined to the surface layer. The depth
35 of the plume was found to be relatively shallow, with depths ranging from 3 to 8 ft at high tide.
36 The temperature difference (ΔT) between ambient water and the thermal plume was found
37 to cover a larger area when ambient temperatures were higher. For example, water with a ΔT
38 of 3°C covered approximately 216 acres (ac) in August when the ambient temperature was
39 17.0°C , but only 14 ac in November when the ambient temperature was 8.5°C . The area of the
40 plume also was found to decrease rapidly with increasing depth, as expected due to the
41 buoyancy of the plume. Throughout the tidal cycle, the smallest surface areas with elevated
42 temperatures occurred between low water slack tide and peak flood tide, and the largest areas

1 occurred between high water slack tide and peak ebb tide (ENSR 2000).

2
3 The 1994 study (EG&G 1995) measured the bottom temperature patterns based on time series
4 measurements at 59 locations in the immediate vicinity of the PNPS discharge. The results of
5 this investigation were consistent with the 1974 study of the surface plume: the plume extended
6 through the water column to the bottom during periods of low tide but was mainly confined to the
7 surface layer during high tide. At the bottom, as at the surface, the smallest temperature
8 increment measured (1°C) covered the largest area (up to 1.2 ac), and water with higher
9 temperatures relative to ambient covered much smaller areas. For example, the highest delta T
10 measured, 9°C, covered less than 0.13 ac of the bottom (ENSR 2000, EG&G 1995).

11
12 At low tide, the turbulent discharge plume is well mixed vertically as it leaves the canal, due in
13 part to the significant downward momentum of the discharge as it spills from the mouth of the
14 discharge canal. The plume remains in contact with the bottom at low tide for up to several
15 hundred meters offshore. At the surface, the plume spreads by mixing with the ambient water,
16 while at the bottom the core temperature of the plume drops and its width narrows with distance
17 offshore. As a result, elevated temperatures are present at low tide over a limited area of the
18 bottom near the discharge canal (EG&G 1995). At high tide, the discharge has a much lower
19 velocity and no downward momentum. As a result, the thermal discharge plume separates from
20 the bottom almost immediately upon leaving the discharge canal (EG&G 1995).

21
22 During the measurement period (26 to 29 August 1994) of the benthic thermal plume study,
23 conditions were relatively calm, warm, and favorable for upwelling. Ambient bottom
24 temperatures were relatively cold (16 to 17°C), and the currents were weak and dominated by
25 tidal fluctuations. Under these conditions, the areas of the sea floor in contact with elevated
26 temperatures due to the heated discharge water were relatively small (EG&G 1995). The
27 conclusions of the 1995 report (EG&G 1995) included the following:

- 28
- 29 • The discharge plume is in contact with the bottom of the bay for significant distances from
30 shore only during the low tide half of the tidal cycle (i.e., when the tide is below mean sea
31 level). Consequently, benthic organisms are exposed to alternating periods of ambient and
32 elevated water temperatures.
 - 33
 - 34 • The maximum extent of the area of the bottom contacted by the plume and the highest
35 temperatures occur at slack water around low tide.
 - 36
 - 37 • The plume begins to expand outward along the bottom about 3 hours before low tide,
38 reaches 75 percent of its maximum area by about 1 hour before low tide, and declines
39 rapidly to less than 50 percent of maximum area about 1 hour after low tide.
 - 40
 - 41
 - 42

Environmental Impacts of Operation

- 1 • The maximum offshore extent of the benthic thermal plume at low tide, based on the area of
2 1°C temperature elevation, did not exceed 170 m (558 ft) from the mouth of the discharge
3 canal, and its width did not exceed 40 m (131 ft) at a distance of 80 m (262 ft) offshore.
4
- 5 • The maximum bottom area covered by the 1°C temperature elevation was about 1.2 ac, and
6 higher temperatures were restricted to smaller areas. The smaller areas of higher
7 temperatures approximately coincide with the areas with denuded or stunted benthic
8 macroalgae (i.e., Irish moss).
9
- 10 • During high tide, there was no discernible temperature increase at any location, even within
11 50 m of the mouth of the discharge canal.
12

13 Because the benthic thermal plume study involved measurements taken over a short period of
14 time and the temperatures and extent of the plume were strongly affected by ambient
15 temperatures, the report (EG&G 1995) also considered the potential for more extreme thermal
16 plume characteristics under worst case conditions. It concluded that extreme bottom
17 temperatures and plume areas could result from a prolonged period of unusually warm weather,
18 spring tide conditions in which the lowest water level can be nearly 1 m (3 ft) below mean water
19 level (MLW), and conditions favorable for downwelling could be produced by warm winds from
20 the north or northeast in summer. The combination of these conditions potentially could result
21 in peak discharge temperatures in excess of 38°C. Given the uncertainty in the area
22 measurements of the study, it was estimated that these conditions potentially could result in the
23 thermal plume contacting the bottom over an area about 4 to 7 times the area measured in the
24 study (EG&G 1995).
25

26 An additional source of heated water discharge at PNPS is backwashing operations. Thermal
27 backwashing is a commonly used method for control of biofouling in the condenser tubes and
28 intake structures of power plants. Condenser tubes at PNPS are cleaned by backwashing on a
29 1- to 2-week interval, depending on the degree of biofouling. Because the plant electrical
30 generation must be reduced during backwashing, the procedure usually is conducted during
31 off-peak hours. The method involves reversing the flow of heated water so that organisms
32 fouling the condenser tubes and intake structure are killed by the elevated temperatures. The
33 process results in the flow of heated water out of the intake structure and into the intake
34 embayment. The thermal backwashing process generally occurs for approximately 45 to 60
35 minutes and produces elevated water temperatures averaging approximately 37.8°C. A thermal
36 survey to determine the effects of backwashing operations at PNPS found that the procedure
37 caused a relatively thin thermal plume, averaging 3 to 5 ft in depth, that spread rapidly from the
38 intake structure across the western end of the intake embayment and along the outer
39 breakwater. The plume completely dissipated within a few hours (Normandeau Associates
40 1977).
41
42

1 The biological impacts of the PNPS thermal discharge have been evaluated by several
2 monitoring programs encompassing both pre- and post-operational periods. These programs
3 have included fish, benthic invertebrate and benthic microalgae monitoring. Fish monitoring
4 programs have included methods such as bottom trawling to sample demersal fish populations
5 inhabiting inshore bottom waters, haul seining to sample inshore fish populations, and gill
6 netting to sample pelagic fish inhabiting the water column of the bay. In complex habitat areas
7 unsuitable for survey with sampling equipment, visual transects were surveyed by divers in
8 order to assess habitat-seeking fish species such as the tautog and cunner. Recreational creel
9 surveys were used to assess the sport fishery in the vicinity of PNPS (ENSR 2000).

10
11 Heat shock to fish may occur when the water temperature meets or exceeds the thermal
12 tolerance of fish species; duration of exposure to high water temperature is also a factor
13 contributing to heat shock. Fish thermoregulate behaviorally by avoiding extreme temperatures
14 and seeking optimal temperatures (Beyers and Rice 2002). Therefore, fish in the bay typically
15 can avoid adverse effects from the thermal plume. The fish monitoring results indicate that the
16 thermal plume excludes several fish species from a relatively small area of habitat near the
17 discharge. However, fish mortality resulting from the thermal plume has been rare. Of the
18 notable fish mortality incidents recorded since PNPS began operation, only two were
19 considered to have been caused by thermal stress (heat shock) from exposure to high
20 temperatures in the plume. Approximately 3000 Atlantic menhaden were killed in August 1975
21 and 2300 clupeids (schooling fish such as menhaden, sardines, and shad) died in August 1978.
22 Such incidents have not been observed since 1978, confirming the rarity of fish mortality from
23 heat shock at PNPS. In addition, finfish surveys conducted as part of the Thermal Discharge
24 Fish Surveillance Program, provided no evidence of adverse impacts on populations resulting
25 from the thermal plume. The area of the plume does not provide unique habitat, and adequate
26 habitat exists in the vicinity in Cape Cod Bay for fish displaced from the area of the plume
27 (ENSR 2000).

28
29 The benthic monitoring programs, which include several studies that have been performed in
30 the vicinity of PNPS since 1973, have focused on invertebrates and macroalgae, particularly the
31 Irish moss and the American lobster. Although benthic invertebrates and macroalgae are less
32 mobile than fish and many are sessile, the relatively small bottom area in contact with the
33 thermal plume at low tide minimizes the potential effects on populations. The episodes of high
34 bottom temperatures during low tide are likely to be partially responsible for the observed effects
35 on benthic organisms in the area near the discharge. The high velocity of the discharge at low
36 tide, which is strong enough to scour the bottom in the area near the discharge, also is likely to
37 affect the biota. At high tide, the plume has essentially no effect on benthic biota because the
38 heated discharge water does not displace the denser, colder, ambient water that remains near
39 the bottom (EG&G 1995). The results of the monitoring programs indicate that the thermal
40 plume has had relatively insignificant impacts on benthic species in the vicinity of PNPS.

Environmental Impacts of Operation

1 Visual observations of bottom transects conducted periodically from 1973 to 1998 to assess
2 Irish moss abundance and density found that the plume does not impact Irish moss coverage,
3 except for in small areas (ENSR 2000). Scouring due to water currents has been hypothesized
4 to cause greater stress to algal colonization than the elevated temperatures of the thermal
5 plume. The observed denuded areas were attributed to scouring of the substrate, while areas
6 where growth of Irish moss was stunted or sparse were attributed to elevated temperatures
7 (ENSR 2000). A multi-year (1981 to 1998) benthic assessment confirmed that the impacts on
8 Irish moss in the area of the thermal plume were minimal due to the relatively small area
9 affected (ENSR 2000). Impacts on other submerged aquatic vegetation, such as eelgrass
10 (*Zostera marina*), are expected to be smaller than those on Irish moss because there are no
11 known coverages in the immediate vicinity of PNPS other than Irish moss.

12
13 Lobster populations were surveyed using research and commercial trap catch data through
14 1993. The data did not indicate measurable impacts from the thermal plume or the current
15 created by the effluent, and the program was discontinued. Based on the bottom temperature
16 study results (EG&G 1995) and the thermal tolerance threshold (30.5°C) of the American
17 lobster, it has been estimated that the loss of bottom habitat for the lobster during periods of
18 highest ambient water temperature (late summer to early fall) would be less than about 0.12 ac.

19
20 The staff has reviewed the available information, including that provided by the applicant, the
21 staff's site visit, the Commonwealth, the 316(a) demonstration, and other public sources. The
22 staff evaluated the potential impacts to aquatic resources due to heat shock during continued
23 operation during the renewal period. The staff concluded that the potential impacts to marine
24 resources due to heat shock during the renewal term would be SMALL.

25
26 During the course of the SEIS preparation, the staff considered mitigation measures for the
27 continued operation of PNPS during the license renewal period. Based on the NRC staff
28 assessment, no new mitigation measures are warranted.

30 **4.1.4 Potential Mitigation Measures**

31
32 The staff has identified a variety of measures that could mitigate potential impacts resulting from
33 continued operation of the PNPS cooling water system.^(a) These could include:
34

(a) It should be noted that the NRC cannot impose mitigation requirements on the applicant. The Atomic Safety and Licensing Appeal Board, in the "Yellow Creek" case determined that EPA has sole jurisdiction over the regulation of water quality with respect to the withdrawal and discharge of waters for nuclear power stations, and that the NRC is prohibited from placing any restrictions or requirements upon the licensees of these facilities with regards to water quality (Tennessee Valley Authority [Yellow Creek Nuclear Plant, Units 1 and 2], ALAB-515, 8 NRC 702, 712-13 [1978]).

- 1 • Automated chlorine monitoring
- 2 • Behavioral barriers
- 3 • Diversion devices
- 4 • Alternative intake systems
- 5 • Alternative intake screen systems
- 6 • Closed cycle systems
- 7 • Variable speed pumps
- 8 • Cooling water flow adjustments
- 9 • Scheduled outages
- 10 • Movement of fish return
- 11 • Habitat restoration
- 12 • Fish stocking

13

14 The NRC staff has not conducted an analysis of each of these measures relative to their
15 applicability to PNPS. This discussion is only meant to provide a brief overview of these
16 technologies. ENSR (2000) conducted an analysis of several of these technologies in the
17 316(b) demonstration report as required by Section 316 of the Clean Water Act. It is expected
18 that a more thorough analysis of the costs and benefits of these technologies would be
19 conducted as part of the 316(b) CDS currently being conducted by PNPS in support of the
20 NPDES permit renewal.

21

22 An automated chlorine monitoring system would allow for continuous monitoring of chlorine
23 levels in the service water and/or condenser cooling water systems. This system could also
24 include a warning system to alert the PNPS operator whenever equipment malfunctions or when
25 chlorine concentrations deviate from preset limits.

26

27 Behavioral barriers are designed to cause fish to actively avoid entry into an area. These may
28 include sound, light, or air bubbles (Clay 1995). Sound barriers, which would be located at an
29 intake structure, would include low-frequency, infra-wave sound; pneumatic or mechanically
30 generated low-frequency sounds; or transducer-generated sound. Light barriers may emit a
31 constant or strobe-type beam of light, while air bubble curtains produce a continuous, dense
32 chain of bubbles. Both barrier types may deter some species of fish from entering the intake
33 structure. ENSR (2000) determined that, of the behavioral barriers evaluated, light barriers
34 would be the most effective as several studies have shown that some fish species are attracted
35 to light. However, this technology is still considered to be experimental in nature and would only
36 be effective on species/life stages that can actively respond to a stimulus (i.e., not fish eggs,
37 early larval life stages, or other planktonic organisms).

38

39 Diversion devices are the most commonly used barriers and are physical structures, such as
40 louvers, barrier nets, or chains and cables, that are designed to guide fish away from a certain
41 area, such as the intake (Clay 1995). Louvers consist of a series of evenly spaced vertical slats
42 that create localized turbulence that fish can detect and actively avoid. Louvers typically have a

Environmental Impacts of Operation

1 smaller spacing between the slats or bars than a standard trash rack. Barrier nets are simply
2 nets placed across an intake channel to prevent fish from access to an intake structure. The
3 design of a barrier net system has to finely balance the mesh size with the intake
4 requirements.^(a) Chains or cables may be vertically hung in an intake structure to form a
5 physical and visible barrier to fish. However, similar to barrier nets, they may alter hydraulic
6 flow patterns in an intake (ENSR 2000). These types of structures also only affect those
7 organisms that can actively respond and would not impact entrainment or impingement of fish
8 eggs, larvae, or other planktonic organisms.

9
10 Another type of mitigation measure may be an alternative intake system. An alternate surface
11 water intake system could include an offshore intake structure with a velocity cap. Vertical
12 placement of the offshore intake within the water column would be a major factor in
13 impingement and entrainment reduction. For example, ENSR (2000) conducted an evaluation
14 of this type of structure and determined that it would result in lower fish impingement but an
15 increased entrainment rate, especially for winter flounder as later stages of winter flounder
16 larvae (stages 3 and 4) tend to settle on the bottom substrate. The Seabrook Nuclear Power
17 Station utilizes a similar structure; however, the intake structure opening is at mid-depth. Based
18 on an analysis by Saila et al. (1997), the losses due to entrainment at this facility are less than
19 the losses observed at other facilities. Groundwater could also be potentially used as a cooling
20 water source. According to EPA Region 1, the Keyspan North Point Station is currently
21 conducting a pilot study to evaluate the feasibility of using offshore groundwater extraction as a
22 cooling water source (Earth Tech 2006a).

23
24 Alternative intake screen systems may include Ristroph traveling screens, wedgewire screens,
25 and/or fine-mesh screens. Ristroph screens are traveling screens fitted with fish buckets that
26 collect fish and lift them out of the water where they are gently sluiced away prior to debris
27 removal with a high pressure spray. They have been approved as the best available technology
28 in several states (Siemens 2006). Recent studies have shown survival of species exceeding 95
29 percent when using the Ristroph screen (EPRI 2006). Wedgewire screens are constructed of
30 wire of triangular cross sections so that the surface of the screen is smooth while the screen
31 openings widen inwards (ENSR 2000). This type of screen has been widely used for
32 hydropower diversion structures and has been shown to essentially eliminate impingement and
33 reduce larval entrainment (ENSR 2000). Fine mesh screens are simply wire screens with the
34 mesh sized to minimize ichthyoplankton entrainment. As reported in ENSR (2000), fine mesh
35 screens have not proven effective at reducing winter flounder larvae entrainment losses.
36 However, as with any screen, smaller mesh could result in more clogging and fouling problems.
37 Closed-cycle systems recycle cooling water in a closed piping system and utilize evaporative

(a) EPA has suggested the Gunderboom fabric barrier as a potential mitigation measure. However, NRC staff does not consider it as a viable option because it could present safety issues at intakes of nuclear power plants.

1 cooling (such as is in a cooling tower or pond) as a means of dissipating the heat from the
2 condensers. Cooling towers could include wet, hybrid, or dry towers. Wet and hybrid cooling
3 towers would still require withdrawal of water from the bay to make up for water losses due to
4 blowdown and evaporation. However, the water withdrawal rate would be significantly lower
5 than the current once-through cooling system. A dry cooling tower utilizes ambient air to
6 dissipate heat, essentially acting as an automobile radiator (ENSR 2000). No make-up water is
7 required for this type of system as the steam is condensed in a closed cycle. However, this
8 results in lower plant efficiency, thus requiring more fuel to produce the same amount of
9 electricity (ENSR 2000).

10
11 Adjustments to the flow of cooling water through the plant is another type of mitigation strategy
12 that may be applicable to PNPS. This could include the use of variable speed pumps, cooling
13 water bypass flow, or rotating the existing screens more often or continuously. Variable-speed
14 pumps would reduce the intake flow during periods of peak entrainment or impingement. These
15 have been shown to be effective at reducing impingement and entrainment, but by reducing the
16 amount of cooling water moving through the system, power generating efficiency may decrease
17 and the thermal plume may increase in size (ENSR 2000). Cooling water bypass flow would
18 reduce the cooling water flow rate through the condensers and add a corresponding amount of
19 bypass flow into the discharge canal (ENSR 2000). This alternative assumes that mortality in
20 the discharge canal would be less than the condensers. It would most likely reduce entrainment
21 but not impingement (ENSR 2000). Another potential mitigation strategy related to the cooling
22 system would be to rotate the existing screens more often or on a continual basis. This would
23 increase the survival of impinged organisms, but it would have little impact on the impingement
24 rate or entrainment.

25
26 Another potential mitigation strategy may be to schedule outages for performing regular
27 inspection, maintenance, and refueling during the peak spawning season of specific fish
28 species such as the winter flounder, Atlantic menhaden, or rainbow smelt.

29
30 Movement of the fish return sluiceway discharge point may also provide some mitigation
31 benefits as impinged fish are currently returned to the intake canal where potentially stunned,
32 disoriented, or injured fish may not be able to actively avoid reentering the intake structure.

33
34 Habitat restoration and fish stocking are also potential mitigation strategies. However, these are
35 compensatory measures as opposed to preventive measures, which are the preferred mitigation
36 strategies of Federal and State resource agencies. Several studies have been funded by the
37 applicant over the last few years to evaluate these options. A monitoring program has been
38 conducted by the applicant to assess the feasibility of improving the local winter flounder stock
39 by releasing young of the year flounder into the Plymouth area. No genetic studies have been
40 conducted to determine if released hatchery fish breed with the wild stock. Up to 25,000 fish,
41 ranging from 26 to 34 mm (1-1.3 in.) in length have been released into Plymouth Harbor on an
42 annual basis since 2001. Post-release sampling has indicated that the released fish do survive

Environmental Impacts of Operation

1 and grow well when released earlier in the season (MRI 2006). The NRC staff has not found
2 evidence indicating that this pilot program has substantially offset impacts from continued
3 operation of PNPS to the local winter flounder population. If expanded, this stocking program
4 may have a beneficial impact on the local winter flounder population.
5

6 The applicant also provided funding to the MDMF for a limited stocking of rainbow smelt eggs
7 and habitat enhancement in the Jones River as a means to enhance production of rainbow
8 smelt in this critical spawning ground (Lawton and Boardman 1999b). Stocking of young-of-
9 year fish or eggs may be a proven mitigation strategy; however, both the EPA and MDMF have
10 stated that re-stocking is not a preferred mitigation alternative (Earth Tech 2006a).
11

12 4.2 Transmission Lines

13
14 The two transmission lines that connect PNPS with the transmission system share a single
15 transmission line right-of-way (ROW) (Figure 2-5). The transmission line ROW, which extends
16 from the PNPS switchyard to the Snake Hill Road substation, has a length of approximately 7.2
17 mi and occupies approximately 260 ac. Ongoing surveillance and maintenance of PNPS
18 transmission lines and ROW ensure continued conformance to transmission line design
19 standards. NSTAR Gas and Electric Corporation's (NSTAR's) Vegetation Management Plan
20 (NSTAR 2006) integrates the selective use of herbicides approved in Massachusetts for use in
21 sensitive areas with the use of mechanical methods (i.e., selective removal of targeted
22 vegetation by hand cutting or mowing) and biological methods (i.e., encouraging development of
23 stable communities of low-growing plants) to restore and maintain habitat and control invasive
24 species in the transmission line ROW. The transmission line ROW maintenance practices
25 employed by NSTAR, which comply with all State and Federal regulations, encourage the
26 development of stable communities of low-growing native plants that provide wildlife habitat and
27 support biodiversity while controlling tall-growing trees and undesirable shrub species that
28 would interfere with the operation of the transmission lines. In addition, NSTAR follows a
29 program developed in coordination with and approved by the Natural Heritage and Endangered
30 Species Program (NHESP) to protect rare species (i.e. turtles) and priority habitats that may be
31 present in the transmission line ROW (NSTAR 2006).
32

33 Category 1 issues in 10 CFR Part 51, Subpart A, Appendix B, Table B-1, that are applicable to
34 transmission lines from PNPS are listed in Table 4-6. Entergy stated in its ER that it is not
35 aware of any new and significant information associated with the renewal of the PNPS OL. The
36 NRC staff has not identified any new and significant information during its independent review
37 of the Entergy ER, the site visit, the scoping process, or evaluation of other available
38 information. Therefore, the staff concludes that there would be no impacts related to these
39 issues beyond those discussed in the GEIS. For all of those issues, the staff concluded in the
40 GEIS that the impacts would be SMALL, and additional facility-specific mitigation measures are
41 not likely to be sufficiently beneficial to be warranted.

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

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Sections
TERRESTRIAL RESOURCES	
Power line right-of-way management (cutting and herbicide application)	4.5.6.1
Bird collisions with power lines	4.5.6.2
Impacts of electromagnetic fields on flora and fauna (plants, agricultural crops, honeybees, wildlife, livestock)	4.5.6.3
Floodplains and wetland on power line right-of-way	4.5.7
AIR QUALITY	
Air quality effects of transmission lines	4.5.2
LAND USE	
On-site land use	3.2
Power line right-of-way	4.5.3

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

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

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

The staff has not identified any new and significant information during its independent review of the PNPS ER, the site visit, the scoping process, consultation with the U.S. Fish and Wildlife Service (FWS) and the Massachusetts Division of Fisheries and Wildlife (MDFW), or evaluation of other information. Therefore, the staff concludes that there would be no impacts of power line right-of-way maintenance on wildlife during the renewal term beyond those discussed in the GEIS.

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

Impacts are expected to be of small significance at all sites.

The staff has not identified any new and significant information during its independent review of the PNPS ER, the site visit, the scoping process, consultation with the FWS and

Environmental Impacts of Operation

1 MDFW, or evaluation of other information. Therefore, the staff concludes that there would
2 be no impacts of bird collisions with power lines during the renewal term beyond those
3 discussed in the GEIS.

- 4
5 • Impacts of electromagnetic fields on flora and fauna (plants, agricultural crops,
6 honeybees, wildlife, livestock). Based on information in the GEIS, the Commission
7 found that:

8
9 No significant impacts of electromagnetic fields on terrestrial flora and fauna have been
10 identified. Such effects are not expected to be a problem during the license renewal
11 term.

12
13 The staff has not identified any new and significant information during its independent
14 review of the PNPS ER, the site visit, the scoping process, or evaluation of other
15 information. Therefore, the staff concludes that there would be no impacts of
16 electromagnetic fields on flora and fauna during the renewal term beyond those discussed in
17 the GEIS.

- 18
19 • Floodplains and wetlands on power line right of way. Based on information in the GEIS, the
20 Commission found that:

21
22 Periodic vegetation control is necessary in forested wetlands underneath power lines
23 and can be achieved with minimal damage to the wetland. No significant impact is
24 expected at any nuclear power plant during the license renewal term.

25
26 The staff has not identified any new and significant information during its independent
27 review of the PNPS ER, the site visit, the scoping process, consultation with the FWS and
28 MDFW, or evaluation of other information. Therefore, the staff concludes that there would
29 be no impacts of power line ROW maintenance on floodplains and wetlands during the
30 renewal term beyond those discussed in the GEIS.

- 31
32 • Air quality effects of transmission lines. Based on the information in the GEIS, the
33 Commission found that:

34
35 Production of ozone and oxides of nitrogen is insignificant and does not contribute
36 measurably to ambient levels of these gases.

37
38 The staff has not identified any new and significant information during its independent
39 review of the PNPS ER, the site visit, the scoping process, or evaluation of other
40 information. Therefore, the staff concludes that there would be no air quality impacts of
41 transmission lines during the renewal term beyond those discussed in the GEIS.

42

- On-site land use. Based on the information in the GEIS, the Commission found that:

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

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

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

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

The staff has not identified any new and significant information during its independent review of the PNPS ER, the site visit, the scoping process, or evaluation of other information. Therefore, the staff concludes that there would be no impacts of power line ROWs on land use during the renewal term beyond those discussed in the GEIS.

There is one Category 2 issue related to transmission lines. An additional issue related to transmission lines (chronic effects) was left uncategorized in the GEIS (NRC 1996a), and is being treated as a Category 2 issue in this SEIS. These issues are listed in Table 4-7 and are discussed in Sections 4.2.1 and 4.2.2.

Table 4-7. Category 2 and Uncategorized Issues Applicable to the PNPS Transmission Lines During the Renewal Term

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

1 **4.2.1 Electromagnetic Fields-Acute Effects**

2
3 Based on the GEIS, the Commission found that electric shock resulting from direct access to
4 energized conductors or from induced charges in metallic structures has not been found to be a
5 problem at most operating plants and generally is not expected to be a problem during the
6 license renewal term. However, site specific review is required to determine the significance of
7 the electric shock potential along the portions of the transmission lines that are within the scope
8 of this SEIS.

9
10 In the GEIS (NRC 1996a), the staff found that without a review of the conformance of each
11 nuclear plant transmission line with National Electrical Safety Code (NESC 1997) criteria, it was
12 not possible to determine the significance of the electric shock potential. Evaluation of
13 individual plant transmission lines is necessary because the issue of electric shock safety was
14 not addressed in the licensing process for some plants. For other plants, land use in the vicinity
15 of transmission lines may have changed, or power distribution companies may have chosen to
16 upgrade line voltage. To comply with 10 CFR 51.53(c)(3)(ii)(H), the applicant must provide an
17 assessment of the potential shock hazard if the transmission lines that were constructed for the
18 specific purpose of connecting the plant to the transmission system do not meet the
19 recommendations of the NESC for preventing electric shock from induced currents.

20
21 The PNPS transmission lines were constructed to the NESC specifications and industry
22 guidance in effect at the time the lines were constructed. PNPS transmission facilities and
23 ROW, which are owned and operated by NSTAR, are maintained to ensure continued
24 compliance with the standards and guidance in effect when they were constructed. In 1977,
25 after the lines were constructed, a new criterion was added to the NESC that established
26 minimum vertical clearances to the ground for power lines with voltages exceeding 98 kilovolts
27 (kV). This criterion states that the clearance must limit the steady-state induced current to 5
28 milliamperes (mA) if the largest anticipated truck, vehicle, or equipment were short-circuited to
29 the ground.

30
31 The PNPS is connected to the electric grid via two 345-kV lines. As part of their license renewal
32 application, Entergy (2006a) reviewed these transmission lines for compliance with the 1977
33 NESC criterion. Because the two lines share the same towers, Entergy performed an analysis
34 on a limiting case in which both lines operated together and, as a conservative assumption,
35 were located at the minimum clearance distance (28 ft) allowed by the Commonwealth of
36 Massachusetts for 345-kV lines. All spans on the lines exceed this minimum
37 clearance distance, and NSTAR conducts surveillance and maintenance activities to ensure
38 that the ground clearances do not change (Entergy 2006a).

39
40 The electric field strength beneath these lines was calculated by NSTAR using the Electric
41 Power Research Institute (EPRI) code, ENVIRO (NSTAR 2001, in Entergy 2006a). Entergy
42 used methods described in EPRI's Transmission Line Reference Book (EPRI 1982, in Entergy

1 2006a) to calculate the induced current based on the distribution of the electric field strength.
2 The analysis assumed a vehicle of the maximum size allowed by the Commonwealth of
3 Massachusetts, which is a tractor-trailer 60 ft long, 8 ft wide, and 13.5 ft high. This analysis
4 determined that the combined effect of the two lines would result in a maximum induced current
5 of 4.5 mA, below the NESC 5-mA criterion. Therefore, the transmission lines comply with the
6 NESC provisions for preventing electric shock from induced current (Entergy 2006a).

7
8 The staff has reviewed the available information, including the applicant's evaluation and
9 computational results, the site visit, the scoping process, and other public sources. Based on
10 this information, the staff evaluated the potential impacts of electric shock resulting from
11 operation of PNPS and its associated transmission lines. It is the staff's conclusion that the
12 potential impacts of electric shock during the renewal term would be SMALL, and no additional
13 mitigation is warranted.

14 15 **4.2.2 Electromagnetic Fields-Chronic Effects**

16
17 In the GEIS, the chronic effects of 60 hertz electromagnetic fields from power lines were not
18 designated as Category 1 or 2, and will not be until a scientific consensus is reached on the
19 health implications of these fields.

20
21 The potential for chronic effects from these fields continues to be studied and is not known at
22 this time. The National Institute of Environmental Health Sciences (NIEHS) directs related
23 research through the U.S. Department of Energy (DOE). The 1999 report of the NIEHS and
24 DOE Working Group (Portier and Wolfe 1999) contains the following conclusion:

25
26 The NIEHS concludes that ELF-EMF (extremely low frequency-electromagnetic field)
27 exposure cannot be recognized as entirely safe because of weak scientific evidence that
28 exposure may pose a leukemia hazard. In our opinion, this finding is insufficient to
29 warrant aggressive regulatory concern. However, because virtually everyone in the
30 United States uses electricity and therefore is routinely exposed to ELF-EMF, passive
31 regulatory action is warranted such as a continued emphasis on educating both the
32 public and the regulated community on means aimed at reducing exposures. The
33 NIEHS does not believe that other cancers or non-cancer health outcomes provide
34 sufficient evidence of a risk to currently warrant concern.

35
36 This statement is not sufficient to cause the staff to change its position with respect to the
37 chronic effects of electromagnetic fields. The staff considers the GEIS finding of "not
38 applicable" still appropriate and continues to follow developments on this issue.
39
40
41

4.3 Radiological Impacts of Normal Operations

Category 1 issues in 10 CFR Part 51, Subpart A, Appendix B, Table B-1, that are applicable to PNPS in regard to radiological impacts are listed in Table 4-8. Entergy stated in its ER (Entergy 2006a) that it has not identified any new or significant information concerning impacts related to these issues with respect to the renewal of the PNPS operating license. The staff did not identify any additional new or significant information during its independent review of the PNPS ER, the site visit, the scoping process, its evaluation of other available information, or public comments on the scoping process. Therefore, the staff concludes that there are no impacts related to these issues beyond those discussed in the GEIS. For these issues, the staff concluded in the GEIS that the impacts are SMALL, and additional plant-specific mitigation measures are not likely to be sufficiently beneficial to be warranted.

Table 4-8. Category 1 Issues Applicable to Radiological Impacts of Normal Operations During the Renewal Term

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

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

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

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

The staff has not identified any new and significant information during its independent review of the PNPS ER, the site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there would be no impacts of radiation exposures to the public during the renewal term beyond those discussed in the GEIS. However, the staff did receive a number of comments on this issue during the scoping process. The staff's evaluation of this information is presented in Section 4.7.

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

1 Projected maximum occupational doses during the license renewal term are within
 2 the range of doses experienced during normal operations and normal maintenance
 3 outages, and would be below regulatory limits.
 4

5 The staff has not identified any new and significant information during its independent
 6 review of the PNPS ER, the staff's site visit, the scoping process, or its evaluation of other
 7 available information. Therefore, the staff concludes that there would be no impacts of
 8 occupational radiation exposures during the renewal term beyond those discussed in the
 9 GEIS.
 10

11 There are no Category 2 issues related to radiological impacts of routine operations.
 12

13 **4.4 Socioeconomic Impacts of Plant Operations During** 14 **the License Renewal Period** 15

16 Category 1 issues in 10 CFR Part 51, Subpart A, Appendix B, Table B-1 that are applicable to
 17 socioeconomic impacts during the renewal term are listed in Table 4-9. Entergy stated in its ER
 18 (Entergy 2006a) that it is not aware of any new and significant information associated with the
 19 renewal of the PNPS operating license. The staff has not identified any new and significant
 20 information during its independent review of the PNPS ER, the site visit, the scoping process, or
 21 its evaluation of other available information. Therefore, the staff concludes that there are no
 22 impacts related to these issues beyond those discussed in the GEIS (NRC 1996a). For these
 23 issues, the staff concluded in the GEIS that the impacts are SMALL, and additional
 24 plant-specific mitigation measures are not likely to be sufficiently beneficial to be warranted.
 25

26 **Table 4-9.** Category 1 Issues Applicable to Socioeconomics During the Renewal Term
 27

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

34
 35 A brief description of the staff's review and the GEIS conclusions, as codified in Table B-1, for
 36 each of these issues follows:
 37

Environmental Impacts of Operation

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

3
4 Impacts to public safety, social services, and tourism and recreation are
5 expected to be of small significance at all sites.
6

7 The staff has not identified any new and significant information during its independent
8 review of the PNPS ER, the site visit, the scoping process, or its evaluation of other
9 available information. Therefore, the staff concludes that there would be no impacts on
10 public safety, social services, and tourism and recreation during the renewal term
11 beyond those discussed in the GEIS.
12

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

15
16 Only impacts of small significance are expected.
17

18 The staff has not identified any new and significant information during its independent
19 review of the PNPS ER, the site visit, the scoping process, or its evaluation of other
20 available information. Therefore, the staff concludes that there would be no impacts on
21 education during the renewal term beyond those discussed in the GEIS.
22

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

25
26 No significant impacts are expected during the license renewal term.
27

28 The staff has not identified any new and significant information during its independent
29 review of the PNPS ER, the site visit, the scoping process, or its evaluation of other
30 available information. Therefore, the staff concludes that there would be no aesthetic
31 impacts during the renewal term beyond those discussed in the GEIS.
32

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

35
36 No significant impacts are expected during the license renewal term.
37

38 The staff has not identified any new and significant information during its independent
39 review of the PNPS ER, the site visit, the scoping process, or its evaluation of other
40 available information. Therefore, the staff concludes that there would be no aesthetic
41 impacts of transmission lines during the renewal term beyond those discussed in the
42 GEIS.

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

Table 4-10. Environmental Justice and GEIS Category 2 Issues
Applicable to Socioeconomics During the Renewal Term

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

(a) Guidance related to environmental justice was not in place at the time the GEIS and the associated revision to 10 CFR Part 51 were prepared. Therefore, environmental justice must be addressed in the staff's supplemental environmental impact statement (NRC 2004b)

4.4.1 Housing Impacts During Operations

10 CFR Part 51, Subpart A, Appendix B, Table B-1 states that impacts on housing availability are expected to be of small significance at plants located in a high-population area where growth-control measures are not in effect. The PNPS site is located in a high-population area and Plymouth County is not subject to growth-control measures that would limit housing development. Based on the NRC criteria, Entergy expects housing impacts to be SMALL during continued operations (Entergy 2006a).

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

Section 2.2.8.1 discusses housing conditions in the region and notes the locations of residences for the approximately 700 employees of PNPS. Plymouth and Barnstable counties experienced substantial growth in housing units over the period of 1990 to 2000. Plymouth's number of

Environmental Impacts of Operation

1 occupied housing units increased by 12.6 percent and Barnstable by 22.2 percent over the
2 decade. Section 2.2.8.5 stated the growth rate of Plymouth and Barnstable counties to be 8.6
3 percent and 19.0 percent, respectively, from 1990 to 2000. Both of these counties' growth rates
4 are higher than Massachusetts' rate as a whole (5.5 percent). Projected population data
5 indicates these rates will continue in these counties in the future.

6
7 The staff reviewed the available information relative to housing impacts and PNPS ER. Based
8 on this review, the staff concludes that the impact on housing during the license renewal period
9 would be SMALL, and additional mitigation is not warranted.

10 11 **4.4.2 Public Services: Public Utility Impacts During Operations**

12
13 Impacts on public utility services are considered SMALL if there is little or no change in the
14 ability of the system to respond to the level of demand, and thus there is no need to add capital
15 facilities. Impacts are considered MODERATE if overtaxing of service capabilities occurs during
16 periods of peak demand. Impacts are considered LARGE if existing levels of service (e.g.,
17 water or sewer services) are substantially degraded and additional capacity is needed to meet
18 ongoing demands for services. The GEIS indicates that, in the absence of new and significant
19 information to the contrary, the only impacts on public utilities that could be significant are
20 impacts on public water supplies (NRC 1996a).

21
22 Analysis of impacts on the public water supply system considered both facility demand and
23 facility-related population growth. PNPS purchases water from the Town of Plymouth Water
24 Division. This water is used as potable water and reactor make-up water at the facility. As
25 described in Section 2.2.2, PNPS estimated annual consumption of water obtained from the
26 Town of Plymouth public water supply system to be 39.1 million gallons per year for a
27 non-outage year. This usage represents approximately 2.3 percent of the town's total yearly
28 consumption. No refurbishment or new construction activities are associated with the PNPS
29 license renewal and PNPS water usage is not expected to change during the license renewal
30 term. Therefore, the impact on the local water supply would not be expected to change.
31 Entergy plans no increase in employment at PNPS during the license renewal term (Entergy
32 2006a). Therefore, facility-related population growth is not expected, and there would be no
33 significant impact on the region's water supplies.

34
35 The Plymouth-Carver aquifer, which is the source of potable water for the Town of Plymouth
36 public water supply system, has sufficient water for existing and projected demand. The town
37 has measures in effect to limit development in order to prevent excess water withdrawal (Town
38 of Plymouth 2006).

39
40 The staff has reviewed the available information, including actual water use records for PNPS
41 and water use and water supply capacities for the major public water supply systems in the
42 region. Based on this information, the staff concludes that the potential impacts of PNPS during

1 the license renewal period on public water supplies are SMALL and that no additional mitigation
2 measures are warranted.

3 4 **4.4.3 Off-site Land Use During Operations**

5
6 Off-site land use during the license renewal term is a Category 2 issue. Table B-1 of 10 CFR 51
7 Subpart A, Appendix B notes that "significant changes in land use may be associated with
8 population and tax revenue changes resulting from license renewal."

9
10 Section 4.7.4 of the GEIS defines the magnitude of land-use changes as a result of plant
11 operation during the license renewal term as follows:

12
13 SMALL - Little new development and minimal changes to an area's land-use pattern.

14
15 MODERATE - Considerable new development and some changes to the land-use pattern.

16
17 LARGE - Large-scale new development and major changes in the land-use pattern.

18
19 The Town of Plymouth Conservation Commission has expressed concern that the breakwaters
20 associated with the PNPS intake and discharge structures may have contributed to erosion of
21 the shoreline in the Priscilla Beach community, located southeast of the facility along Cape Cod
22 Bay, resulting in a cobble rather than sand beach^(a). The Massachusetts Office of Coastal Zone
23 Management's Shoreline Change Project provides data on changes in the location of the state's
24 shoreline over time (MOCZM 2006). The Shoreline Change Project presents long and short-
25 term shoreline change rates at 40 m (131 ft) intervals along the Massachusetts coast,
26 classifying change in the location of the shoreline as either negative (erosion) or positive
27 (accretion). The shoreline change data were derived from analyses of historical maps and
28 aerial photographs spanning the time period from the mid-1800s to 1994. The staff examined
29 shoreline change data from 32 transects covering the shoreline from the southern breakwater at
30 PNPS southeast to the Priscilla Beach/White Horse Rocks area, for a total of 4200 ft. For the
31 first time period studied, 1866 to 1951, most of this segment of shoreline experienced accretion
32 (gain). The second time period, 1951 to 1978, saw erosion (loss) over many segments of this
33 shoreline, with the greatest rate of erosion occurring in the portion farthest away from
34 (southeast of) PNPS. Some segments experienced accretion. During the third time period
35 studied, 1987 to 1994, more segments experienced erosion than accretion but not in any
36 particular pattern or trend (i.e., some areas that experienced erosion in the second period
37 experienced accretion during the third period and for others the opposite occurred). The
38 segments with the greatest erosion rates during the second period (i.e., those farthest away
39 from PNPS) experienced accretion or a slower rate of erosion during the third time period.

(a) Interview with Town of Plymouth officials on May 2, 2006.

Environmental Impacts of Operation

1 Based on the review of this data, no detectable trend of erosion associated with the PNPS
2 facility was observed.

3
4 Tax revenue can affect land use because it enables local jurisdictions to be able to provide the
5 public services (e.g., transportation and utilities) necessary to support development.
6 Section 4.7.4.1 of the GEIS states that the assessment of tax-driven land-use impacts during
7 the license renewal term should consider (1) the size of the plant's payments relative to the
8 community's total revenues, (2) the nature of the community's existing land-use pattern, and
9 (3) the extent to which the community already has public services in place to support and guide
10 development. If the plant's tax payments are projected to be small relative to the community's
11 total revenue, tax-driven land-use changes during the plant's license renewal term would be
12 small, especially where the community has pre-established patterns of development and has
13 provided adequate public services to support and guide development. Section 4.7.2.1 of the
14 GEIS states that if tax payments by the plant owner are less than 10 percent of the taxing
15 jurisdictions revenue, the significance level would be small. If the plant's tax payments are
16 projected to be medium to large relative to the community's total revenue, new tax-driven land-
17 use changes would be moderate. If the plant's tax payments are projected to be a dominant
18 source of the community's total revenue, new tax-driven land-use changes would be large. This
19 would be especially true where the community has no pre-established pattern of development or
20 has not provided adequate public services to support and guide development.

21
22 PNPS pays annual property taxes to the Town of Plymouth. As discussed in Section 2.2.8.6,
23 property taxes paid to the Town of Plymouth for PNPS have declined since 1998 when the
24 Commonwealth of Massachusetts deregulated its utility industry, and in 1999 when Boston
25 Edison Company sold PNPS to Entergy Corporation for significantly less than the assessed
26 value. Subsequent to the State's deregulation law and Entergy's purchase of PNPS, the Town
27 of Plymouth and Entergy agreed to payments in lieu of taxes of \$1 million annually with the
28 potential for payments to increase should Entergy make capital improvements or substantial
29 additions to the facility. The agreement takes effect in FY2007 and continues through 2012. It
30 would be renegotiated in the event of license renewal (Entergy 2006a). In addition, the
31 Massachusetts legislature has required the owners and operators of the transmission lines
32 (NSTAR) to make payments to the Town of Plymouth until the end of the current PNPS license
33 in 2012. NSTAR payments will decline from \$12 million in 2006 to \$1 million in 2007, and
34 continue annually at that amount through 2012. Until 1999, PNPS property taxes provided
35 approximately 22 percent of the Town of Plymouth's total property tax revenues or about 17
36 percent of the town's total revenues. In FY2007, PNPS (including Entergy and NSTAR
37 payments) is expected to pay only about 2 percent of the total property taxes received by the
38 Town of Plymouth, or about 1.5 percent of the town's total revenues.

39
40 No refurbishment or new construction activities are associated with the PNPS license renewal.
41 Therefore, the Entergy payment of \$1 million per year to the Town of Plymouth would not be
42 expected to increase substantially (e.g., enough to raise it to 10 percent of the town's total

1 revenues) as a result of the renegotiation that would occur at license renewal. Based on this
2 analysis, tax payments for PNPS are expected to remain at less than 10 percent of the Town of
3 Plymouth's total revenues over the license renewal term. Therefore, the staff concludes that the
4 tax-related land use impacts would remain SMALL.

5 6 **4.4.4 Public Services: Transportation Impacts During Operations**

7
8 Table B-1, 10 CFR Part 51 states: "Transportation impacts (level of service) of highway traffic
9 generated... during the term of the renewed license are generally expected to be of small
10 significance. However, the increase in traffic associated with additional workers and the local
11 road and traffic control conditions may lead to impacts of moderate or large significance at
12 some sites." All applicants are required by 10 CFR 51.53(c)(3)(ii)(J) to assess the impacts of
13 highway traffic generated by the proposed project on the level of service of local highways
14 during the term of the renewed license.

15
16 Section 2.2.8.1 addressed existing transportation conditions in the vicinity of PNPS and found
17 no serious substandard conditions in the highway network. The possible exception is Rocky Hill
18 Road, which suffers from some safety issues associated with limited sight distances, tight
19 curves, and no shoulders. The recent Old Colony Planning Council study of this highway makes
20 specific recommendations for the town to improve safety on this local roadway (OCPC 2006).
21 The study did not cite the PNPS as contributing to these problems. Currently, PNPS truck traffic
22 is directed to use Power House Road to access the plant. With no increase in personnel
23 anticipated during the relicensing period, any changes in future transportation conditions in the
24 area would not be attributable to PNPS.

25
26 The staff has reviewed the available information on traffic and transportation conditions and the
27 potential effects of relicensing. Based on this information, the staff concludes that the potential
28 impacts of relicensing on transportation are SMALL and no additional mitigation is needed.

29 30 **4.4.5 Historic and Archaeological Resources**

31
32 The National Historic Preservation Act (NHPA) requires that Federal agencies take into account
33 the effects of their undertakings on historic properties. The historic preservation review process
34 mandated by Section 106 of the NHPA is outlined in regulations issued by the Advisory Council
35 on Historic Preservation at 36 CFR Part 800. Renewal of an operating license is an undertaking
36 that could potentially affect historic properties. Therefore, according to the NHPA, the NRC is to
37 make a reasonable effort to identify historic properties in the areas of potential effects. If no
38 historic properties are present or affected, the NRC is required to notify the State Historic
39 Preservation Officer before proceeding. If it is determined that historic properties are present,
40 the NRC is required to assess and resolve possible adverse effects of the undertaking.

1 **4.4.5.1 Site Specific Cultural Resources Information**

2
3 A review of the Massachusetts Historical Commission (MHC) files shows that there are no
4 National Register eligible or listed archaeological or historic above ground resources identified
5 on the PNPS site. As noted in Section 2.2.9.2, an archaeological survey of a 517-ac portion of
6 the PNPS site, including the area where the station and the transmission line were constructed,
7 identified 25 archaeological sites (24 historic and one prehistoric), all of which were eventually
8 determined to be ineligible for listing on the National Register (AEC 1972). This testing also
9 concluded that there is no evidence of prehistoric occupation in the area around the station
10 (AEC 1972).

11
12 There is potential for archaeological resources to be present on other portions of the PNPS site
13 that have not been surveyed (i.e., in the recreation area, the woodlands area, and within the
14 transmission line corridor). One example reported by Entergy (2006a) is a possible cellar
15 described by local informants as having been located and subsequently destroyed by
16 construction of Power House Road. In addition, a small number of historic artifacts and two
17 possible historic sites were observed by the NRC staff during the site visit (Section 2.2.9.2).
18 As noted in Section 2.2.9.2, while 21 National Register and/or State Register listed historic
19 resources have been identified within the Town of Plymouth, none are located within the
20 boundaries of the PNPS site (Entergy 2006a).

21
22 **4.4.5.2 Conclusions**

23
24 A 1990 Environmental Assessment conducted by the NRC reported that operations at the
25 PNPS site had not disturbed the integrity of local historic sites in the Town of Plymouth
26 (NRC 1990). In a 2005 correspondence between the MHC and Entergy it was further
27 determined that no National Register eligible historic or archaeological resources on the PNPS
28 site would likely be impacted through continuing operations at the station (Entergy 2006a).

29
30 No new facilities, service roads or transmission lines are proposed for the PNPS site as part of
31 this operating license renewal, nor are refurbishment activities proposed. Additionally, Entergy
32 has an environmental review and evaluation procedure (EN-EV-115) in place to identify and
33 assess the effects of its activities upon cultural resources (Entergy 2006d). Therefore, the
34 potential for National Register eligible historic or archaeological resources to be impacted by
35 renewal of this operating license is SMALL. Based on this conclusion, there would be no need
36 to review mitigation measures.

37
38 **4.4.6 Environmental Justice**

39
40 Environmental justice refers to a Federal policy that requires Federal agencies to identify and
41 address, as appropriate, disproportionately high and adverse human health or environmental

1 effects of its actions on minority^(a) or low-income populations. The memorandum accompanying
2 Executive Order 12898 (59 FR 7629) directs Federal executive agencies to consider
3 environmental justice under NEPA. The Council on Environmental Quality has provided
4 guidance for addressing environmental justice (CEQ 1997). Although the Executive Order is not
5 mandatory for independent agencies, the NRC has voluntarily committed to undertake
6 environmental justice reviews. Specific guidance is provided in the NRC Office of Nuclear
7 Reactor Regulation Office Instruction LIC-203, *Procedural Guidance for Preparing*
8 *Environmental Assessments and Considering Environmental Issues* Rev. 1 (NRC 2004a). In
9 2004, the Commission issued a final *Policy Statement on the Treatment of Environmental*
10 *Justice Matters in NRC Regulatory and Licensing Actions* (NRC 2004b).

11
12 The scope of the review, as defined in NRC guidance (NRC 2004a), includes identification of
13 impacts on minority and low-income populations, the location and significance of any
14 environmental impacts during operations on populations that are particularly sensitive, and
15 information pertaining to mitigation. It also includes evaluation of whether these impacts are
16 likely to be disproportionately high and adverse.

17
18 The staff identified minority and low-income populations within the 50-mi radius of the site. A
19 minority population exists in a census block group if the percentage of each minority and
20 aggregated minority category within the census block group exceeds the corresponding
21 percentage of minorities in the state of which it is a part by 20 percentage points, or the
22 corresponding percentage of minorities within the census block group is at least 50 percent. A
23 low-income population exists if the percentage of low-income population within a census block
24 group exceeds the corresponding percentage of low-income population in the state of which it is
25 a part by 20 percentage points, or if the corresponding percentage of low-income population
26 within a census block group is at least 50 percent.

27
28 For the PNPS review, the staff examined the geographic distribution of minority and low-income
29 populations within 50 mi of the site, employing the 2000 Census for low-income and minority
30 populations (USCB 2000). The analysis was supplemented by field inquiries to the planning
31 department and local officials in the towns in Plymouth County proximate to the PNPS.

32 **4.4.6.1 Minority Populations**

33
34
35 The percent of each minority group and of minorities in aggregate was calculated for each of the

(a) The Commission policy statement on environmental justice matters defines "minority" as American Indian or Alaskan Native; Asian; Native Hawaiian or other Pacific Islander; Black races; or Hispanic ethnicity. "Other" races and multi-racial individuals may be considered as separate minorities (NRC 2004b).

Environmental Impacts of Operation

1 3863 block groups within 50 mi of PNPS and compared to the corresponding State's minority
2 threshold percentages to determine whether environmental justice-defined minority populations
3 exist.

4
5 Massachusetts, with approximately 83 percent of the block groups, accounts for 514 block
6 groups defined as minority communities, with the remaining 17 percent of block groups in
7 Rhode Island accounting for 137 block groups defined as minority communities (aggregating all
8 minority racial groups and Hispanic populations). The location of these minority block groups is
9 shown in Figure 2-12.

10
11 No minority communities were located within a 6-mi radius of PNPS. The nearest
12 concentrations of minority groups to PNPS were in Brockton, approximately 25 mi to the
13 northwest. Other minority communities were located in or near to Boston, Massachusetts, and
14 Providence, Rhode Island.

15 16 **4.4.6.2 Low-Income Populations**

17
18 NRC guidance defines "low-income" by using U.S. Census Bureau (USCB) statistical poverty
19 thresholds (NRC 2004a). The same approach to defining low-income environmental justice
20 thresholds is used for minorities (i.e., where the low-income population of the census block
21 group exceeds 50 percent, or where the percentage of persons below the poverty level in a
22 census block group is 20 percent points or more than the state's percentage of low-income
23 persons).

24
25 In Massachusetts, of the 3204 block groups within 50 mi of PNPS, low-income populations exist
26 in 190 block groups, and in Rhode Island, 79 of the 659 block groups in the study area were
27 defined as low-income.

28
29 No low-income populations were identified within the 6-mi radius of PNPS. The nearest low-
30 income population occurring within the 50-mi radius was in northwest Plymouth County in
31 Brockton. This population is approximately 25 mi northwest of the PNPS site. Other low-income
32 populations within 50 mi of PNPS were clustered near Boston and in Bristol County, near the
33 communities of Fall River and New Bedford, Massachusetts and in Providence County, Rhode
34 Island. The location of these low-income block groups is shown in Figure 2-13.

35
36 With the locations of minority and low-income populations identified, the staff proceeded to
37 evaluate whether any of the environmental impacts of the proposed action could affect these
38 populations in a disproportionately high and adverse manner. Based on NRC staff guidance
39 (NRC 2001), air, land, and water resources within 50 mi of the PNPS site were examined.
40 Within that area, all of the potential environmental impacts were considered SMALL, with the
41 exception of potential impacts to local marine fish populations.

1 The pathways through which the environmental impacts associated with the PNPS license
 2 renewal can affect human populations are discussed in each topical section. The staff
 3 evaluated whether minority and low-income populations could be disproportionately affected by
 4 these impacts. The staff found no unusual resource dependencies or practices, such as
 5 subsistence agriculture, hunting, or fishing that would be affected and, in turn, adversely affect
 6 minority and low-income populations. In addition, the staff did not identify any location-
 7 dependent disproportionately high and adverse impacts affecting these minority and low-income
 8 populations. The staff concludes that offsite impacts from PNPS on minority and low-income
 9 populations would be SMALL, and no special mitigation actions are warranted.

10
 11 **4.5 Ground-Water Use and Quality**

12
 13 Category 1 issues in 10 CFR Part 51, Subpart A, Appendix B, Table B 1, that are applicable to
 14 PNPS groundwater use and quality are listed in Table 4-11. Entergy stated in its ER that it is
 15 not aware of any new and significant information associated with the renewal of the PNPS OL
 16 (Entergy 2006a). The staff has not identified any new and significant information during its
 17 independent review of the PNPS ER, the staff's site visit, the scoping process, or its evaluation
 18 of other available information. Therefore, the staff concludes that there are no impacts related
 19 to these issues beyond those discussed in the GEIS. For these issues, the GEIS concluded
 20 that the impacts are SMALL, and additional plant specific mitigation measures are not likely to
 21 be sufficiently beneficial to be warranted.

22
 23 **Table 4-11.** Category 1 Issues Applicable to Groundwater Use and Quality During the
 24 Renewal Term
 25

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Sections
GROUND-WATER USE AND QUALITY	
Ground-water use conflicts (potable and service water; plants that use <100 gpm)	4.8.1.1
Ground-water quality degradation (saltwater intrusion)	4.8.2.1

30
 31 A brief description of the staff's review and the GEIS conclusions, as codified in Table B-1,
 32 10 CFR 51, follows.

- 33
- 34 • Ground-water use conflicts (potable and service water; plants that use <100 gpm).
 35 Based on information in the GEIS, the Commission found that:

36
 37 Plants using less than 100 gpm are not expected to cause any ground-water use
 38 conflicts.

Environmental Impacts of Operation

1 As discussed in Section 2.2.2, PNPS groundwater use is less than 100 gpm. The staff has
2 not identified any new and significant information during its independent review of the
3 PNPS ER, the site visit, the scoping process, or its evaluation of other available
4 information. Therefore, the staff concludes that there would be no groundwater use
5 conflicts during the renewal term beyond those discussed in the GEIS.

- 6
7 • Ground-water quality degradation (saltwater intrusion). Based on information in the
8 GEIS, the Commission found that:

9
10 Nuclear power plants do not contribute significantly to saltwater intrusion.

11
12 The staff has not identified any new and significant information during its independent
13 review of the PNPS ER, the site visit, the scoping process, or its evaluation of other
14 available information. Therefore, the staff concludes that there would be no groundwater
15 quality degradation impacts associated with saltwater intrusion during the renewal term
16 beyond those discussed in the GEIS.

17
18 There are no Category 2 issues related to groundwater use and quality for PNPS.
19

20 4.6 Threatened or Endangered Species

21
22 Threatened or endangered species are listed as a Category 2 issue in 10 CFR Part 51,
23 Subpart A, Appendix B, Table B-1. This issue is listed in Table 4-12.

24
25 **Table 4-12.** Category 2 Issue Applicable to Threatened or Endangered Species During the
26 Renewal term

27

28 ISSUE—10 CFR Part 51, Subpart A, 29 Appendix B, Table B-1	GEIS Section	10 CFR 51.53(c)(3)(ii) Subparagraph	SEIS Section
30 THREATENED OR ENDANGERED SPECIES (FOR ALL PLANTS)			
31 Threatened or endangered species	4.1	E	4.6

32

33 This issue requires consultation with appropriate agencies to determine whether threatened or
34 endangered species are present and whether they would be adversely affected by continued
35 operation of the nuclear facility during the license renewal term. The presence of threatened or
36 endangered species in the vicinity of the PNPS site is discussed in Sections 2.2.5 and 2.2.6.
37 On April 25, 2006, the staff contacted the FWS and NMFS to request information on threatened
38 and endangered species and the impacts of license renewal (NRC 2006c). In response, on
39 May 23, 2006, the FWS provided additional information regarding Federally listed species that

1 have been observed or may occur in the vicinity of PNPS and its associated transmission line
2 ROW, as well as the concerns that the FWS have regarding those species (FWS 2006). The
3 FWS stated in this letter that formal consultation is not required. NMFS responded on June 28,
4 2006, with a listing of marine species that were potentially affected by PNPS operations (NMFS
5 2006). The staff has prepared a biological assessment (BA) that documents its review, and the
6 BA has been transmitted to NMFS for their concurrence. The BA is provided in Appendix E of
7 this draft SEIS.

8 9 **4.6.1 Marine Aquatic Species**

10
11 As described in Section 2.2.5.3.6, there are ten Federally listed endangered or threatened
12 marine aquatic species with some potential to occur in the vicinity of the PNPS. Four species of
13 sea turtle Federally listed as endangered or threatened may occur in Cape Cod Bay. The
14 loggerhead (*Caretta caretta*), Kemp's ridley (*Lepidochelys kemp*), leatherback (*Dermochelys*
15 *coriacea*), and green (*Chelonia mydas*) turtles have all been observed within Cape Cod Bay, but
16 none has been documented at the PNPS site. Throughout the operation of the plant, there
17 have been no incidents of turtles being impinged on the screens, nor have any ever been
18 removed from the intake embayment (Entergy 2006a).

19
20 Three Federally endangered great whale species are found seasonally in New England waters
21 and have been documented in Cape Cod Bay: North Atlantic right whale (*Eubalaena glacialis*),
22 humpback whale (*Megaptera novaeangliae*), and fin whale (*Balaenoptera physalus*). In addition,
23 two other species, sei whale (*B. borealis*) and sperm whale (*Physter macrocephalus*), are
24 known to migrate in New England waters off of the coast of Massachusetts. Cape Cod Bay is
25 designated as a critical habitat for the North Atlantic right whale. Although these species are
26 documented in Cape Cod Bay and/or coastal Massachusetts waters, no whales have been
27 observed in the shallow waters off PNPS, or in the intake and discharge areas, by applicant
28 biologists since biological monitoring began at PNPS in the late 1960s (Entergy 2006a).

29
30 The range of the endangered shortnose sturgeon (*Acipenser brevirostrum*) includes the PNPS
31 area; however, there are no known occurrences of the shortnose sturgeon in Plymouth or the
32 surrounding area (NHESP 2006). Shortnose sturgeon have never been observed in Cape Cod
33 Bay near PNPS, or in the facility intake and discharge canal areas during the duration of the
34 ecological monitoring studies since the plant first came on line (Entergy 2006).

35
36 The staff concludes that continued operation of PNPS during the license renewal term is not
37 likely to adversely affect any Federally listed marine aquatic species. Thus, the staff concludes
38 that the impact on threatened or endangered marine aquatic species from an additional 20
39 years of operation would be SMALL, and no additional mitigation is warranted. The staff's

Environmental Impacts of Operation

1 findings were documented in the BA (Appendix E) that has been forwarded to the NMFS for
2 concurrence.

4 4.6.2 Terrestrial and Freshwater Aquatic Species

5
6 No Federal or State-listed threatened or endangered terrestrial species have been observed on
7 the PNPS site or the transmission line ROW. Five species with a Federal listing status of
8 endangered or threatened have been identified in the Town of Plymouth. The FWS (2006)
9 identified four Federally listed species as potentially occurring in the PNPS vicinity or the
10 transmission line ROW: the piping plover (*Charadrius melodus*), roseate tern (*Sterna dougallii*),
11 bald eagle (*Haliaeetus leucocephalus*), and population 1 of the northern red-bellied cooter
12 (*Pseudemys rubriventris*). The fifth Federally listed species, the dwarf wedgemussel
13 (*Alasmidonta heterodon*), does not have habitat or the potential to occur in these area.

14
15 Although these three Federally listed birds occur in the vicinity of the facility, they are not
16 dependent on habitats within the facility and are unlikely to be affected by facility operations.
17 The piping plover is known to occur along Plymouth Beach just north of the PNPS (FWS 2006)
18 and may move through the PNPS site while foraging along the shoreline and during migration
19 (NHESP 1990). The piping plover has made a dramatic recovery in Massachusetts during the
20 period that PNPS has been operating. The Massachusetts population increased from 139
21 breeding pairs in 1986 to over 500 breeding pairs in 1999, and now represents one-third of the
22 entire Atlantic coast population (NHESP 1990). The roseate tern also is known to occur along
23 Plymouth Beach just north of PNPS (FWS 2006), and it may pass over the PNPS site during
24 migration (NHESP 1988). The roseate tern population in Massachusetts has been slowly
25 increasing, from 1600 breeding pairs in 1978 to 1810 breeding pairs in 1999 (NHESP 2005a).
26 Wintering bald eagles occasionally occur in the area of the PNPS (FWS 2006), and in 2005,
27 juveniles and adults were observed at Plimoth Plantation, approximately 2 mi northwest of
28 PNPS (Entergy 2006a). The bald eagle breeding population in Massachusetts has been
29 recovering slowly, and in 2002 there were 12 breeding pairs producing approximately 15 chicks
30 annually (NHESP 2005). Thus, there is no evidence that these species have been adversely
31 affected by previous operation of the PNPS facility. Given that no expansion of existing facilities
32 or disturbance of additional land is anticipated, these species are unlikely to be adversely
33 affected during the renewal period (FWS 2006).

34
35 The northern red-bellied cooter is the only Federally listed species for which an area in the
36 vicinity of PNPS and the transmission line ROW has been designated by FWS as critical
37 habitat. Approximately 1400 ft of the transmission line ROW, near its southern end and
38 adjacent to the boundary of Myles Standish State Forest, crosses the southeastern tip of an
39 area containing numerous ponds that was designated as critical habitat (at 50 CFR 17.95) for
40 the northern red-bellied cooter (FWS 1980) (Figure 2-6). The specific habitats used by the

1 northern red-bellied cooter, which consist of ponds with abundant vegetation and areas of
2 sandy soil on nearby land for nesting (NHESP 1995b), do not occur within the transmission line
3 ROW. The FWS concurred that the area of critical habitat crossed by the transmission line
4 ROW does not provide the specific habitat needs of the northern red-bellied cooter (FWS 2006).
5 The FWS noted that this area of the habitat was considered critical based on its value as a
6 buffer against activities that may degrade water quality and quantity within ponds occupied by
7 the turtle, and that the turtle potentially could traverse the ROW. The closest pond where the
8 red-bellied cooter has been observed historically, Crooked Pond (50 CFR 17.95), is separated
9 from the transmission line ROW by approximately 1500 ft of forested land. The second closest
10 pond where the turtle has been observed, Island Pond (50 CFR 17.95), is separated from the
11 ROW by approximately 1800 ft of forested land, residences, and roadway (Long Pond Road)
12 (FWS 1980).
13

14 In addition to the Vegetation Management Plan, NSTAR follows a program, developed in
15 coordination with and approved by the NHESP, to protect the northern red-bellied cooter and
16 other turtles that may be present in the transmission line ROW during maintenance activities
17 (NSTAR 2006). The northern red-bellied cooter has never been observed by NSTAR, Entergy,
18 or Boston Edison biologists in this transmission line ROW, and no other Federally or State-listed
19 endangered or threatened species is known or believed to occur in this transmission line ROW.
20 Given that no expansion of existing facilities or disturbance of additional land associated with
21 the transmission line ROW is anticipated, this species is unlikely to be adversely affected during
22 the renewal period (FWS 2006).
23

24 Approximately 22 other rare species listed by the Commonwealth of Massachusetts may have
25 the potential to occur on the PNPS site or transmission line ROW based on the possible
26 presence of suitable habitat. However, because no expansion of existing facilities or
27 disturbance of additional land associated with the transmission line ROW is anticipated, if these
28 species were to occur in this area, it is unlikely that they would be adversely affected during the
29 renewal period.
30

31 The staff reviewed information from the site audit, Entergy's ER, other reports, and information
32 from the FWS and NHESP. The staff concludes that the impacts on Federally or State-listed
33 terrestrial endangered, threatened, proposed, or candidate species of an additional 20 years of
34 operation and maintenance of PNPS and associated transmission lines and ROW would be
35 SMALL, and no additional mitigation is warranted. Because formal consultation is not required
36 by the FWS, a BA was not developed to evaluate the potential impacts of continued operation of
37 PNPS on Federally listed terrestrial and freshwater aquatic species.
38
39
40

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

The NRC staff reviewed the discussion of environmental impacts in the GEIS and conducted its own independent review (including comments received during the scoping period) to identify new and significant information on environmental issues listed in 10 CFR Part 51, Subpart A, Appendix B, Table B-1, related to PNPS during the renewal term. Processes for identification and evaluation of new and significant information are described in Section 1.2.2. Issues that were raised during scoping or through the staff's independent review of other available information are examined here to determine whether they represent new and significant information.

As discussed in Section 4.3, radiation exposure issues for the license renewal term are Category 1 issues. During the scoping process, members of the public (1) expressed concern about the possible impacts on human health (e.g., cancer) from exposure to radiation from Pilgrim's effluents and (2) cited a number of documents to support their concerns. The NRC reviewed these documents for potential new and significant information regarding the Category 1 radiation exposure issues.

With regard to (1), cancer is not rare; in fact, cancer is very common in the U.S. population. According to the American Cancer Society, more than a half million Americans die from cancer each year, an average of more than 1500 people a day (ACS 2005). There are many possible causes and risk factors for cancer, including radiation exposure.

Although radiation may cause cancers at high doses and high dose rates, currently there are no data that unequivocally establish the occurrence of cancer following exposure to doses below 10,000 millirem (mrem), received at low dose rates. However, radiation protection experts conservatively assume that any amount of radiation may pose some risk of causing cancer or a severe hereditary effect, and that the risk is higher for higher radiation exposures. Therefore, a linear, no-threshold dose-response model is used to describe the relationship between radiation dose and risks such as cancer induction. Simply stated, any increase in dose, no matter how small, results in an incremental increase in health risks. This theory is accepted by the NRC as a conservative model for estimating health risks from radiation exposure, recognizing that the model probably overestimates those risks. According to the health risk estimates in International Commission on Radiological Protection Publication 60 (ICRP 1990), the risk of radiation exposure causing cancer is very low at doses below 10 mrem per year (mrem/yr).

1 Thousands of studies have been performed on the biological effects of radiation exposure.
2 None of the scientifically valid studies show health effects at acute doses less than 10,000
3 mrem. Based on a consensus of the conclusions of national and international experts such as
4 the National Council on Radiation Protection and Measurements and the International
5 Commission on Radiological Protection (ICRP), NRC and EPA have established conservative-
6 dose limits for the protection of human health. In 40 CFR Part 190, EPA set a limit of 25
7 mrem/yr to the whole body of a member of the public from the entire nuclear fuel cycle,
8 including nuclear power plants. NRC established dose design objectives in 10 CFR Part 50,
9 Appendix I, to implement the EPA standards for radiological effluents from nuclear power plants.

10
11 In spring 2006, the National Research Council of the National Academies published, "Health
12 Risks from Exposure to Low Levels of Ionizing Radiation, BEIR VII Phase 2" (NRCNA 2006). A
13 prepublication version of the report was made public in June 2005 (BEIR VII 2005). A number
14 of scoping comments suggested that this report includes new and significant information that
15 support the concern about the possible impacts on human health from exposure to radiation
16 from PNPS effluents.

17
18 The major conclusion of the BEIR VII report is that current scientific evidence is consistent with
19 the hypothesis that there is a linear, no threshold dose response relationship between exposure
20 to ionizing radiation and the development of cancer in humans. This conclusion is consistent
21 with the radiological protection model that the NRC uses to develop its regulations. Therefore,
22 the NRC's regulations continue to adequately protect public health and safety and the
23 environment. None of the findings in the BEIR VII report warrant changes to the NRC
24 regulations. The BEIR VII report does not say there is no safe level of exposure to radiation; it
25 does not address "safe versus not safe." It does continue to support the conclusion that there is
26 some amount of cancer risk associated with any amount of radiation exposure and that the risk
27 increases with exposure and exposure rate. It does conclude that the risk of cancer induction at
28 the dose levels in the NRC's and EPA's radiation standards is very small. Similar conclusions
29 have been made in all of the associated BEIR reports since 1972 (BEIR I, III, and V).

30
31 Since the BEIR VII findings are consistent with the prior BEIR studies, which were previously
32 reviewed and found consistent with the bases of the current NRC regulations, the NRC staff
33 concludes that the BEIR VII Phase 2 report does not constitute new and significant information.

34
35 With regard to the potential human health effect of PNPS effluents, as discussed in Sections
36 2.1.4 and 2.2.7 of this SEIS, Entergy monitors the amounts of radionuclides released in the
37 effluents from Pilgrim to ensure compliance with these NRC regulations. Entergy also conducts
38 an environmental radiological monitoring program to confirm the expected levels of radioactive
39 materials in the area around PNPS. Based on recent effluent release reports (Entergy 2002,
40 2003, 2004, 2005a, 2006c) the NRC staff expects the releases of radioactive material from

Environmental Impacts of Operation

1 Pilgrim to be well within regulations during the license renewal period and less than 10 mrem/yr
2 to the maximally exposed member of the public. In comparison, the same member of the public
3 receives an average dose of approximately 360 mrem/yr from natural background and medical
4 sources of radiation (NRC 2005). In other words, the additional dose to the maximally exposed
5 member of the public from PNPS operations is less than 3 percent of the average annual
6 background and medical dose to a member of the general public.

7
8 The NRC inspects Entergy's radiological effluent and environmental radiological monitoring
9 programs at PNPS. In addition, Massachusetts Department of Public Health (MDPH) conducts
10 environmental radiological monitoring around PNPS. As part of the Pilgrim site audit, the NRC
11 staff met with officials of the MDPH to discuss the results of the MDPH radiological
12 environmental monitoring program around Pilgrim. MDPH indicated that the results of the
13 MDPH monitoring program have been consistent with the results from Entergy's monitoring
14 program.^(a)

15
16 With regard to the possibility of a causal relationship between PNPS effluents and human
17 health, authors of various reports have stated or implied that there are cause-and-effect
18 relationships in the statistical associations between cancer rates and reactor operations. While
19 it is true that cancer rates vary among locations, it is very difficult to ascribe the cause of a
20 cluster of cancers to some local environmental exposure, such as radiation from a nuclear
21 power facility. Statistical association alone does not prove causation, and well-established
22 scientific methods must be used to determine that for two things that appear to be associated
23 over time, it can be concluded that one causes the other. For example, a person could say, "In
24 the winter I wear boots, and in the winter I get colds." While there is a strong statistical
25 association between wearing boots and getting colds, it would be inappropriate to say that
26 wearing boots causes colds.

27
28 The scientific community adheres to several principles of good science that must be employed
29 before a cause-and-effect claim can be made. These principles include: whether the study can
30 be replicated; whether it has considered all the data or was selective (e.g., in the population or
31 in the years studied); whether it evaluated all possible explanations for the observations;
32 whether the data was valid and reliable; and whether its conclusions were subjected to
33 independent peer review, evaluation, and confirmation.

(a) Personal communication between Richard L. Emch, Jr., Senior Project Manager, Office of Nuclear Reactor Regulation, NRC; Charles R. Flynn, Senior Health Physicist, Earth Tech USA, (NRC Contractor); Susanne K. Condon, Director, Bureau of Environmental Health Assessment, Assistant Commissioner, MDPH; and Robert Walker, Director, Radiation Control Program, MDPH; May 3, 2006.

1 A number of studies that conformed to these principles have been performed to examine the
2 health effects around nuclear power facilities:

- 3
- 4 • National Cancer Institute – In 1990, at the request of Congress, the National Cancer
5 Institute conducted a study of cancer mortality rates around 52 nuclear power plants and 10
6 other nuclear facilities. The study covered the period from 1950 to 1984 and evaluated the
7 change in mortality rates before and during facility operations. The study concluded there
8 was no evidence that nuclear facilities may be linked causally with excess deaths from
9 leukemia or from other cancers in populations living nearby (NCI 1990, in NRC 2006a).
 - 10
 - 11 • University of Pittsburgh – Investigators from the University of Pittsburgh found no link
12 between radiation released during the 1979 accident at the Three Mile Island nuclear station
13 and cancer deaths among nearby residents. For 20 years, their study followed over 32,000
14 people who lived within 8 kilometers (5 mi) of the facility at the time of the accident (UOP
15 2000, in NRC 2006a).
 - 16
 - 17 • Connecticut Academy of Sciences and Engineering – In January 2001, the Connecticut
18 Academy of Sciences and Engineering issued a report on a study around the Haddam Neck
19 Nuclear Power Plant in Connecticut and concluded that radiation emissions were so low as
20 to be negligible (CASE 2001, in NRC 2006a).
 - 21
 - 22 • American Cancer Society – In 2004, the American Cancer Society concluded that although
23 reports about cancer clusters in some communities have raised public concern, studies
24 show that clusters do not occur more often near nuclear plants than they do by chance
25 elsewhere in the population. Likewise, there is no evidence that links the isotope strontium-
26 90 with increases in breast cancer, prostate cancer, or childhood cancer rates. Radiation
27 emissions from nuclear power plants are closely controlled and involve negligible levels of
28 exposure for nearby communities (ACS 2001, in NRC 2006a).
 - 29
 - 30 • Florida Bureau of Environmental Epidemiology – In 2001, the Florida Bureau of
31 Environmental Epidemiology reviewed claims that there are striking increases in cancer
32 rates in southeastern Florida counties caused by increased radiation exposures from
33 nuclear power plants. However, using the same data to reconstruct the calculations on
34 which the claims were based, Florida officials were not able to identify unusually high rates
35 of cancers in these counties compared with the rest of the state of Florida and the nation
36 (FDOH 2001, in NRC 2006a).
 - 37
 - 38 • Illinois Public Health Department – In 2000, the Illinois Public Health Department compared
39 childhood cancer statistics for counties with nuclear power plants to similar counties without
40 nuclear plants and found no statistically significant difference (IPDH 2000, in NRC 2006a..

Environmental Impacts of Operation

1 In summary, there are no studies to date that are widely accepted by the scientific community
2 that show a correlation between radiation dose from nuclear power facilities and cancer to the
3 general public. The amount of radioactive material released from nuclear power facilities is well
4 measured, well monitored, and known to be very small. The doses of radiation that are
5 received by members of the public as a result of exposure to nuclear power facilities are so low
6 that resulting cancers have not been observed and would not be expected.

7
8 Issue (2) in the scoping comments included citations that supposedly support the potential for
9 impacts on human health from exposure to radiation from PNPS effluents. In these scoping
10 comments, a number of commenters expressed concern that operation of PNPS results in
11 excess cancers in the population around the plant site. Commenters cited the following
12 documents in support of these concerns:

- 13
14 • National Research Council of the National Academies, 2006, Health Risks from Exposure to
15 Low Levels of Ionizing Radiation, BEIR VII, Phase 2, Committee to Assess Health Effects
16 from Exposure to Low Levels of Ionizing Radiation, National Academies Press, Washington,
17 D.C., 406p.
- 18
19 • Morris, M.S., and R.S. Knorr, Southeastern Massachusetts Health Study. Final Report.
20 Boston, MA: Bureau of Environmental Health Assessment, Massachusetts Department of
21 Public Health; 1990.
- 22
23 • Knorr, R.S., and M.S. Morris, 1996, *The Southeastern Massachusetts Health Study*
24 (published in the *Archives of Environmental Health*, Vol. 51, p.266, July-August 1996)
- 25
26 • Clapp, R.W., Cobb, S., Chan, C.K., and B. Walker, 1987, Leukemia near Massachusetts
27 nuclear power plant, *Lancet* (Dec 5): 1324-1325.
- 28
29 • Clapp, R.W., 1992, Statement before the Southeastern Massachusetts Health Study Review
30 Committee.
- 31
32 • Clapp, R.W., 2006, Analysis of 1974-1989 Massachusetts Cancer Registry for Leukemia
33 and Thyroid Cancer, personal communication with Pilgrim Watch.
- 34
35 • Clapp, R.W., 2006, Analysis of 1998-2002 Massachusetts Cancer Registry for Leukemia
36 and Thyroid Cancer, personal communication with Pilgrim Watch.
- 37 • Land, W.T., unknown date, Meteorological Analysis of Radiation Releases for the Coastal
38 Areas of the State of Massachusetts for June 3rd to June 20th 1982.

- 1 • England, R.W., and E. Mitchell, 1987, Estimates of Environmental Accumulations of
2 Radioactivity Resulting from Routine Operation of New England Nuclear Power Plants
3 (1973-1984), A Report of the Nuclear Emission Research project, Whittemore School of
4 Business and Economics, University of New Hampshire, Durham, New Hampshire.
5

6 Of these (2) citations, the majority of the scoping comments referred to the Southeastern
7 Massachusetts Health Study (SMHS). The SMHS was conducted by investigators from the
8 MDPH to determine if communities near PNPS in Plymouth, Massachusetts, had elevated
9 leukemia incidence rates associated with radioactive plant discharges (Hoffman et al. 1992).
10 The authors of the SMHS have stated that the study shows both a statistical association and a
11 cause-and-effect relationship between leukemia incidence around PNPS and exposure to
12 radiological effluents from the plants. The final report, released to the public in October 1990,
13 found a two to four fold increase in the risk of leukemia among residents of certain towns within
14 a 20-mi radius from the plant (MPDH 1990).
15

16 Although the authors of the SMHS have stated that there is a statistical association between
17 leukemia incidence around PNPS and exposure to radiological effluents from the plant, peer
18 reviews of the SMHS have shown that the study did not present the necessary information to
19 meet the criteria discussed above to support a cause-and-effect relationship. In fact, 6 years
20 after issuing the SMHS report, the authors stated that several factors do not support a causal
21 interpretation of the study results (Knorr and Morris, 1996).
22

23 The peer reviews (Sever 1993; Hoffman 1992; NRC NUREG/BR-0125 1992) focused on
24 several issues that do not support a causal relationship. The first issue is temporality. There is
25 a latency period of several years between radiation exposure and leukemia incidence, and the
26 short duration of the increased incidence of leukemia reported in the study is inconsistent with
27 the increase being radiation induced. The elevated incidence disappeared just when it would
28 have been approaching a maximum if it had been caused by radiation exposure from PNPS.
29 Second, the results of the study are inconsistent with the results of the large body of evidence
30 from studies conducted before and after the SMHS that are widely accepted within the scientific
31 community. Some of those studies, including the BEIR VII report are discussed above; none of
32 them showed an increase in leukemia incidence from low radiation doses or proximity to nuclear
33 power plants. Third, the level of radioactive material released from PNPS and the resulting
34 estimated doses met NRC's rules and are well within NRC's radiation standards. The SMHS
35 did not actually estimate doses based on plant effluent reports, but inferred that the doses to
36 members of the public were much higher near the plant than at distances in the range of 20 mi.
37 This inference is not correct; there is almost no difference (i.e., the last 5 years of effluent
38 release reports show that the dose to the maximally exposed person from PNPS operations is
39 less than 3 percent of the average dose to the general public 20 mi away) (Entergy 2002, 2003,
40 2004, 2005a, 2006c; NRC 2005a). Finally, the SMHS concluded that two-thirds of the leukemia

Environmental Impacts of Operation

1 cases near the plants were caused by radiation. If this conclusion were true, the combined total
2 of the radiation induced leukemia cases and the normally expected number of non-radiation
3 induced leukemia cases would have been much higher than observed.

4
5 In summary of (2), with regard to the SMHS, NRC has considered the relevant information in
6 these citations and concludes that the peer reviews and even the authors now agree that the
7 SMHS does not demonstrate a causal relationship between the PNPS effluents and the
8 potential effect of excess cancers in the areas around the site. With regard to the balance of
9 these citations, NRC finds that they also fail to overturn the large body of evidence from widely
10 accepted studies within the scientific community that find that the potential for this causality is
11 not scientifically plausible.

12
13 In the GEIS, radiation exposure to the public during the license renewal term was considered a
14 Category 1 issue (see Chapter 1 and Section 4.3 for a discussion of Category 1 issues and
15 radiological impacts from normal operations). The GEIS concluded that the risk to the public
16 from continued operation of a nuclear plant would not increase during the license renewal term.
17 Doses to members of the public from PNPS emissions were specifically evaluated in Appendix
18 E of the GEIS and were found to be well within the regulatory limits.

19
20 In summary, NRC's dose limits are conservative and supported by the EPA and international
21 agencies such as; ICRP, United Nations Scientific Committee on the Effects of Atomic
22 Radiation, and the European Commission on Radiation Protection. Review and evaluation of
23 new studies and analyses of the health effects of radiation exposure is an ongoing process at
24 the NRC. The scientifically defensible epidemiological studies on the biological effects of
25 ionizing radiation provide solid evidence that the current regulatory standards are protective of
26 human health. Entergy has demonstrated that releases from PNPS during the renewal period
27 are expected to be below regulatory limits (Entergy 2002, 2003, 2004, 2005a, 2006c).

28
29 The NRC staff has reviewed the information within the documents referenced by the
30 commenters and finds that the information fails to demonstrate that the GEIS (as codified in 10
31 CFR Part 51, Subpart A, Appendix B, Table B-1) regarding the human health impact of radiation
32 exposure resulting from the operation of PNPS is incorrect.

33
34 The staff concludes that the information provided during the scoping process was not new and
35 significant with respect to the findings of the GEIS.

36 37 **4.8 Cumulative Impacts**

38
39 The staff considered the potential for cumulative impacts of operations of PNPS during the
40 renewal term. For the purposes of this analysis, past actions are those related to the resources

1 at and since the time of the plant licensing and construction, present actions are those related to
2 the resources at the time of current operation of the power plant, and future actions are
3 considered to be those that are reasonably foreseeable through the end of plant operation.
4 Therefore, the analysis considers potential impacts through the end of the current license term
5 as well as the 20-year renewal license term. The geographical area over which past, present,
6 and future actions would occur is dependent on the resource evaluated and is described below
7 for each resource.

8
9 The impacts of the proposed action, as described in Chapter 4, are combined with other past,
10 present, and reasonably foreseeable future actions at PNPS regardless of what agency
11 (Federal or non-Federal) or person undertakes such other actions. These combined impacts
12 are defined as “cumulative” in 40 CFR 1508.7 and include individually minor but collectively
13 significant actions taking place over a period of time (CEQ 1997). It is possible that an impact
14 that may be SMALL by itself could result in a MODERATE or LARGE impact when considered
15 in combination with the impacts of other actions on the affected resource. Likewise, if a
16 resource is regionally declining or imperiled, even a SMALL individual impact could be important
17 if it contributes to or accelerates the overall resource decline.

18 19 **4.8.1 Cumulative Impacts on Marine Aquatic Resources**

20
21 For the purposes of this analysis, the geographic area considered for impingement impacts on
22 marine aquatic resources is the Plymouth/Kingston/Duxbury areas and western Cape Cod Bay.
23 As discussed in Section 4.1, the staff found no new and significant information that would
24 indicate that the conclusions regarding any of the marine aquatic resources in the vicinity of
25 PNPS are inconsistent with the conclusions in the GEIS (NRC 1996a). The staff has
26 determined that entrainment would likely have a MODERATE cumulative impact on the local
27 winter flounder population and that impingement would likely have a MODERATE cumulative
28 impact on the Jones River population of rainbow smelt. Entrainment and impingement would
29 likely have SMALL to MODERATE cumulative impacts on other marine aquatic species. The
30 staff found the cumulative impacts on all marine aquatic species due to the PNPS cooling water
31 discharge would be SMALL.

32
33 There is a variety of natural and anthropogenic factors that may influence biota in the area
34 surrounding PNPS, including fishing mortality, entrainment and impingement from PNPS and
35 other water intakes, heat shock from PNPS and other thermal dischargers, environmental
36 changes associated with regional increases in water temperature, habitat modification and loss,
37 and predator-prey interactions. In addition, changes to water and sediment quality from runoff,
38 urbanization, and industrial activities may and act as stressors on the biological environment.
39 To evaluate the impacts of these other stressors on biological communities in the area and in
40 turn, be able to elucidate the cumulative impacts of PNPS’s cooling system on the aquatic

Environmental Impacts of Operation

1 resources of Cape Cod Bay, the staff consulted with State and Federal resource agencies,
2 reviewed the applicants ER and other environmental reports, and conducted an independent
3 search for other potential stressors in Cape Cod Bay.

4
5 Other activities that may affect marine aquatic resources in Cape Cod Bay include periodic
6 maintenance dredging, continued urbanization and development, and construction of new over-
7 water or near-water structures, such as docks, and shoreline stabilization measures, such as
8 sheet pile walls, rip-rap, or other hard structures. For instance, it is likely that the harbors and
9 channels in the Plymouth/Kingston/Duxbury areas would require some dredging. However,
10 based on discussions with plant personnel, there are no plans for dredging of the intake
11 embayment or discharge canal at PNPS.

12
13 Cumulative impacts on the aquatic food web potentially could include reductions in the
14 abundance of important phytoplankton and zooplankton species in the vicinity due to their
15 entrainment in the cooling systems or from exposure to the heated discharges. This could
16 potentially lead to effects on other species in the food web. However, based upon the review
17 conducted by the NRC staff, there is no evidence that the operation of the PNPS cooling system
18 has had an impact on phytoplankton or zooplankton communities, or any resultant effects on
19 the aquatic food web, in Cape Cod Bay.

20
21 Impacts to fish and other macrobiota may include entrainment of small life stages, impingement
22 of juvenile or adult forms, toxicity due to exposure to chemicals associated with the cooling
23 water discharge, or physiological or behavioral changes associated with exposure to the
24 discharge thermal plume. As discussed in Section 4.1, PNPS has a large degree of
25 ichthyoplankton entrainment and impingement (based on absolute numbers); however, this
26 impact was determined to be of moderate significance only for local populations of the winter
27 flounder. Because entrainment would have a MODERATE impact on the local winter flounder
28 population, cumulative impacts to the local winter flounder population would also be
29 MODERATE. Regarding rainbow smelt, due to high impingement rates, very low impingement
30 survivability, and declining population trends based on best available data for the Jones River
31 population, NRC staff concluded that cumulative impacts on the Jones River population of
32 rainbow smelt would be MODERATE.

33
34 Other large-volume water intakes in Cape Cod Bay may also have a potentially significant
35 impact on aquatic resources. There are no other large-volume water intakes in the immediate
36 vicinity of PNPS; however, the Mirant Canal Station on Cape Cod Canal is another generating
37 facility that extracts and discharges cooling water. Other sources of potentially significant
38 impacts to aquatic resources include fishing pressure (both commercial and recreational) and
39 indirect impacts via loss of habitat (e.g., as a result of dredging, siltation, etc.).
40

1 Cumulative impacts may also be associated with fishing pressure. Cape Cod Bay and the Gulf
2 of Maine support significant commercial and recreational fisheries for many of the fish and
3 invertebrate species potentially affected by PNPS. Commercial and recreational fishing
4 pressure may contribute to reduced stock sizes in Cape Cod Bay. Impingement and
5 entrainment impacts from PNPS may also contribute to reduced stock sizes, in turn lowering the
6 catch per unit effort for both commercial and recreational fishing. However, with the exception
7 of winter flounder and rainbow smelt, most of the fish stocks potentially impacted by PNPS are
8 considered to be healthy or the levels of take by PNPS are very minimal.

9
10 Potential future environmental impacts include the loss of sensitive habitats, including coastal
11 marshes and submerged aquatic vegetation; continued non-point source impacts on the bay
12 from stormwater runoff and contaminated groundwater; and fishing mortality.

13
14 As described in Chapter 2, operation of the PNPS cooling system has not had a detectable
15 effect on water quality in Cape Cod Bay, and the staff determined that the impacts of continued
16 operation of the cooling water system on water quality would be classified as SMALL. Given the
17 large assimilative capacity of Cape Cod Bay and the fact that PNPS withdraws a relatively small
18 percentage of the net volumetric flow of water - generally less than 0.1 percent (ENSR and MRI
19 2005), the cumulative impact of continued operation of the PNPS cooling system on water
20 quality is SMALL. It is also expected that operation of the PNPS cooling system would not
21 appreciably contribute to the cumulative impacts on the surface water supply.

22
23 Potential or proposed projects in the area that may impact aquatic habitat include: dredging for
24 the Plymouth Harbor Federal Navigation Project by the U.S. Army Corps of Engineers; the filling
25 of 26 ac within Plymouth Bay by the Town of Plymouth; the construction of a pile-supported,
26 fixed pier and floating docks in the Federal anchorage in Plymouth Harbor; dredging to
27 reestablish the entrance to Ellisville Harbor in Plymouth; and the ability to retain and maintain
28 the Cordage Park Marina in Plymouth Bay (USACE 2006).

29
30 There is a potential for MODERATE cumulative impacts on local populations of winter flounder
31 and rainbow smelt, but the cumulative impacts of continued operation of PNPS on other marine
32 aquatic resources is expected to be SMALL to MODERATE.

33 34 **4.8.2 Cumulative Impacts on Terrestrial and Freshwater Resources**

35
36 This section analyzes past, present, and future actions that could result in adverse cumulative
37 impacts to terrestrial resources such as wildlife populations, the size and distribution of habitat
38 areas, and aquatic resources such as streams, wetlands and floodplains. For purposes of this
39 cumulative effects analysis, the geographic area considered in the evaluation includes the Town
40 of Plymouth, which contains the PNPS site and its associated transmission line ROW.

Environmental Impacts of Operation

1 The transmission line ROW does not cross any State or Federal parks, wildlife refuges, or
2 wildlife management areas (Entergy 2006a), nor does it cross any major lakes, ponds, or
3 streams but does cross one small stream. NSTAR, the owner of the transmission lines, follows
4 ROW management procedures that were found to be protective of sensitive ecological
5 resources, including wildlife habitat, wetlands, and floodplains. The maintenance procedures
6 minimize disturbance of wildlife and wetlands and prevent potential offsite effects, such as
7 erosion, on surrounding areas with other land uses.

8
9 Maintenance and operation of the transmission system are not expected to destabilize or
10 noticeably alter the existing terrestrial or freshwater aquatic environment. Likewise, operation of
11 PNPS is not likely to have a detectable effect on terrestrial or freshwater aquatic species
12 located in the vicinity of the PNPS site or the transmission line ROW. No other Federal or non
13 Federal activities have been identified that would have an adverse effect on terrestrial and
14 freshwater aquatic species in the area. The staff concludes that the incremental contribution to
15 cumulative impacts on terrestrial and freshwater aquatic resources resulting from continued
16 operation of PNPS and its associated transmission line ROW would be SMALL, and that no
17 additional mitigation would be warranted.

18 **4.8.3 Cumulative Human Health Impacts**

19
20
21 The EPA and NRC have developed radiological dose limits for protection of the public and
22 workers to address the cumulative impact of acute and long-term exposure to radiation and
23 radioactive material. These dose limits are codified in 40 CFR Part 190 and 10 CFR Part 20.
24 For the purpose of this analysis, the area within a 50-mi radius of the PNPS site was included.
25 As stated in Section 2.2.7, a radiological environmental monitoring program (REMP) has been
26 conducted around the PNPS site since 1968 with the results presented annually in the PNPS
27 REMP Report (Entergy 2002, 2003, 2004, 2005a, 2006c). Although no other nuclear fuel cycle
28 operations are located within the subject area, the REMP measures radiation and radioactive
29 materials from all sources, including natural background. Monitoring results for the 5-year period
30 from 2001 through 2005 were reviewed as part of the cumulative impacts assessment.
31 Additionally, in Sections 2.2.7 and 4.3, the staff concluded that impacts of radiation exposure to
32 the public and workers (occupational) from operation of PNPS during the renewal term would be
33 SMALL. Therefore, the monitoring program and staff's conclusion considered cumulative
34 impacts. The NRC and the Commonwealth of Massachusetts would regulate any future
35 actions in the vicinity of the PNPS site that could contribute to cumulative radiological impacts.

36
37 The staff determined that the electric field induced currents from the PNPS transmission lines
38 are well below the National Electrical Safety Code (NESC) recommendations for preventing
39 electric shock from induced currents. Therefore, the PNPS transmission lines do not detectably
40 affect the overall potential for electric shock from induced currents within the analysis area.

1 With respect to chronic effects of electromagnetic fields, although the NRC staff considers the
2 GEIS finding of “not applicable” to be appropriate in regard to PNPS, the PNPS transmission
3 lines are not likely to detectably contribute to regional exposure to extremely low frequency
4 electromagnetic fields (ELF-EMFs). The PNPS transmission lines pass through a sparsely
5 populated, rural area with very few residences or businesses close enough to the lines to have
6 detectable ELF-EMFs.

7
8 Therefore, the staff concludes that cumulative radiological impacts of continued operations of
9 PNPS would be SMALL, and that no further mitigation measures are warranted.

10 11 **4.8.4 Cumulative Socioeconomic Impacts**

12
13 The continued operation of PNPS is not likely to result in significant cumulative impacts for any
14 of the socioeconomic impact measures assessed in Section 4.4 of this SEIS (public services,
15 housing, and offsite land use). This is because operating expenditures, staffing levels, and local
16 tax payments during renewal would be similar to those during the current license period.
17 Similarly, the proposed action is not likely to result in significant cumulative impacts on historic
18 and archaeological resources.

19
20 When combined with the impact of other potential activities likely to occur in the area
21 surrounding the plant, socioeconomic impacts resulting from PNPS license renewal would not
22 produce an incremental change in any of the impact measures used. The staff therefore
23 determined that the impacts on employment, personal income, housing, local public services,
24 utilities, and education occurring in the local socioeconomic environment as a result of license
25 renewal activities, in addition to the impacts of other potential economic activity in the area,
26 would be SMALL. The staff determined that the impact on offsite land use would be SMALL
27 because no refurbishment activities are planned at PNPS, and no new incremental changes to
28 plant-related tax payments are expected that could influence land use by fostering considerable
29 growth. The impacts of license renewal on transportation and environmental justice would also
30 be SMALL. There are no reasonably foreseeable scenarios that would alter these conclusions
31 in regard to cumulative impacts.

32
33 There are no archeological or historic above ground resources eligible for listing on the National
34 Register of Historic Places identified on the PNPS site. The staff has concluded that the
35 impacts of license renewal on historic and archaeological resources would be SMALL. The
36 continued operation and maintenance of the PNPS site and the transmission line corridor would
37 not be expected to impact any properties beyond the site or transmission corridor boundaries.
38 Therefore, the contribution to a cumulative impact on historic and archaeological resources
39 would be negligible.

Environmental Impacts of Operation

1 Based on this analysis, the staff concludes that the cumulative impact to socioeconomic
2 resources resulting from continued operation of PNPS during the license renewal period would
3 be SMALL, and no additional mitigation measures are warranted.
4

5 **4.8.5 Cumulative Impacts on Groundwater Use and Quality**

6
7 PNPS groundwater use is less than 100 gpm. The Town of Plymouth public water supply
8 system, which provides water to PNPS for its potable and reactor make-up water needs, obtains
9 its water from local groundwater. There are no operable groundwater production wells at
10 PNPS. The applicant is not proposing an increase in demand of groundwater well usage during
11 the renewal period. As demand for water supplies increases in the vicinity of PNPS, additional
12 withdrawals of groundwater may be involved to satisfy the water needs of other water users in
13 the region. However, Entergy does not anticipate a need for additional workers during the
14 license renewal period. Renewal of the PNPS OL would not increase the population of the
15 two-county area where most of the existing PNPS employees currently live and, therefore,
16 would not increase the demand for groundwater.
17

18 On the basis of this analysis, the staff concludes that the cumulative impact to groundwater
19 resources during the license renewal period would be SMALL and no additional mitigation
20 measures are warranted.
21

22 **4.8.6 Cumulative Impacts on Threatened and Endangered Species**

23
24 The geographic area considered in the analysis of potential cumulative impacts to threatened or
25 endangered species includes the Town of Plymouth, which contains the PNPS site and its
26 associated transmission line ROW, and the waters of Cape Cod Bay in the vicinity of the PNPS
27 site. As discussed in Sections 2.2.5 and 2.2.6, a number of threatened or endangered species
28 could occur within this area, including both terrestrial and aquatic species. The staff's findings,
29 presented in the Biological Assessment (for marine aquatic species only [see Appendix E]) and
30 in Section 4.6, are that continued operation of PNPS and maintenance of its associated
31 transmission line ROW during the license renewal term would have no effect, or would not likely
32 adversely affect, any Federally listed species or any designated critical habitat. No other
33 Federal or non Federal activities have been identified that would have an adverse effect on any
34 Federally threatened or endangered species in the area. However, NMFS's Ship Strike
35 Reduction Strategy is designed to reduce vessel strikes of the endangered North Atlantic right
36 whale; implementation of the Strategy's measures would have positive effects on the North
37 Atlantic right whale in Cap Cod Bay. Therefore, the staff concludes that the contribution of
38 PNPS operations to cumulative impacts on Federally protected species or designated critical
39 habitat would be SMALL, and no additional mitigation is warranted.
40

1 **4.8.7 Conclusions Regarding Cumulative Impacts**

2
3 The NRC staff considered the potential impacts resulting from the operation of PNPS and
4 maintenance of the transmission line ROW since PNPS went on line through the end of the
5 license renewal term and resulting from other past, present, and future actions in the vicinity of
6 PNPS. The staff's determination is that the cumulative impacts resulting from the incremental
7 contribution of PNPS operation and maintenance of transmission line ROW would be SMALL for
8 all resources with the exception of marine aquatic species, which would experience SMALL to
9 MODERATE cumulative impacts.
10

11 **4.9 Summary of Impacts of Operations During the**
12 **Renewal Term**

13
14 Neither Entergy nor the NRC staff is aware of information that is both new and significant
15 related to any of the applicable Category 1 issues associated with the PNPS operation during
16 the renewal term. Consequently, the staff concludes that the environmental impacts associated
17 with these issues are bounded by the impacts described in the GEIS. For each of these issues,
18 the GEIS concluded that the impacts would be SMALL and that additional plant-specific
19 mitigation measures are not likely to be sufficiently beneficial to warrant implementation.
20 Plant-specific environmental evaluations were conducted for 11 Category 2 issues applicable to
21 PNPS operation during the renewal term and for environmental justice and chronic effects of
22 electromagnetic fields. For 8 issues and environmental justice, the staff concluded that the
23 potential environmental impact of renewal term operations of PNPS would be of SMALL
24 significance in the context of the standards set forth in the GEIS and that additional mitigation
25 would not be warranted. For impacts on the local winter flounder population due to entrainment,
26 the staff's conclusion is that the impacts would be MODERATE. Also, impacts on the Jones
27 River population of rainbow smelt due to impingement would be MODERATE. Impacts due to
28 entrainment and impingement on other marine aquatic resources would be SMALL to
29 MODERATE. Potential mitigation measures are discussed in Section 4.1.4. In addition, the
30 staff determined that a consensus has not been reached by appropriate Federal health
31 agencies regarding chronic adverse effects from electromagnetic fields. Therefore, the staff did
32 not conduct an evaluation of this issue.
33

34 Cumulative impacts of past, present, and reasonably foreseeable future actions were
35 considered, regardless of what agency (Federal or non-Federal) or person undertakes such
36 other actions. The staff concluded that cumulative impacts of PNPS license renewal would be
37 SMALL for all potentially affected resources, with the exceptions of the local winter flounder
38 population and rainbow smelt population, for which impacts would be MODERATE, and other
39 marine aquatic species, for which impacts would be SMALL to MODERATE.

4.10 References

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5.0 Environmental Impacts of Postulated Accidents

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

- (1) The environmental impacts associated with the issue have been determined to apply either to all plants or, for some issues, to plants having a specific type of cooling system or other specified plant or site characteristics.
- (2) A single significance level (i.e., SMALL, MODERATE, or LARGE) has been assigned to the impacts (except for collective off-site radiological impacts from the fuel cycle and from high-level waste and spent fuel disposal).
- (3) Mitigation of adverse impacts associated with the issue has been considered in the analysis, and it has been determined that additional plant-specific mitigation measures are likely not to be sufficiently beneficial to warrant implementation.

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

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

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

5.1 Postulated Plant Accidents

Two classes of accidents are evaluated in the GEIS. These are design-basis accidents and severe accidents, as discussed below.

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

1 **5.1.1 Design-Basis Accidents**
2

3 In order to receive U.S. Nuclear Regulatory Commission (NRC) approval to operate a nuclear
4 power facility, an applicant for an initial operating license (OL) must submit a Safety Analysis
5 Report (SAR) as part of its application. The SAR presents the design criteria and design
6 information for the proposed reactor and comprehensive data on the proposed site. The SAR
7 also discusses various hypothetical accident situations and the safety features that are provided
8 to prevent and mitigate accidents. The NRC staff reviews the application to determine whether
9 the plant design meets the Commission's regulations and requirements and includes, in part,
10 the nuclear plant design and its anticipated response to an accident.
11

12 Design-basis accidents (DBAs) are those accidents that both the licensee and the NRC staff
13 evaluate to ensure that the plant can withstand normal and abnormal transients, and a broad
14 spectrum of postulated accidents, without undue hazard to the health and safety of the public.
15 A number of these postulated accidents are not expected to occur during the life of the plant,
16 but are evaluated to establish the design basis for the preventive and mitigative safety systems
17 of the facility. The acceptance criteria for DBAs are described in Title 10 of the *Code of Federal*
18 *Regulations* Part 50 and Part 100 (10 CFR Part 50 and 10 CFR Part 100).
19

20 The environmental impacts of DBAs are evaluated during the initial licensing process, and the
21 ability of the plant to withstand these accidents is demonstrated to be acceptable before
22 issuance of the OL. The results of these evaluations are found in license documentation such
23 as the applicant's Final Safety Analysis Report (FSAR), the NRC staff's Safety Evaluation
24 Report (SER), the Final Environmental Statement (FES), and Section 5.1 of this Supplemental
25 Environmental Impact Statement (SEIS). A licensee is required to maintain the acceptable
26 design and performance criteria throughout the life of the plant, including any extended-life
27 operation. The consequences for these events are evaluated for the hypothetical maximally
28 exposed individual; as such, changes in the plant environment will not affect these evaluations.
29 Because of the requirements that continuous acceptability of the consequences and aging
30 management programs be in effect for license renewal, the environmental impacts as
31 calculated for DBAs should not differ significantly from initial licensing assessments over the life
32 of the plant, including the license renewal period. Accordingly, the design of the plant relative to
33 DBAs during the extended period is considered to remain acceptable, and the environmental
34 impacts of those accidents were not examined further in the GEIS.
35

36 The Commission has determined that the environmental impacts of DBAs are of SMALL
37 significance for all plants because the plants were designed to successfully withstand these
38 accidents. Therefore, for the purposes of license renewal, DBAs are designated as a
39 Category 1 issue in 10 CFR Part 51, Subpart A, Appendix B, Table B-1. The early resolution of
40 the DBAs makes them a part of the current licensing basis of the plant; the current licensing
41 basis of the plant is to be maintained by the licensee under its current license and, therefore,

1 under the provisions of 10 CFR 54.30, is not subject to review under license renewal. This
 2 issue, applicable to Pilgrim Nuclear Power Station (PNPS), is listed in Table 5-1.

3
 4 **Table 5-1.** Category 1 Issue Applicable to Postulated Accidents During the Renewal Term
 5

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

6
 7
 8
 9
 10 Based on information in the GEIS, the Commission found that:

11
 12 The NRC staff has concluded that the environmental impacts of design-basis
 13 accidents are of small significance for all plants.

14
 15 Entergy Nuclear Operations, Inc. (Entergy) stated in its Environmental Report (ER)
 16 (Entergy 2006a) that it is not aware of any new and significant information associated with the
 17 renewal of the PNPS OL. The NRC staff has not identified any new and significant information
 18 during its independent review of the PNPS ER, the site visit, the scoping process, or its
 19 evaluation of other available information. Therefore, the NRC staff concludes that there are no
 20 impacts related to DBAs beyond those discussed in the GEIS.

21
 22 **5.1.2 Severe Accidents**

23
 24 Severe nuclear accidents are those that are more severe than DBAs because they could result
 25 in substantial damage to the reactor core, regardless of offsite consequences. In the GEIS, the
 26 NRC staff assessed the impacts of severe accidents using the results of existing analyses and
 27 site-specific information to conservatively predict the environmental impacts of severe accidents
 28 for each plant during the renewal period.

29
 30 Severe accidents initiated by external phenomena, such as tornadoes, floods, earthquakes,
 31 fires, and sabotage, traditionally have not been discussed in quantitative terms in FES's and
 32 were not specifically considered for the PNPS site in the GEIS (NRC 1996). However, in the
 33 GEIS, the NRC staff did evaluate existing impact assessments performed by the NRC and by
 34 the industry at 44 nuclear plants in the United States and concluded that the risk from beyond-
 35 design-basis earthquakes at existing nuclear power plants is SMALL. Additionally, the NRC
 36 regulatory requirements under 10 CFR Part 73 provide reasonable assurance that the risk from
 37 sabotage is SMALL. Furthermore, the NRC staff concluded that the risks from other external
 38 events are adequately addressed by a generic consideration of internally initiated severe
 39 accidents.

Environmental Impacts of Postulated Accidents

1 Based on information in the GEIS, the Commission found that:

2
3 The probability weighted consequences of atmospheric releases, fallout onto
4 open bodies of water, releases to groundwater, and societal and economic
5 impacts from severe accidents are small for all plants. However, alternatives to
6 mitigate severe accidents must be considered for all plants that have not
7 considered such alternatives.
8

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

12
13 **Table 5-2.** Category 2 Issue Applicable to Postulated Accidents During the Renewal Term

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

19 The NRC staff has not identified any new and significant information with regard to the
20 consequences from severe accidents during its independent review of the PNPS ER (2006a),
21 the site visit, the scoping process, or its evaluation of other available information. Therefore,
22 the NRC staff concludes that there are no impacts of severe accidents beyond those discussed
23 in the GEIS. However, in accordance with 10 CFR 51.53(c)(3)(ii)(L), the NRC staff has
24 reviewed severe accident mitigation alternatives (SAMAs) for PNPS. The results of its review
25 are discussed in Section 5.2.
26
27

28 **5.2 Severe Accident Mitigation Alternatives**

29
30 Section 51.53(c)(3)(ii)(L) of 10 CFR requires that license renewal applicants consider
31 alternatives to mitigate severe accidents if the staff has not previously evaluated SAMAs for the
32 applicant's plant in an environmental impact statement (EIS) or related supplement or in an
33 environmental assessment. The purpose of this consideration is to ensure that plant changes
34 (i.e., hardware, procedures, and training) with the potential for improving severe accident safety
35 performance are identified and evaluated. SAMAs have not been previously considered for
36 PNPS; therefore, the remainder of Chapter 5 addresses those alternatives.

5.2.1 Introduction

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

The SAMA evaluation for PNPS was conducted with a four-step approach. In the first step Entergy quantified the level of risk associated with potential reactor accidents using the plant-specific probabilistic safety assessment (PSA) and other risk models. In the second step Entergy examined the major risk contributors and identified possible ways (i.e., SAMAs) of reducing that risk. Common ways of reducing risk are changes to components, systems, procedures, and training. Entergy initially identified 281 potential SAMAs for PNPS. Entergy screened out 222 SAMAs from further consideration because they are not applicable at PNPS due to design differences, have already been implemented at PNPS, or are addressed by a similar SAMA. The remaining 59 SAMAs were subjected to further evaluation.

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

Finally, in the fourth step, the costs and benefits of each of the remaining SAMAs were compared to determine whether the SAMA was cost-beneficial, meaning the benefits of the SAMA were greater than the cost (a positive cost-benefit). Entergy found five SAMAs to be potentially cost-beneficial (Entergy 2006a). However, in response to NRC staff inquiries regarding estimated benefits for certain SAMAs and lower cost alternatives, Entergy identified two additional potentially cost-beneficial SAMAs (Entergy 2006b and 2006c). The potentially cost-beneficial SAMAs do not relate to adequately managing the effects of aging during the period of extended operation; therefore, they need not be implemented as part of license renewal pursuant to 10 CFR Part 54. Entergy's SAMA analyses and the NRC's review are discussed in more detail below.

5.2.2 Estimate of Risk

Entergy submitted an assessment of SAMAs for PNPS as part of the ER (Entergy 2006a). This assessment was based on the most recent PNPS PSA available at that time, a plant-specific offsite consequence analysis performed using the MELCOR Accident Consequence Code System 2 (MACCS2) computer program, and insights from the PNPS Individual Plant Examination (IPE) (BEC 1992) and Individual Plant Examination of External Events (IPEEE) (BEC 1994).

Environmental Impacts of Postulated Accidents

The baseline core damage frequency (CDF) for the purpose of the SAMA evaluation is approximately 6.4×10^{-6} per year. This CDF is based on the risk assessment for internally-initiated events. Entergy did not include the contribution to risk from external events within the PNPS risk estimates; however, it did account for the potential risk reduction benefits associated with external events by increasing the estimated benefits for internal events by a factor of five. The breakdown of CDF by initiating event is provided in Table 5-3.

Table 5-3. PNPS Core Damage Frequency

Initiating Event	CDF (Per Year)	Percent Contribution to CDF
Loss of direct current (DC) power buses	3.1×10^{-6}	48
Loss of offsite power	1.3×10^{-6}	20
Loss of alternating current (AC) power buses	8.8×10^{-7}	14
Loss of salt service water	3.9×10^{-7}	6
Transients	3.6×10^{-7}	6
Loss of coolant accidents	1.8×10^{-7}	3
Station blackout	1.5×10^{-7}	2
Anticipated transient without scram	5.3×10^{-8}	1
Interfacing system loss-of-coolant accident (LOCA)	3.6×10^{-8}	<1
Internal flooding	1.3×10^{-8}	<1
Total CDF (from internal events)	6.4×10^{-6}	100

As shown in Table 5-3, events initiated by loss of DC buses and loss of offsite power are the dominant contributors to CDF. Station blackout (SBO) sequences contribute 1.5×10^{-7} per year (about 2 percent of the total internal events CDF), while anticipated transient without scram (ATWS) sequences are insignificant contributors to CDF (5.3×10^{-8} per year).

In the ER, Entergy estimated the dose to the population within 50 miles of the PNPS site to be approximately 0.136 person-sievert (Sv) (13.6 person-roentgen equivalents (person-rem)) per year. The breakdown of the total population dose by containment release mode is summarized in Table 5-4. Containment failures within the late time frame (greater than 7.5 hours following event initiation) dominate the population dose risk at PNPS.

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

Containment Release Mode	Population Dose (Person-Rem¹ Per Year)	Percent Contribution
Late Containment Failure	12.7	93
Early Containment Failure	0.7	5
Containment Bypass	0.2	2
Intact Containment	negligible	negligible
Total	13.6	100

¹One person-rem = 0.01 person-Sv

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

5.2.3 Potential Plant Improvements

Once the dominant contributors to plant risk were identified, Entergy searched for ways to reduce that risk. In identifying and evaluating potential SAMAs, Entergy considered insights from the plant-specific PSA, and SAMA analyses performed for other operating plants that have submitted license renewal applications. Entergy identified 281 potential risk-reducing improvements (SAMAs) to plant components, systems, procedures and training. Entergy removed 222 SAMAs from further consideration because they are not applicable at PNPS due to design differences, have already been implemented at PNPS, or are addressed by a similar SAMA. A detailed cost-benefit analysis was performed for each of the 59 remaining SAMAs.

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

5.2.4 Evaluation of Risk Reduction and Costs of Improvements

Entergy evaluated the risk-reduction potential of the remaining 59 SAMAs. The majority of the SAMA evaluations were performed in a bounding fashion in that the SAMA was assumed to completely eliminate the risk associated with the proposed enhancement.

Entergy estimated the costs of implementing the 59 candidate SAMAs through the application of engineering judgement, and use of other licensees' estimates for similar improvements. The cost estimates conservatively did not include the cost of replacement power during extended

Environmental Impacts of Postulated Accidents

1 outages required to implement the modifications, nor did they include contingency costs
2 associated with unforeseen implementation obstacles.

3
4 The staff reviewed Entergy's bases for calculating the risk reduction for the various plant
5 improvements and concludes that the rationale and assumptions for estimating risk reduction
6 are reasonable and somewhat conservative (i.e., the estimated risk reduction is similar to or
7 somewhat higher than what would actually be realized). Accordingly, the staff based its
8 estimates of averted risk for the various SAMAs on Entergy's risk reduction estimates.

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

14
15 The staff concludes that the risk reduction and the cost estimates provided by Entergy are
16 sufficient and appropriate for use in the SAMA evaluation.

17 18 **5.2.5 Cost-Benefit Comparison**

19
20 The cost-benefit analysis performed by Entergy was based primarily on NUREG/BR-0184
21 (USNRC 1997) and was executed consistent with this guidance. NUREG/BR-0058 has recently
22 been revised to reflect the agency's revised policy on discount rates. Revision 4 of
23 NUREG/BR-0058 states that two sets of estimates should be developed – one at three percent
24 and one at seven percent (NRC 2004). Entergy provided both sets of estimates (Entergy
25 2006a).

26
27 Entergy identified five potentially cost-beneficial SAMAs in the baseline analysis contained in
28 the ER (using a seven percent discount rate, and considering the combined impact of both
29 external events and uncertainties). The potentially cost-beneficial SAMAs are:

- 30
- 31 • SAMA 30 – install key-locked control switches to enable AC bus cross-ties and modify
32 procedures to enhance the reliability of the AC power system.
 - 33
34 • SAMA 34 – modify plant procedures to use DC bus cross-ties to enhance the reliability
35 of the DC power system.
 - 36
37 • SAMA 56 – install additional fuses in panel C7 to enable the direct torus vent (DTV)
38 valve function during loss of containment heat removal accident sequences.
 - 39
40 • SAMA 57 – modify plant procedures to allow use of the diesel fire pump hydro turbine in
41 the event that emergency diesel generator (EDG) A fails or fuel oil transfer pump P-
42 141A is unavailable.

- SAMA 58 – modify plant procedures to allow alternately feeding B1 loads via B3 when A3 is available, and alternately feeding B2 loads via B4 when A4 is available.

In response to a request for additional information, Entergy provided a revised assessment based on a modified multiplier for external events and a separate accounting of uncertainties (Entergy 2006b). The revised assessment resulted in identification of the same potentially cost-beneficial SAMAs. No additional SAMAs were identified when the benefits were evaluated using a three percent discount rate, or when the benefits were increased by a factor of 1.6 to account for uncertainties. However, in response to additional NRC staff inquiries regarding estimated benefits for certain SAMAs and lower cost alternatives, Entergy identified two additional potentially cost-beneficial SAMAs (Entergy 2006b and 2006c):

- Control containment venting withing a narrow pressure band (SAMA 53), and
- Use the security diesel generator to extend the life of the 125 volt DC batteries (a new SAMA).

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

5.2.6 Conclusions

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

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

5.3 References

- 1
2
3 Boston Edison Company (BEC). 1992. Letter from E. T. Boulette, BEC to U.S. Nuclear
4 Regulatory Commission Document Control Desk. Subject: Response to Generic Letter 88-20,
5 Individual Plant Examination for Severe Accident Vulnerabilities. September 30, 1992.
6
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10 Vulnerabilities. June 30, 1994.
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12 Entergy Nuclear Operations, Inc. 2006a. *Applicant's Environmental Report--Operating License*
13 *Renewal Stage, Pilgrim Nuclear Power Station*, Docket No, 50-293, Plymouth, Massachusetts.
14
15 Entergy Nuclear Operations, Inc. 2006b. Letter from Stephen J. Bethay, Entergy to NRC
16 Document Control Desk. Subject: License Renewal Application Amendment 4: Response to
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20 Entergy Nuclear Operations, Inc. 2006c. Letter from Stephen J. Bethay, Entergy to NRC
21 Document Control Desk. Subject: License Renewal Application Amendment 7, August 30,
22 2006.
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24 Nuclear Regulatory Commission (NRC). 1996. *Generic Environmental Impact Statement for*
25 *License Renewal of Nuclear Plants*. NUREG-1437, Volumes 1 and 2, Washington, D.C.
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27 Nuclear Regulatory Commission (NRC). 1997. *Regulatory Analysis Technical Evaluation*
28 *Handbook*. NUREG/BR-0184, Washington, D.C.
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30 Nuclear Regulatory Commission (NRC). 1999. *Generic Environmental Impact Statement for*
31 *License Renewal of Nuclear Plants Main Report*. "Section 6.3 – Transportation, Table 9.1,
32 Summary of findings on NEPA issues of license renewal of nuclear power plants," Final
33 Report. NUREG-1437, Volume 1, Addendum 1, Washington D.C.
34
35 Nuclear Regulatory Commission (NRC). 2004. *Regulatory Analysis Guidelines of the U.S.*
36 *Nuclear Regulatory Commission*. NUREG/BR-0058, Rev. 4, Washington, D.C.

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

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

- (1) The environmental impacts associated with the issue have been determined to apply either to all plants or, for some issues, to plants having a specific type of cooling system or other specified plant or site characteristics.
- (2) A single significance level (i.e., SMALL, MODERATE, or LARGE) has been assigned to the impacts (except for collective offsite radiological impacts from the fuel cycle and from high-level waste [HLW] and spent fuel disposal).
- (3) Mitigation of adverse impacts associated with the issue has been considered in the analysis, and it has been determined that additional plant-specific mitigation measures are likely not to be sufficiently beneficial to warrant implementation.

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

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

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

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

Fuel Cycle

1 Commission (NRC) staff also addresses the impacts from radon-222 and technetium-99 in the
2 GEIS.
3

4 **6.1 The Uranium Fuel Cycle**

5
6 Category 1 issues in 10 CFR Part 51, Subpart A, Appendix B, Table B-1 that are applicable to
7 PNPS from the uranium fuel cycle and solid waste management are listed in Table 6-1.
8

9 **Table 6-1.** Category 1 Issues Applicable to the Uranium Fuel Cycle and Solid Waste
10 Management During the Renewal Term
11

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section
URANIUM FUEL CYCLE AND WASTE MANAGEMENT	
Offsite radiological impacts (individual effects from other than the disposal of spent fuel and high level waste)	6.2.1; 6.2.2.1; 6.2.2.3; 6.2.3; 6.2.4
Offsite radiological impacts (collective effects)	6.2.2.1; 6.2.3; 6.2.4
Offsite radiological impacts (spent fuel and high level waste disposal)	6.2.2.1; 6.2.2.2; 6.2.3; 6.2.4
Nonradiological impacts of the uranium fuel cycle	6.2.2.6; 6.2.2.7; 6.2.2.8; 6.2.2.9; 6.2.3; 6.2.4
Low-level waste storage and disposal	6.2.2.2; 6.4.2; 6.4.3
Mixed waste storage and disposal	6.4.5
Onsite spent fuel	6.4.6
Nonradiological waste	6.5
Transportation	6.3, Addendum 1

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26
27 Entergy stated in its Environmental Report (ER) (Entergy 2006) that it is not aware of any new
28 and significant information associated with the renewal of the PNPS operating license. The
29 staff has not identified any new and significant information during its independent review of the
30 PNPS ER (Entergy 2006), the site visit, the scoping process, or its evaluation of other available
31 information. Therefore, the staff concludes that there are no impacts related to these issues
32 beyond those discussed in the GEIS. For these issues, the staff concluded in the GEIS that the
33 impacts are SMALL except for the collective offsite radiological impacts from the fuel cycle and
34 from HLW and spent fuel disposal, as discussed below, and that additional plant-specific
35 mitigation measures are not likely to be sufficiently beneficial to be warranted.

1 A brief description of the staff review and the GEIS conclusions, as codified in Table B-1,
2 10 CFR Part 51, for each of these issues follows:

- 3
4 • Offsite radiological impacts (individual effects from other than the disposal of spent fuel and
5 high level waste). Based on information in the GEIS, the Commission found that:

6
7 Off-site impacts of the uranium fuel cycle have been considered by the
8 Commission in Table S-3 of this part (10 CFR 51.51[b]). Based on
9 information in the GEIS, impacts on individuals from radioactive gaseous
10 and liquid releases including radon-222 and technetium-99 are small.

11
12 The staff has not identified any new and significant information during its independent
13 review of the PNPS ER (Entergy 2006), the site visit, the scoping process, or its evaluation
14 of other available information. Therefore, the staff concludes that there would be no offsite
15 radiological impacts of the uranium fuel cycle during the renewal term beyond those
16 discussed in the GEIS.

- 17
18 • Offsite radiological impacts (collective effects). Based on information in the GEIS, the
19 Commission found that:

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

37
38 Nevertheless, despite all of the uncertainty, some judgement as to the regulatory
39 NEPA (National Environmental Policy Act of 1969, as amended) implications of
40 these matters should be made and it makes no sense to repeat the same
41 judgement in every case. Even taking the uncertainties into account, the
42 Commission concludes that these impacts are acceptable in that these impacts

Fuel Cycle

1 would not be sufficiently large to require the NEPA conclusion, for any plant, that
2 the option of extended operation under 10 CFR Part 54 should be eliminated.
3 Accordingly, while the Commission has not assigned a single level of
4 significance for the collective effects of the fuel cycle, this issue is considered
5 Category 1.
6

7 The staff has not identified any new and significant information during its independent
8 review of the PNPS ER (Entergy 2006), the staff's site visit, the scoping process, or its
9 evaluation of other available information. Therefore, the staff concludes that there would be
10 no offsite radiological impacts (collective effects) from the uranium fuel cycle during the
11 renewal term beyond those discussed in the GEIS.
12

- 13 • Offsite radiological impacts (spent fuel and high level waste disposal). Based on
14 information in the GEIS, the Commission found that:

15
16 For the high level waste and spent fuel disposal component of the fuel cycle,
17 there are no current regulatory limits for offsite releases of radionuclides for the
18 current candidate repository site. However, if we assume that limits are
19 developed along the lines of the 1995 National Academy of Sciences (NAS)
20 report, "Technical Bases for Yucca Mountain Standards" (NAS 1995), and that in
21 accordance with the Commission's Waste Confidence Decision, 10 CFR 51.23, a
22 repository can and likely will be developed at some site which will comply with
23 such limits, peak doses to virtually all individuals will be 100 millirem per year or
24 less. However, while the Commission has reasonable confidence that these
25 assumptions will prove correct, there is considerable uncertainty since the limits
26 are yet to be developed, no repository application has been completed or
27 reviewed, and uncertainty is inherent in the models used to evaluate possible
28 pathways to the human environment. The NAS report indicated that 100 millirem
29 per year should be considered as a starting point for limits for individual doses,
30 but notes that some measure of consensus exists among national and
31 international bodies that the limits should be a fraction of the 100 millirem per
32 year. The lifetime individual risk from 100 millirem annual dose limit is about
33 3×10^{-3} .
34

35 Estimating cumulative doses to populations over thousands of years is more
36 problematic. The likelihood and consequences of events that could seriously
37 compromise the integrity of a deep geologic repository were evaluated by the
38 Department of Energy in the "Final Environmental Impact Statement:
39 Management of Commercially Generated Radioactive Waste," October 1980
40 (DOE 1980). The evaluation estimated the 70-year whole-body dose
41 commitment to the maximum individual and to the regional population resulting

1 from several modes of breaching a reference repository in the year of closure,
2 after 1,000 years, after 100,000 years, and after 100,000,000 years. Subse-
3 quently, the NRC and other federal agencies have expended considerable effort
4 to develop models for the design and for the licensing of a high level waste
5 repository, especially for the candidate repository at Yucca Mountain. More
6 meaningful estimates of doses to population may be possible in the future as
7 more is understood about the performance of the proposed Yucca Mountain
8 repository. Such estimates would involve very great uncertainty, especially with
9 respect to cumulative population doses over thousands of years. The standard
10 proposed by the NAS is a limit on maximum individual dose. The relationship of
11 potential new regulatory requirements, based on the NAS report, and cumulative
12 population impacts has not been determined, although the report articulates the
13 view that protection of individuals will adequately protect the population for a
14 repository at Yucca Mountain. However, EPA's (U.S. Environmental Protection
15 Agency's) generic repository standards in 40 CFR part 191 generally provide an
16 indication of the order of magnitude of cumulative risk to population that could
17 result from the licensing of a Yucca Mountain repository, assuming the ultimate
18 standards will be within the range of standards now under consideration. The
19 standards in 40 CFR part 191 protect the population by imposing "containment
20 requirements" that limit the cumulative amount of radioactive material released
21 over 10,000 years. Reporting performance standards that will be required by
22 EPA are expected to result in releases and associated health consequences in
23 the range between 10 and 100 premature cancer deaths with an upper limit of
24 1,000 premature cancer deaths world-wide for a 100,000 metric tonne (MTHM)
25 repository.

26
27 Nevertheless, despite all of the uncertainty, some judgement as to the regulatory
28 NEPA implications of these matters should be made and it makes no sense to
29 repeat the same judgement in every case. Even taking the uncertainties into
30 account, the Commission concludes that these impacts are acceptable in that
31 these impacts would not be sufficiently large to require the NEPA conclusion, for
32 any plant, that the option of extended operation under 10 CFR part 54 should be
33 eliminated. Accordingly, while the Commission has not assigned a single level of
34 significance for the impacts of spent fuel and high level waste disposal, this issue
35 is considered Category 1.

36
37 On February 15, 2002, based on a recommendation by the Secretary of the Department of
38 Energy, the President recommended the Yucca Mountain site for the development of a
39 repository for the geologic disposal of spent nuclear fuel and HLW. The U.S. Congress
40 approved this recommendation on July 9, 2002, in Joint Resolution 87, which designated
41 Yucca Mountain as the repository for spent nuclear waste. On July 23, 2002, the President
42 signed Joint Resolution 87 into law; Public Law 107-200, 116 Stat. 735 (2002) designates

Fuel Cycle

1 Yucca Mountain as the repository for spent nuclear waste. This development does not
2 represent new and significant information with respect to the offsite radiological impacts
3 from license renewal related to disposal of spent nuclear fuel and HLW.
4

5 The EPA developed Yucca Mountain-specific repository standards, which were
6 subsequently adopted by the NRC in 10 CFR Part 63. In an opinion, issued July 9, 2004,
7 the U.S. Court of Appeals for the District of Columbia Circuit (the Court) vacated EPA's
8 radiation protection standards for the candidate repository, which required compliance with
9 certain dose limits over a 10,000 year period. The Court's decision also vacated the
10 compliance period in NRC's licensing criteria for the candidate repository in 10 CFR Part 63.
11

12 Therefore, for the HLW and spent fuel disposal component of the fuel cycle, there is some
13 uncertainty with respect to regulatory limits for offsite releases of radioactive nuclides for the
14 current candidate repository site. However, prior to promulgation of the affected provisions
15 of the Commission's regulations, it was assumed that limits would be developed in line with
16 the 1995 NAS report, *Technical Bases for Yucca Mountain Standards* (NAS 1995), and that
17 in accordance with the Commission's Waste Confidence Decision, 10 CFR 51.23, a
18 repository that would comply with such limits could and likely would be developed at some
19 site. Peak doses to virtually all individuals would be 100 mrem per year or less.
20

21 Despite the current uncertainty with respect to these rules, some judgment as to the 1969
22 NEPA implications of offsite radiological impacts of spent fuel and HLW disposal should be
23 made. The staff concludes that these impacts are acceptable in that the impacts would not
24 be sufficiently large to require the NEPA conclusion that the option of extended operation
25 under 10 CFR Part 54 should be eliminated.
26

27 The staff has not identified any new and significant information during its independent
28 review of the PNPS ER (Entergy 2006), the site visit, the scoping process, or its evaluation
29 of other available information. Therefore, the staff concludes that there would be no offsite
30 radiological impacts related to spent fuel and HLW disposal during the renewal term beyond
31 those discussed in the GEIS.
32

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

35
36 The nonradiological impacts of the uranium fuel cycle resulting from the
37 renewal of an operating license for any plant are found to be small.

1 The staff has not identified any new and significant information during its independent
2 review of the PNPS ER (Entergy 2006), the staff's site visit, the scoping process, or its
3 evaluation of other available information. Therefore, the staff concludes that there would be
4 no nonradiological impacts of the uranium fuel cycle during the renewal term beyond those
5 discussed in the GEIS.

- 6
7 • Low-level waste storage and disposal. Based on information in the GEIS, the Commission
8 found that:

9
10 The comprehensive regulatory controls that are in place and the low public
11 doses being achieved at reactors ensure that the radiological impacts to the
12 environment will remain small during the term of a renewed license. The
13 maximum additional on-site land that may be required for low-level waste
14 storage during the term of a renewed license and associated impacts will be
15 small. Nonradiological impacts on air and water will be negligible. The
16 radiological and nonradiological environmental impacts of long-term disposal
17 of low-level waste from any individual plant at licensed sites are small. In
18 addition, the Commission concludes that there is reasonable assurance that
19 sufficient low-level waste disposal capacity will be made available when
20 needed for facilities to be decommissioned consistent with NRC
21 decommissioning requirements.

22
23 The staff has not identified any new and significant information during its independent
24 review of the PNPS ER (Entergy 2006), the site visit, the scoping process, or its evaluation
25 of other available information. Therefore, the staff concludes that there would be no
26 impacts of low-level waste storage and disposal associated with the renewal term beyond
27 those discussed in the GEIS.

- 28
29 • Mixed waste storage and disposal. Based on information in the GEIS, the Commission
30 found that:

31
32 The comprehensive regulatory controls and the facilities and procedures that
33 are in place ensure proper handling and storage, as well as negligible doses
34 and exposure to toxic materials for the public and the environment at all plants.
35 License renewal will not increase the small, continuing risk to human health
36 and the environment posed by mixed waste at all plants. The radiological and
37 nonradiological environmental impacts of long-term disposal of mixed waste
38 from any individual plant at licensed sites are small. In addition, the
39 Commission concludes that there is reasonable assurance that sufficient mixed
40 waste disposal capacity will be made available when needed for facilities to be
41 decommissioned consistent with NRC decommissioning requirements.

Fuel Cycle

1 The staff has not identified any new and significant information during its independent
2 review of the PNPS ER (Entergy 2006), the site visit, the scoping process, or its evaluation
3 of other available information. Therefore, the staff concludes that there would be no
4 impacts of mixed waste storage and disposal associated with the renewal term beyond
5 those discussed in the GEIS.

- 6
7 • Onsite spent fuel. Based on information in the GEIS, the Commission found that:

8
9 The expected increase in the volume of spent fuel from an additional 20 years
10 of operation can be safely accommodated on site with small environmental
11 effects through dry or pool storage at all plants if a permanent repository or
12 monitored retrievable storage is not available.

13
14 The staff has not identified any new and significant information during its independent
15 review of the PNPS ER (Entergy 2006), the site visit, the scoping process, or its evaluation
16 of other available information. Therefore, the staff concludes that there would be no
17 impacts of onsite spent fuel associated with license renewal beyond those discussed in the
18 GEIS.

- 19
20 • Nonradiological waste. Based on information in the GEIS, the Commission found that:

21
22 No changes to generating systems are anticipated for license renewal.
23 Facilities and procedures are in place to ensure continued proper handling
24 and disposal at all plants.

25
26 The staff has not identified any new and significant information during its independent
27 review of the PNPS ER (Entergy 2006), the site visit, the scoping process, or its evaluation
28 of other available information. Therefore, the staff concludes that there would be no
29 nonradiological waste impacts during the renewal term beyond those discussed in the
30 GEIS.

- 31
32 • Transportation. Based on information contained in the GEIS, the Commission found that:

33
34 The impacts of transporting spent fuel enriched up to 5 percent uranium-235
35 with average burnup for the peak rod to current levels approved by NRC up
36 to 62,000 MWd/MTU (megawatt-days per metric ton of uranium) and the
37 cumulative impacts of transporting high-level waste to a single repository,
38 such as Yucca Mountain, Nevada are found to be consistent with the impact
39 values contained in 10 CFR 51.52(c), Summary Table S-4 – Environmental
40 Impact of Transportation of Fuel and Waste to and from One Light-Water-
41 Cooled Nuclear Power Reactor. If fuel enrichment or burnup conditions are

1 not met, the applicant must submit an assessment of the implications for the
2 environmental impact values reported in § 51.52.

3
4 PNPS meets the fuel-enrichment and burnup conditions set forth in Addendum 1 to the
5 GEIS. The staff has not identified any new and significant information during its
6 independent review of the PNPS ER (Entergy 2006), the site visit, the scoping process, or
7 its evaluation of other available information. Therefore, the staff concludes that there would
8 be no impacts of transportation associated with license renewal beyond those discussed in
9 the GEIS.

10
11 There are no Category 2 issues for the uranium fuel cycle and solid waste management.
12

13 **6.2 References**

14
15 10 CFR Part 51. Code of Federal Regulations, Title 10, *Energy*, Part 51, “Environmental
16 Protection Regulations for Domestic Licensing and Related Regulatory Functions.”

17
18 10 CFR Part 54. Code of Federal Regulations, Title 10, *Energy*, Part 54, “Requirements for
19 Renewal of Operating Licenses for Nuclear Power Plants.”

20
21 10 CFR Part 63. Code of Federal Regulations, Title 10, *Energy*, Part 63, “Disposal of High-
22 Level Radioactive Wastes in a Geologic Repository at Yucca Mountain, Nevada.”

23
24 40 CFR Part 191. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 191,
25 “Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear
26 Fuel, High-Level and Transuranic Radioactive Waste.”

27
28 Department of Energy (DOE). 1980. *Final Environmental Impact Statement: Management of*
29 *Commercially Generated Radioactive Waste*. DOE/EIS-0046F, Washington, D.C.

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31 Entergy Nuclear Operations, Inc. (Entergy). 2006. *Applicant’s Environmental Report –*
32 *Operating License Renewal Stage Pilgrim Nuclear Power Station*. Docket No. 50-293,
33 Plymouth, Massachusetts.

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35 Joint Resolution 87, 2002. Public Law 107-200, 116 Stat 735.

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

39
40 National Environmental Policy Act of 1969, as amended (NEPA) 42 USC 4321, et seq.
41

Fuel Cycle

- 1 Nuclear Regulatory Commission (NRC). 1996. *Generic Environmental Impact Statement for*
- 2 *License Renewal of Nuclear Plants*. NUREG-1437, Volumes 1 and 2, Washington, D.C.
- 3
- 4 Nuclear Regulatory Commission (NRC). 1999. *Generic Environmental Impact Statement for*
- 5 *License Renewal of Nuclear Plants, Main Report*, "Section 6.3 – Transportation, Table 9.1,
- 6 Summary of findings on NEPA issues for license renewal of nuclear power plants," Final
- 7 Report. NUREG-1437, Volume 1, Addendum 1, Washington, D.C.

7.0 Environmental Impacts of Decommissioning

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

The incremental environmental impacts associated with decommissioning activities resulting from continued plant operation during the renewal term are discussed in the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), NUREG-1437, Volumes 1 and 2 (NRC 1996; 1999)^(a). The GEIS includes a determination of whether the analysis of the environmental issue could be applied to all plants and whether additional mitigation measures would be warranted. Issues were then assigned a Category 1 or a Category 2 designation. As set forth in the GEIS, Category 1 issues are those that meet all of the following criteria:

- (1) The environmental impacts associated with the issue have been determined to apply either to all plants or, for some issues, to plants having a specific type of cooling system or other specified plant or site characteristics.
- (2) A single significance level (i.e., SMALL, MODERATE, or LARGE) has been assigned to the impacts (except for collective offsite radiological impacts from the fuel cycle and from high level waste and spent fuel disposal).
- (3) Mitigation of adverse impacts associated with the issue has been considered in the analysis, and it has been determined that additional plant-specific mitigation measures are likely not to be sufficiently beneficial to warrant implementation.

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

Category 2 issues are those that do not meet one or more of the criteria for Category 1; therefore, additional plant-specific review of these issues is required. There are no Category 2 issues related to decommissioning.

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

7.1 Decommissioning

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

Table 7-1. Category 1 Issues Applicable to the Decommissioning of PNPS Following the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section
DECOMMISSIONING	
Radiation doses	7.3.1
Waste management	7.3.2
Air quality	7.3.3
Water quality	7.3.4
Ecological resources	7.3.5
Socioeconomic impacts	7.3.7

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

- Radiation doses. Based on information in the GEIS, the Commission found that:

Doses to the public will be well below applicable regulatory standards regardless of which decommissioning method is used. Occupational doses would increase no more than 1 man-rem caused by buildup of long-lived radionuclides during the license renewal term.

The staff has not identified any new and significant information during its independent review of the PNPS ER (Entergy 2006), the site visit, the scoping process, or its evaluation of other available information. Therefore, the staff concludes that there would be no

1 radiation dose impacts associated with decommissioning following the license renewal term
2 beyond those discussed in the GEIS.

- 3
4 • Waste management. Based on information in the GEIS, the Commission found that:

5
6 Decommissioning at the end of a 20-year license renewal period would generate no
7 more solid wastes than at the end of the current license term. No increase in the
8 quantities of Class C or greater than Class C wastes would be expected.

9
10 The staff has not identified any new and significant information during its independent review of
11 the PNPS ER (Entergy 2006), the site visit, the scoping process, or its evaluation of other
12 available information. Therefore, the staff concludes that there would be no impacts from solid
13 waste associated with decommissioning following the license renewal term beyond those
14 discussed in the GEIS.

- 15
16 • Air quality. Based on information in the GEIS, the Commission found that:

17
18 Air quality impacts of decommissioning are expected to be negligible either at
19 the end of the current operating term or at the end of the license renewal term.

20
21 The staff has not identified any new and significant information during its independent review of
22 the PNPS ER (Entergy 2006), the site visit, the scoping process, or its evaluation of other
23 available information. Therefore, the staff concludes that there would be no impacts on air
24 quality associated with decommissioning following the license renewal term beyond those
25 discussed in the GEIS.

- 26
27 • Water quality. Based on information in the GEIS, the Commission found that:

28
29 The potential for significant water quality impacts from erosion or spills is no
30 greater whether decommissioning occurs after a 20-year license renewal period
31 or after the original 40-year operation period, and measures are readily available
32 to avoid such impacts.

33
34 The staff has not identified any new and significant information during its independent review of
35 the PNPS ER (Entergy 2006), the site visit, the scoping process, or its evaluation of other
36 available information. Therefore, the staff concludes that there would be no impacts on water
37 quality associated with decommissioning following the license renewal term beyond those
38 discussed in the GEIS.

Environmental Impacts of Decommissioning

- 1 • Ecological resources. Based on information in the GEIS, the Commission found that:

2
3 Decommissioning after either the initial operating period or after a 20-year
4 license renewal period is not expected to have any direct ecological impacts.
5

6 The staff has not identified any new and significant information during its independent review of
7 the PNPS ER (Entergy 2006), the site visit, the scoping process, or its evaluation of other
8 available information. Therefore, the staff concludes that there would be no impacts on
9 ecological resources associated with decommissioning following the license renewal term
10 beyond those discussed in the GEIS.
11

- 12 • Socioeconomic Impacts. Based on information in the GEIS, the Commission found that:

13
14 Decommissioning would have some short-term socioeconomic impacts. The
15 impacts would not be increased by delaying decommissioning until the end of a
16 20-year relicense period, but they might be decreased by population and
17 economic growth.
18

19 The staff has not identified any new and significant information during its independent review of
20 the PNPS ER (Entergy 2006), the site visit, the scoping process, or its evaluation of other
21 available information. Therefore, the staff concludes that there would be no socioeconomic
22 impacts associated with decommissioning following the license renewal term beyond those
23 discussed in the GEIS.
24

25 7.2 References

26
27 10 CFR Part 51. Code of Federal Regulations, Title 10, *Energy*, Part 51, "Environmental
28 Protection Regulations for Domestic Licensing and Related Regulatory Functions."
29

30 Entergy Nuclear Generation Company (Entergy). 2006. *Applicant's Environmental Report –*
31 *Operating License Renewal Stage Pilgrim Nuclear Power Station*. Docket No. 50-293,
32 Plymouth, Massachusetts.
33

34 Nuclear Regulatory Commission (NRC). 1996. *Generic Environmental Impact Statement for*
35 *License Renewal of Nuclear Plants*. NUREG-1437, Volumes 1 and 2, Washington, D.C.
36

37 Nuclear Regulatory Commission (NRC). 1999. *Generic Environmental Impact Statement for*
38 *License Renewal of Nuclear Plants, Main Report*, "Section 6.3 – Transportation, Table 9.1,
39 Summary of findings on NEPA issues for license renewal of nuclear power plants," Final
40 Report. NUREG-1437, Volume 1, Addendum 1, Washington, D.C.
41

Environmental Impacts of Decommissioning

- 1 Nuclear Regulatory Commission (NRC). 2002. *Generic Environmental Impact Statement on*
- 2 *Decommissioning of Nuclear Facilities: Supplement 1, Regarding the Decommissioning of*
- 3 *Nuclear Power Reactors*. NUREG-0586, Supplement 1, Volumes 1 and 2, Washington, D.C.

8.0 Environmental Impacts of Alternatives to License Renewal

This chapter examines the potential environmental impacts associated with denying the renewal of an operating license (OL) (i.e., the no-action alternative); the potential environmental impacts from electric generating sources other than Pilgrim Nuclear Power Station (PNPS); the possibility of purchasing electric power from other sources to replace power generated by PNPS and the associated environmental impacts; the potential environmental impacts from a combination of generating and conservation measures; and other generation alternatives that were deemed unsuitable for replacement of power generated by PNPS. The environmental impacts are evaluated using the U.S. Nuclear Regulatory Commission's (NRC's) three-level standard of significance—SMALL, MODERATE, or LARGE—developed using the Council on Environmental Quality guidelines and set forth in the footnotes to Table B-1 of Title 10 of the Code of Federal Regulations (CFR) Part 51, Subpart A, Appendix B:

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

MODERATE - Environmental effects are sufficient to alter noticeably, but not to destabilize important attributes of the resource.

LARGE - Environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

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

8.1 No-action Alternative

The NRC's regulations implementing the National Environmental Policy Act of 1969, as amended (NEPA) specify that the no-action alternative be discussed in an NRC environmental impact statement (EIS) (see 10 CFR Part 51, Subpart A, Appendix A[4]). For license renewal, the no-action alternative refers to a scenario in which the NRC would not renew the OL for PNPS and Entergy Nuclear Operations, Inc. (Entergy) would then cease plant operations by the end of the current license and initiate decommissioning of the plant.

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

Environmental Impacts of License Renewal

1 Entergy will be required to shut down PNPS and comply with NRC decommissioning
2 requirements in 10 CFR 50.82 whether or not the OL is renewed. If the PNPS OL is renewed,
3 shutdown of the facility and decommissioning activities will not be avoided, but will be
4 postponed for up to an additional 20 years.
5

6 The environmental impacts associated with decommissioning, following a license renewal
7 period of up to 20 years or following the no-action alternative, would be bounded by the
8 discussion of impacts in Chapter 7 of the GEIS, Chapter 7 of this draft supplemental EIS
9 (SEIS), and the *Final Generic Environmental Impact Statement on Decommissioning of Nuclear*
10 *Facilities*, NUREG 0586, Supplement 1 (NRC 2002). The impacts of decommissioning after 60
11 years of operation are not expected to be significantly different from those occurring after 40
12 years of operation.
13

14 Impacts from the decision to permanently cease operations are not considered in
15 NUREG-0586, Supplement 1^(a). Therefore, immediate impacts that occur between plant
16 shutdown and the beginning of decommissioning are considered here. These impacts will
17 occur when the unit shuts down regardless of whether the license is renewed or not and are
18 discussed below, with the results presented in Table 8-1, which is presented at the end of this
19 section (Section 8.1). Plant shutdown will result in a net reduction in power production capacity.
20 The power not generated by PNPS during the license renewal term would likely be replaced by
21 (1) power supplied by other independent producers using generating technologies that will differ
22 from that employed at PNPS, (2) demand-side management (DSM) and energy conservation,
23 or (3) some combination of these options. The environmental impacts of these options are
24 discussed in Section 8.2.
25

26 **8.1.1 Land Use**

27

28 In Chapter 4, the staff concluded that the impacts of continued plant operation on land use
29 would be SMALL. Onsite land use will not be affected immediately by the cessation of
30 operations. Plant structures and other facilities are likely to remain in place until
31 decommissioning. In the near term the transmission line associated with PNPS will likely be
32 retained until final disposition of the dormant facility and site are ascertained. In the long term,
33 it is possible that the transmission lines that extend from the onsite switch yard to
34 interconnections at Jordan and Snake Hill Roads will be removed at which point maintenance of
35 the right-of-way (ROW) will discontinue and the ROW will revert to the conditions found in
36 adjacent areas. Also, as a result of plant shutdown, there would be a reduction in uranium

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

1 mining activity positively impacting approximately 715 acres (ac). Therefore, the staff
2 concludes that the impacts on land use from plant shutdown would be SMALL.

3 4 **8.1.2 Ecology**

5
6 In Chapter 4 of this draft SEIS, the NRC staff concluded that the ecological impacts of
7 continued plant operation ranged from SMALL to MODERATE. Cessation of operations will be
8 accompanied by elimination of the cooling water intake flow and the facility's thermal plume.
9 The environmental impacts to aquatic species, including threatened and endangered species,
10 associated with these changes are generally positive. The impacts of plant closure on the
11 terrestrial ecosystem range between negative and positive depending on final disposition of the
12 Entergy Woodlands area across which the PNPS transmission lines runs. Currently, there is an
13 active management program on that property that preserves habitat and controls invasive
14 species. Cessation of that program would produce negative impact. Therefore, the staff
15 concludes that overall ecological impacts from shutdown of the plant would be SMALL.

16 17 **8.1.3 Water Use and Quality–Surface Water**

18
19 In Chapter 4 of this draft SEIS, the NRC staff concluded that impacts of continued plant
20 operation on surface water use and quality were SMALL. When the plant stops operating there
21 will be an immediate reduction in the consumptive use of water because of the elimination of
22 the cooling water intake and in the amount of heat discharged to Cape Cod Bay. Therefore, the
23 staff concludes that the impacts on surface water use and quality from plant shutdown would be
24 SMALL.

25 26 **8.1.4 Water Use and Quality–Groundwater**

27
28 In Chapter 4, the staff determined that the facility does not utilize onsite groundwater resources.
29 In addition, impacts of continued subsurface discharge of treated sanitary wastes by the facility
30 were determined to be SMALL. When the plant stops operating, there will be an immediate
31 reduction in discharge of treated sanitary waste. Therefore, the staff concludes that
32 groundwater quality impacts from shutdown of the plant would be SMALL.

33 34 **8.1.5 Air Quality**

35
36 In Chapter 4, the staff found the impacts of continued plant operation on air quality to be
37 SMALL. When the plant stops operating, there will be a reduction in emissions from activities
38 related to plant operation such as use of diesel generators and workers transportation.
39 Therefore, the staff concludes that the impact on air quality from shutdown of the plant would
40 be SMALL.

1 **8.1.6 Waste**

2
3 The impacts of waste generated by continued plant operation are discussed in Chapter 6. The
4 impacts of low-level and mixed waste from plant operation are characterized as SMALL. When
5 the plant stops operating, the plant will stop generating high-level waste and generation of low-
6 level and mixed waste associated with plant operation and maintenance will be reduced.
7 Therefore, the staff concludes that the impact of waste generated after shutdown of the plant
8 would be SMALL.

9
10 **8.1.7 Human Health**

11
12 In Chapter 4 of this draft SEIS, the NRC staff concluded that the impacts of continued plant
13 operation on human health were SMALL. After the cessation of operations, the amount of
14 radioactive material released to the environment in gaseous and liquid forms will be reduced.
15 Therefore, the staff concludes that the impact of shutdown of the plant on human health would
16 be SMALL. In addition, the variety of potential accidents at the plant will be reduced to a limited
17 set associated with shutdown events and fuel handling. In Chapter 5 of this draft SEIS, the
18 NRC staff concluded that the impacts of accidents during operation were SMALL. Therefore,
19 the staff concludes that the impacts of potential accidents following shutdown of the plant would
20 be SMALL.

21
22 **8.1.8 Socioeconomics**

23
24 In Chapter 4, the NRC staff concluded that the socioeconomic impacts of continued plant
25 operation would be SMALL. But, should the plant shutdown, there would be immediate
26 socioeconomic impacts due to the loss of jobs (approximately 700) and there may also be an
27 immediate reduction in property tax revenues for Plymouth Township. These impacts may,
28 however, be offset as a result of the projected regional economic growth. The NRC staff
29 concludes that the socioeconomic impacts of plant shutdown would be MODERATE. See
30 Appendix J to NUREG-0586, Supplement 1 (NRC 2002), for additional discussion of the
31 potential impacts of plant shutdown.

32
33 **8.1.9 Socioeconomics (Transportation)**

34
35 In Chapter 4, the staff concluded that the impacts of continued plant operation on transportation
36 would be SMALL. Cessation of operations will be accompanied by reduced traffic in the vicinity
37 of the plant. Most of the reduction will be associated with a reduction in plant workforce, but
38 there will also be a reduction in shipment of maintenance materials to and from the plant.
39 Therefore, the staff concludes that the impacts of plant closure on transportation would be
40 SMALL.

1 **8.1.10 Aesthetics**

2
3 In Chapter 4, the staff concluded that the aesthetic impacts of continued plant operation would
4 be SMALL. Plant structures and other facilities are likely to remain in place until
5 decommissioning. Upon decommissioning the number of onsite structures would be reduced.
6 Therefore, the staff concludes that the aesthetic impacts of plant closure would be SMALL.
7

8 **8.1.11 Historic and Archaeological Resources**

9
10 In Chapter 4, the staff concluded that the impacts of continued plant operation on historic and
11 archaeological resources would be SMALL. Onsite land use will not be affected immediately by
12 the cessation of operations. Plant structures and other facilities are likely to remain in place
13 until decommissioning. The transmission lines associated with the project may ultimately be
14 removed once the facility stops operating and, should this occur, maintenance of the
15 transmission line ROW will cease. Therefore, the staff concludes that the impacts on historic
16 and archaeological resources from plant shutdown would be SMALL.
17

18 **8.1.12 Environmental Justice**

19
20 In Chapter 4, the staff concluded that the environmental justice impact of continued operation of
21 the plant would be SMALL because continued operation of the plant would not have a
22 disproportionately high and adverse impact on minority and low-income populations. Shutdown
23 of the plant likewise is not expected to disproportionately impact minority and low-income
24 populations. The staff concludes that the environmental justice impacts of plant shutdown
25 would be SMALL. See Appendix J to NUREG-0586, Supplement 1 (NRC 2002), for additional
26 discussion of these impacts.
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Environmental Impacts of License Renewal

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

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Impact Category	Impact	Comment
Land Use	SMALL	Impacts are expected to be SMALL because plant shutdown is expected to result in few changes to offsite and onsite land use, and transition to alternate uses is expected over an extended timeframe.
Ecology	SMALL	Small negative impacts to terrestrial ecology of conservation management of transmission corridor ceases. Moderate positive impacts to local winter flounder populations.
Water Use and Quality-Surface Water	SMALL	Impacts are expected to be SMALL because surface water intake and discharges will decrease.
Water Use and Quality-Groundwater	SMALL	Impacts are expected to be SMALL because groundwater discharges will decrease.
Air Quality	SMALL	Impacts are expected to be SMALL because discharges related to plant operation and worker transportation will decrease.
Waste	SMALL	Impacts are expected to be SMALL because generation of high-level waste will stop, and generation of low-level and mixed waste will decrease.
Human Health	SMALL	Impacts are expected to be SMALL because radiological doses to workers and members of the public, which are within regulatory limits, will be reduced.
Socioeconomics	MODERATE	Impacts are expected to be MODERATE because of a decrease in employment and tax revenues.
Socioeconomics (Transportation)	SMALL	Impacts are expected to be SMALL because the decrease in employment would reduce traffic.
Aesthetics	SMALL	Impacts are expected to be SMALL because plant structures will remain for an extended period.
Historic and Archaeological Resources	SMALL	Impacts are expected to be SMALL because shutdown of the plant will not change land use.
Environmental Justice	SMALL	Impacts are expected to be SMALL because there are no disproportionate impacts to minority or low income populations.

8.2 Alternative Energy Sources

This section discusses the environmental impacts associated with developing alternative sources of electric power to replace power generated by PNPS under the assumption that the OL for PNPS is not renewed. The order of alternative energy sources presented in this section does not imply which alternative would be most likely to occur or which is expected to have the least environmental impacts.

The following central generating station alternatives are considered in detail:

- coal-fired generation at an alternate greenfield^(a) site (Section 8.2.1)
- natural gas-fired generation at either the PNPS site or an alternate greenfield site (Section 8.2.2)
- nuclear generation at an alternate greenfield site (Section 8.2.3)

The alternative of importing power to replace power generated at PNPS is discussed in Section 8.2.4. Other power generation alternatives and conservation alternatives considered by the staff are discussed in Section 8.2.5. Section 8.2.6 discusses the environmental impacts of a combination of generation and conservation alternatives.

Each year the Energy Information Administration (EIA), a component of the U.S. Department of Energy (DOE), issues an Annual Energy Outlook. In its *Annual Energy Outlook 2006 with Projections to 2030*, EIA projects that natural gas-fired plants will account for approximately 40 percent of new electric generating capacity between the years 2004 and 2030 (DOE/EIA_2006a). This technology is designed primarily to supply peak and intermediate electric generating capacity, but combined-cycle gas-fired systems can also be used to meet baseload^(b) requirements. Coal-fired plants are projected by EIA to account for approximately 50 percent of new capacity additions during this period. Coal-fired plants are generally used to meet baseload requirements. Renewable energy sources, primarily wind, biomass gasification, and municipal solid waste units, are projected by EIA to account for 8 percent of capacity additions.

(a) A greenfield site is assumed to be an undeveloped site with no previous construction.

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

Environmental Impacts of License Renewal

1 EIA's projections of technologies are based on the assumption that providers of new generating
2 capacity will seek to minimize cost while meeting applicable environmental requirements.
3 According to EIA, advanced coal-fired and advanced combined-cycle generating facilities are
4 expected to be approximately competitive with each other in 2015, on a total evaluated cost of
5 production basis, while advanced coal-burning facilities are expected to gain a competitive edge
6 by 2030 (DOE/EIA 2006a). EIA projects that oil-fired plants will account for little or none of the
7 new generating capacity additions in the United States (U.S.) during the 2004 to 2030 time
8 frame because of high fuel costs (DOE/EIA 2006a). EIA also projects that about 6 gigawatts of
9 new nuclear power generating capacity will be constructed prior to 2020 when the Energy
10 Policy Act of 2005 tax credits expire (DOE/EIA 2006a). NRC established a reactor licensing
11 program organization to manage reactor and site licensing applications (NRC 2001). Several
12 site licensing applications are currently under review by the NRC and nuclear operating
13 companies have announced their intention to submit reactor license applications beginning in
14 late 2007. NRC has announced plans to reorganize the agency to further prepare for the
15 industry's announced interest in licensing and building new nuclear plants (NRC 2006). Thus, a
16 new nuclear plant alternative for replacing power generated by PNPS is considered in this draft
17 SEIS and resulting impacts are presented in Section 8.2.3.

18
19 Since PNPS has a gross electric output of 715 megawatts electric (MW[e]), the staff evaluated
20 coal, natural gas, and new nuclear alternatives having comparable capabilities. As discussed
21 further below, siting a 715 MW(e) alternative technology depends, in part, on the land area
22 available at PNPS. If the available land at PNPS is inadequate to support a particular
23 technology, the analysis addresses impacts under the assumption that the new generating
24 capacity is built at a hypothetical greenfield site. For technologies that can be constructed at
25 PNPS, the analysis considers impacts at both PNPS and at a greenfield site. The location of
26 the hypothetical greenfield site is not specified herein.

27
28 Since PNPS began operating in 1972, the era of regulated utilities generating power for
29 distribution within their service territories has largely passed. Today New England in general,
30 and Massachusetts in particular, obtain most electric power from independent power producers
31 that operate generating facilities throughout and beyond the region. Thus, both appropriate
32 market conditions as well as siting opportunities would have to be present for one of the
33 alternative technologies evaluated in Section 8.2 to actually be developed.

34
35 While the greenfield site considered here need not be situated within the New England region,
36 the availability of transmission line capacity to deliver the output of an alternative technology to
37 current PNPS customers could significantly constrain siting choices. Based on a recent DOE
38 Report (DOE/EIA 2006b) it appears that transmission line constraints currently occur within
39 both New England and adjoining New York State. According to the DOE, new projects are
40 expected to ease transmission line congestion in New England, though continued growth in
41 demand and the retirement of older facilities will result in a need to consider investments in both

1 new generating and transmission line capacity (DOE/EIA, 2006b). Finally, the feasibility of
2 finding a greenfield site and obtaining approvals to construct either a coal-fired or nuclear
3 facility there by 2012, when the PNPS OL expires, is questionable. This difficulty is not
4 addressed in Section 8.2, but rather it is assumed that power would be obtained from various
5 sources in the interim while one of the alternate technologies is constructed and comes on-line.
6 In contrast, it may be possible for a gas-fired facility to be operational by 2012 at either the
7 PNPS site or at a greenfield location.

8 9 **8.2.1 Coal-Fired Generation**

10
11 The assumptions and numerical values used in Section 8.2.1 are based on the staff's
12 independent assessment and on information provided by Entergy in the PNPS Environmental
13 Report (ER) (Entergy 2006). Where information from the PNPS ER was used, it was
14 independently reviewed by the staff and compared to environmental impact information in the
15 GEIS. Impacts of a coal-fired alternative evaluated by the staff assume that the new plant
16 would have a gross electrical capacity of 715 MW(e); this differs somewhat from the
17 assumption made in the ER. Furthermore, while the PNPS OL renewal period is only 20 years,
18 the impact of operating a coal-fired alternative for a full 40 years is considered, since 40 years
19 is the expected operating life of a new coal-fired plant.

20
21 There is insufficient land area at PNPS to support operations of a 715 gross MW(e) coal-fired
22 alternative. Therefore, the coal-fired alternative is analyzed only for a greenfield site. Based on
23 Table 8-1 of the GEIS, a pulverized coal-fired facility requires approximately 1.7 ac of land per
24 MW(e). To replace PNPS with a coal-fired facility a 1215 ac parcel would be needed while only
25 140 ac are available at PNPS. It is unrealistic to think that a pulverized coal-fired facility with
26 associated coal yard, waste disposal area, and transportation systems could be accommodated
27 at PNPS. It should be noted that several of the newer coal utilization technologies (e.g., IGCC)
28 could be accommodated on smaller sites than estimated here. However, these alternate
29 technologies would still involve transportation of fuel to the power plant and that facet of coal
30 combustion which involves construction of either a new rail line or coal pier, is not compatible
31 with conditions of the PNPS site.

32
33 The coal-fired plant would consume approximately 2.18 million tons per year of pulverized
34 bituminous coal with an ash content of approximately 8.2 percent. Entergy assumes a heat
35 rate^(a) of 10,200 BTU/kWh and a capacity factor^(b) of 0.85 in the ER (Entergy 2006). After

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

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

Environmental Impacts of License Renewal

1 combustion, 99.9 percent of the ash would be collected and disposed of at the plant site. In
2 addition, approximately 77,700 tons of scrubber sludge would also be disposed on-site based
3 on annual lime usage of approximately 26,300 tons. Lime is used in the scrubbing process for
4 control of sulfur dioxide (SO₂) emissions.

5
6 Coal and lime would be delivered to the generating station site by either rail or barge. If
7 deliveries were by rail, then a rail spur would be constructed to bring coal onto the site from a
8 main rail line. Should waterborne delivery prove feasible, a receiving dock would be
9 constructed for berthing either barges or colliers alongside the facility. Development of a coal-
10 fired facility at an alternate site would also necessitate the construction of a transmission line to
11 connect the new plant to the regional transmission system.

12 13 **8.2.1.1 Closed-Cycle Cooling System**

14
15 For purposes of this section, the staff assumed that a coal-fired plant located at an alternate
16 site would use a closed-cycle cooling system.

17
18 The overall impacts of the coal-fired generating system are discussed in the following sections
19 and summarized in Table 8-2, at the end of this section (Section 8.2.1.1). The implications of
20 constructing a new coal-fired plant at an alternate greenfield site will depend on the actual
21 location of that site; however, as presented below, a general evaluation of impacts is possible.

22 23 • **Land Use**

24
25 Construction of a 715 gross MW(e) pulverized coal-fired alternative at a greenfield site
26 could impact up to 1215 ac of land (NRC 1996). Additional land would be needed to bring a
27 rail spur onto the greenfield site and, as well, for a transmission line to deliver the plant's
28 output to the nearest transmission inter-tie. Depending on the length of transmission line
29 and rail line routing, this alternative would result in MODERATE to LARGE land-use impacts
30 at and in the vicinity of the greenfield site.

31
32 Additionally, land use changes would occur at an undetermined coal mining area where
33 approximately 24 square miles (mi²) would be affected for mining coal and disposing of
34 mining wastes to support a 715 MW(e) coal-fired power plant (the GEIS estimates that
35 approximately 34 mi² would be disturbed for a 1000 MW[e] coal-fired plant [NRC 1996]).

36 37 • **Ecology**

38
39 Siting a coal-fired plant at a greenfield site would introduce construction and operating
40 impacts. Ecological resources would be altered due to the need to convert roughly 1215 ac
41 of land to industrial use (generating facilities, coal storage, ash and scrubber sludge

1 disposal). Even if some of the site had been previously disturbed, it is expected that
2 impacts of developing a 1215 ac area would include wildlife habitat loss, reduced
3 productivity, habitat fragmentation, and reduction in onsite biological diversity.
4

5 Use of a nearby surface water resource to provide cooling tower make-up would have some
6 impact on local aquatic resources. Construction and maintenance of a transmission line
7 and rail spur would incrementally add to the terrestrial ecological impacts. Overall, the staff
8 concludes that ecological impacts at an alternate site would be MODERATE to LARGE.
9

10 • **Water Use and Quality**

11
12 Surface Water

13
14 For the coal-fired alternative at a greenfield site, impacts to surface waters would result from
15 withdrawal of water for various operating needs of the facility. These operating needs would
16 include cooling tower make-up and possibly auxiliary cooling for equipment and potable
17 water requirements.
18

19 Discharges to surface water could result from cooling tower blowdown, coal pile runoff, and
20 runoff from coal ash and scrubber byproduct disposal areas. Both the use of surface
21 waters and runoff to surface waters would be regulated by the State (or U.S. Environmental
22 Protection Agency [EPA] in the case of a facility built in Massachusetts) within which the
23 facility is located. Consequently, it can be expected that a coal-fired facility at a greenfield
24 site would comply with requirements of a discharge permit and would legally be obligated to
25 meet water quality standards. Overall, the staff concludes that the potential impacts to
26 surface water resources and water quality would be SMALL to MODERATE. The impact
27 level would importantly depend on the discharge volume and characteristics of the receiving
28 water body.
29

30 Groundwater

31
32 Groundwater use at an alternate site for potable water purposes could potentially occur. It
33 is also possible that other plant requirements could be met with groundwater depending on
34 site-specific hydrogeologic conditions. Potential impacts to groundwater quality may occur
35 as a result of onsite coal storage and onsite disposal of ash and scrubber sludge. In all
36 cases, it is expected that a coal-fired facility would be obligated to comply with a
37 groundwater use and discharge permit issued by the State within which the facility is
38 located. Therefore, the staff concludes that the potential impacts to groundwater resources
39 would be SMALL to MODERATE.
40
41

Environmental Impacts of License Renewal

• **Air Quality**

The air quality impacts of a pulverized coal-fired facility vary considerably from those of a comparable nuclear plant, due to emissions of sulfur oxides (SO_x), nitrogen oxides (NO_x), particulates, carbon monoxide (CO), hazardous air pollutants (e.g., mercury) and naturally occurring radioactive materials.

PNPS is located in Plymouth County, Massachusetts which has been designated an attainment area (i.e., meets the National Ambient Air Quality Standards promulgated by EPA and found in 40 CFR Part 50 for CO, NO₂, lead, and SO₂). In addition, Plymouth County is in attainment of the Federal standards for particulate air pollution (less than 10 [PM₁₀] and less than 2.5 [PM_{2.5}] microns [μm]). However, Plymouth County, as part of the Boston-Lawrence-Worcester ozone non-attainment area, does not meet the Federal 8-hour standard for ozone.

The EPA has various regulatory requirements for visibility protection in 40 CFR Part 51, Subpart P, including a specific requirement for review of any major stationary source in an area designated as attainment or unclassified under the Clean Air Act (CAA). These requirements could apply to the coal-fired alternative depending on the attainment status of the region within which the alternative is located. As noted above, the Plymouth County vicinity is in attainment of all Federal criteria pollutants except ozone.

A new coal-fired generating plant located in Massachusetts would need a prevention of significant deterioration permit issued under Title 1, Part C, of the CAA. The project would also need an operating permit under Title V of the CAA. The plant would be required to comply with the new source performance standards for such plants as set forth in 40 CFR Part 60 Subpart Da. The standards establish limits for particulate matter and opacity (40 CFR 60.42a), SO₂ (40 CFR 60.43a), and NO_x (40 CFR 60.44a).

Section 169A of the CAA (42 USC 7401) establishes a national goal of preventing future and remedying existing impairment of visibility in mandatory Class I Federal areas when impairment results from man-made air pollution. EPA issued a regional haze rule on July 1, 1999 (64 FR 35714) (EPA 1999). The rule specifies that for each mandatory Class I federal area located within a state, the State must establish goals that provide for reasonable progress towards achieving natural visibility conditions. The reasonable progress goals must provide for an improvement in visibility for the most impaired days over the period of the implementation plan and ensure no degradation in visibility for the least impaired days over the same period (40 CFR 51.308[d][1]). If a coal-fired plant were located close to a mandatory Class I area (there are none in Massachusetts), additional air pollution control requirements could be imposed.

1 In 1998, the EPA issued a rule requiring 22 eastern states, including Massachusetts, to
2 revise their state implementation plans to reduce NO_x emissions. NO_x emissions contribute
3 to violations of the national ambient air quality standard for ozone. The total amount of NO_x
4 which can be emitted by each of the 22 states in the year 2007 ozone season (May 1 to
5 September 30) is set out at 40 CFR 51.121(e). For Massachusetts, the amount is 85,296
6 tons.

7
8 EPA issued the Clean Air Interstate Rule (CAIR) in May 2005 (70 FR 25162 [EPA 2005]).
9 CAIR provides a Federal framework requiring certain states to reduce emissions of SO₂ and
10 NO_x. EPA anticipates that states will achieve this reduction primarily by limiting emissions
11 from the power generation sector. CAIR covers 28 eastern states and any new fossil-fired
12 power plant sited in Massachusetts would be subject to the CAIR limitations.

13
14 Air quality impacts for various pollutants are as follows:

15
16 Sulfur oxides emissions. Entergy indicates in its ER that a coal-fired plant would use a
17 hydrated lime-wet scrubbing system for flue gas desulfurization (Entergy 2006). A new
18 coal-fired power plant would be subject to the requirements in Title IV of the CAA. Title IV
19 was enacted to reduce emissions of SO_x and NO_x, the two principal precursors of acid rain,
20 by restricting emissions of these pollutants from power plants. Title IV caps aggregate
21 annual power plant SO_x emissions and imposes controls on SO_x emissions through a
22 system of marketable allowances. EPA issues one allowance for each ton of SO_x that a unit
23 is allowed to emit.

24
25 New units do not receive allowances, but are required to have allowances to cover their SO_x
26 emissions. Owners of new units must, therefore, acquire allowances from owners of other
27 power plants or reduce SO_x emissions at other power plants they own. Allowances can be
28 banked for use in future years. Thus, a new coal-fired power plant would not add to net
29 regional SO_x emissions, although it might contribute to the local SO_x burden.

30
31 Regardless, SO_x emissions would be greater for the coal alternative than the OL renewal
32 alternative. The staff estimates that with using the hydrated lime-wet scrubbing system to
33 control SO_x emissions, the stack emissions of this constituent from a new 715 MW(e) coal-
34 fired facility would be approximately 1428 tons per year.

35
36 Nitrogen oxides emissions. Section 407 of the CAA establishes technology-based emission
37 limitations for NO_x emissions. The market-based allowance system used for SO_x emissions
38 is not used for NO_x emissions. A new coal-fired power plant would be subject to the new
39 source performance standards for such plants at 40 CFR 60.44a(d)(1).

Environmental Impacts of License Renewal

1 This regulation, issued September 16, 1998 (63 FR 49453 [EPA 1998]), limits the discharge
2 of any gases that contain nitrogen oxides (expressed as NO₂) in excess of 200 nanograms
3 per joule of gross energy output (1.6 pound/MWh), based on a 30-day rolling average.
4

5 The staff estimates that using the technology referenced in Entergy's ER (NO_x burners with
6 overfire air and selective catalytic reduction [SCR]) the total annual NO_x emissions for a new
7 coal-fired power plant would be approximately 522 tons. This level of NO_x emissions would
8 be greater than for the OL renewal alternative since a nuclear power plant releases almost
9 no NO_x during normal operations.
10

11 Particulate emissions. The staff estimates that the total annual stack emissions would
12 include 89 tons of filterable total suspended particulates and 21 tons of particulate matter
13 having an aerodynamic diameter less than or equal to 10 μm (PM₁₀) (40 CFR 50.6). As
14 indicated in the PNPS ER, fabric filters or electrostatic precipitators would be used for
15 particulate control. In addition to flue emissions, coal-handling equipment would introduce
16 fugitive particulate emissions from coal piles, reclamation equipment, conveyors, and other
17 sources. Particulate emissions would be greater under the coal alternative than the OL
18 renewal alternative. Fugitive dust would also be generated during the construction of a
19 coal-fired plant and construction vehicles and motorized equipment would further contribute
20 to construction phase air emissions.
21

22 Carbon monoxide emissions. The staff estimates that the total CO emissions from coal
23 combustion would be approximately 544 tons per year. This level of emission is greater
24 than would occur under the OL renewal alternative.
25

26 Hazardous air pollutants including mercury. In December 2000, the EPA issued regulatory
27 findings on emissions of hazardous air pollutants from electric utility steam-generating units
28 (USEPA 2000b). EPA determined that coal- and oil-fired electric utility steam-generating
29 units are significant emitters of hazardous air pollutants. Coal-fired power plants were
30 found by EPA to emit arsenic, beryllium, cadmium, chromium, dioxins, hydrogen chloride,
31 hydrogen fluoride, lead, manganese, and mercury (EPA 2000b). EPA concluded that
32 mercury is the hazardous air pollutant of greatest concern. EPA found that (1) there is a
33 link between coal consumption and mercury emissions; (2) electric utility steam-generating
34 units are the largest domestic source of mercury emissions; and (3) certain segments of the
35 U.S. population (e.g., the developing fetus and subsistence fish-eating populations) are
36 believed to be at potential risk of adverse health effects due to mercury exposures resulting
37 from consumption of contaminated fish (EPA 2000b). Accordingly, EPA added coal- and
38 oil-fired electric utility steam-generating units to the list of source categories under Section
39 112(c) of the CAA for which emission standards for hazardous air pollutants will be issued
40 (EPA 2000b).
41

1 Uranium and thorium. Coal contains uranium and thorium. Uranium concentrations are
2 generally in the range of 1 to 10 parts per million (ppm). Thorium concentrations are
3 generally about 2.5 times greater than uranium concentrations (Gabbard 1993). One
4 estimate is that a typical coal-fired plant released roughly 5.2 tons of uranium and 12.8 tons
5 of thorium in 1982 (Gabbard 1993). The population dose equivalent from the uranium and
6 thorium releases and daughter products produced by the decay of these isotopes has been
7 calculated to be significantly higher than that from nuclear power plants (Gabbard 1993).
8

9 Carbon dioxide. A coal-fired plant would also have unregulated carbon dioxide(CO₂)
10 emissions that could contribute to global warming. The level of emissions from a coal-fired
11 plant would be greater than the OL renewal alternative.
12

13 Summary. The GEIS analysis did not quantify emissions from coal-fired power plants, but
14 implied that air impacts would be substantial. The GEIS also mentioned global warming
15 from unregulated carbon dioxide emissions and acid rain from SO_x and NO_x emissions as
16 potential impacts (NRC 1996). Adverse human health effects such as cancer and
17 emphysema have been associated with the products of coal combustion. The appropriate
18 characterization of air impacts from coal-fired generation would be MODERATE. The
19 impacts would be clearly noticeable, but would not destabilize air quality.
20

21 • **Waste**
22

23 Coal combustion generates waste in the form of ash and scrubber sludge. A 715 gross
24 MW(e) coal-fired plant would generate approximately 222,000 tons of such waste annually
25 for 40 years. The waste would be disposed onsite, accounting for approximately 142 ac of
26 land area over the 40-year plant life. Impacts of onsite waste disposal to groundwater and
27 surface water could extend beyond the operating life of the plant if leachate and runoff from
28 the waste storage area occurs. Disposal of the waste could noticeably affect land use and
29 groundwater quality, but with appropriate management and monitoring, it would not
30 destabilize any resources. After closure of the waste site and revegetation, the land could
31 be available for other uses.
32

33 In May 2000, the EPA issued a "Notice of Regulatory Determination on Wastes From the
34 Combustion of Fossil Fuels (65 FR 32214 [EPA 2000a]). EPA concluded that some form of
35 national regulation is warranted to address coal combustion waste products because: (a)
36 the composition of these wastes could present danger to human health and the
37 environment under certain conditions; (b) EPA has identified 11 documented cases of
38 proven damages to human health and the environment by improper management of these
39 wastes in landfills and surface impoundments; (c) present disposal practices are such that,
40 in 1995, these wastes were being managed in 40 percent to 70 percent of landfills and
41 surface impoundments without reasonable controls in place, particularly in the area of

Environmental Impacts of License Renewal

1 groundwater monitoring; and (d) EPA identified gaps in state oversight of coal combustion
2 wastes. Accordingly, EPA announced its intention to issue regulations for disposal of coal
3 combustion waste under subtitle D of the Resource Conservation and Recovery Act
4 (RCRA). In addition to the waste streams generated during plant operations, considerable
5 debris would be generated during construction of a coal fired facility.
6

7 For all of the preceding reasons, the appropriate characterization of impacts from the waste
8 generated by a coal-fired facility (construction and operating phases) is MODERATE; the
9 impacts would be clearly noticeable, but would not destabilize any important resource.
10

- 11 • **Human Health**

12
13 Coal-fired power generation introduces risks to workers from fuel and limestone mining,
14 from fuel and lime/limestone transportation, and from disposal of coal combustion waste. In
15 addition, there are public health risks from inhalation of stack emissions that can be
16 widespread and difficult to quantify. The coal alternative also introduces the risk of coal-pile
17 fires and attendant inhalation risks.
18

19 In the GEIS, the staff stated that there could be human health impacts (cancer and emphy-
20 sema) from inhalation of toxins and particulates, but it did not identify the significance of
21 these impacts (NRC 1996). In addition, the discharges of uranium and thorium from coal-
22 fired plants can potentially produce radiological doses in excess of those arising from
23 nuclear power plant operations (Gabbard 1993).
24

25 Regulatory agencies, including EPA and State agencies, set air emission standards and
26 requirements based on human health impacts. These agencies also impose site-specific
27 emission limits as needed to protect human health. As discussed previously, EPA has
28 recently concluded that certain segments of the U.S. population (e.g., the developing fetus
29 and subsistence fish-eating populations) are believed to be at potential risk of adverse
30 health effects due to mercury exposures from sources such as coal-fired power plants.
31 However, in the absence of more quantitative data, human health impacts from radiological
32 doses and inhaling toxins and particulates generated by burning coal are characterized as
33 SMALL.
34

- 35 • **Socioeconomics**

36
37 Construction of a coal-fired facility at an alternative greenfield site would take approximately
38 four years. The work force would be expected to vary between 800 and 2000 workers
39 during the 4-year construction period (NRC 1996). During construction, the surrounding
40 communities would experience demands on housing and public services that could have
41 MODERATE impacts unless some of the work force is composed of local residents. After

1 construction, the host community would be impacted by the loss of the construction jobs.
2 However, this loss would be offset by the approximately 200 permanent jobs associated
3 with the new facility. Socioeconomic impacts would be greater if the facility were
4 constructed at a rural location than if it were constructed in a more developed area. The
5 staff considers the most appropriate characterization of non-transportation socioeconomic
6 impacts of developing a new greenfield site to be MODERATE to LARGE.

7
8 During the 4-year construction period of the coal-fired unit, up to 2000 construction workers
9 would be working at the site. The addition of these workers would increase traffic on
10 highways and local roads that lead to the construction site. The impact of this additional
11 traffic could have a MODERATE impact on nearby roadways, particularly if the greenfield
12 site is an a rural area.

13
14 Impacts associated with plant operating personnel commuting to work are considered
15 SMALL. The number of plant operating personnel at a new coal-fired facility would be
16 approximately 200. For rail transportation of coal and lime to the greenfield site, impacts
17 are likely to range from MODERATE to LARGE. On average, approximately one 70-car
18 train load per day would deliver coal to the new generating station and one 10-car train load
19 per week would deliver lime to the facility. Should deliveries of coal be accomplished via
20 barge, approximately two barges per week would deliver fuel to the facility. Overall,
21 transportation impacts of coal and lime delivery would be MODERATE to LARGE.

22
23 • **Aesthetics**

24
25 The boiler house and associated air pollution control equipment at a new coal-fired facility
26 could be up to 200 feet (ft) in height and a typical exhaust stack would be somewhere in the
27 range of 400 to 600 ft high. Cooling tower(s) could be either of the mechanical
28 (approximately 75 ft tall) or natural draft type (approximately 400 ft tall). The new
29 generating facility and the plume generated by its cooling towers(s) would be visible from a
30 considerable distance. Additionally, the facility would be noticeable at night due to its 24-
31 hour operating schedule and the need for on-site safety lighting.

32
33 Beyond near site aesthetic impacts, development of a new coal-fired facility at a greenfield
34 site would entail construction of a new transmission line and a new rail spur to bring coal
35 and lime to the plant. The rail spur and transmission line could extend a considerable
36 distance off-site to tie-in points with existing rail and transmission systems. The visual
37 intrusion of these two linear elements, particularly the transmission line, could be significant.
38 Consequently, the overall aesthetic impacts of a new coal-fired facility at a greenfield site
39 are expected to be MODERATE to LARGE.

Environmental Impacts of License Renewal

1 Coal-fired generation would introduce mechanical sources of noise that would be audible
2 off-site. Sources contributing to total noise produced by plant operation are classified as
3 continuous or intermittent. Continuous sources include the mechanical equipment
4 associated with normal plant operations. Intermittent sources include the equipment related
5 to coal handling, solid-waste disposal, on-site activities related to coal and lime delivery, use
6 of outside loudspeakers, and the commuting of plant employees. The incremental noise
7 impacts of a coal-fired plant at a greenfield site are considered to be MODERATE.

8
9 Noise impacts associated with rail delivery of coal and lime to a greenfield site would be
10 most significant for residents living along the new rail spur leading to the plant. Since this is
11 a new generating station site, these residents would not have experienced previous rail
12 noise. Although noise from passing trains significantly raises noise levels near the rail
13 corridor, the short duration of the noise reduces impact. Nevertheless, the impact of noise
14 on residents in the vicinity of the facility and the rail line is considered MODERATE.

15
16 • **Historic and Archaeological Resources**

17
18 Before construction at an alternate greenfield site, studies would likely be needed to
19 identify, evaluate, and address mitigation of the potential impacts of new plant construction
20 on cultural resources. The studies would likely be needed for all areas of potential
21 disturbance at the proposed plant site and along associated corridors where new
22 construction would occur (e.g., roads, transmission corridors, rail lines, or other ROWs).
23 Historic and archaeological resource impacts can generally be effectively managed and
24 therefore, are considered SMALL.

25
26 • **Environmental Justice**

27 Impacts of constructing a coal-fired facility at an alternate greenfield site would depend
28 upon the site chosen and the nearby population distribution. It is expected that these
29 impacts are likely to be SMALL to MODERATE.

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Environmental Impacts of License Renewal

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

Alternate Greenfield Site		
Impact Category	Impact	Comments
Land Use	MODERATE to LARGE	Uses approximately 1215 ac, for plant, offices, parking, transmission line, and rail spur; additional land impacts for coal and limestone mining.
Ecology	MODERATE to LARGE	Impact depends on location and ecology of the site, surface water body used for cooling tower make-up and discharge, and transmission line route, potential habitat loss and fragmentation, reduced productivity and biological diversity.
Water Use and Quality-Surface Water	SMALL to MODERATE	Impact will depend on the volume of water withdrawn and discharged and the characteristics of the surface water body.
Water Use and Quality-Groundwater	SMALL to MODERATE	Impact will depend on the volume of water withdrawn and discharged and the characteristics of the aquifers.
Air Quality	MODERATE	<ul style="list-style-type: none"> • Sulfur oxides (1428 tons/yr) • Nitrogen oxides (522 tons/yr) • Particulates (89 tons/yr of total suspended particulates) (21 tons/yr of PM₁₀) • Carbon Monoxide (544 tons/yr) <p>Small amounts of mercury and other hazardous air pollutants and naturally occurring radioactive materials - mainly uranium and thorium.</p>
Waste	MODERATE	Total volume of approximately 220,000 tons/yr requiring approximately 142 ac for disposal over 40 life of plant.

Environmental Impacts of License Renewal

Table 8-2. (contd)

Alternate Greenfield Site		
Impact Category	Impact	Comments
Human Health	SMALL	Impacts are uncertain but considered SMALL in the absence of more quantitative data.
Socioeconomics	MODERATE to LARGE	Construction impacts depend on location, but could be LARGE if plant is located in a rural area.
Socioeconomics (Transportation)	MODERATE to LARGE	Transportation impacts associated with construction workers and coal and lime shipments. For rail transportation of coal and lime, the impact is considered MODERATE to LARGE. For barge transportation, the impact is considered MODERATE.
Aesthetics	MODERATE to LARGE	Impacts from boiler house, cooling tower, and new transmission line.
Historic and Archeological Resources	SMALL	Alternate location would necessitate cultural resource studies.
Environmental Justice	SMALL to MODERATE	Impacts will vary depending on population distribution and makeup at the site.

8.2.1.2 Once-Through Cooling System

This section discusses the environmental impacts of constructing a coal-fired generating station at a greenfield site using once-through cooling. The impacts (SMALL, MODERATE, or LARGE) of this option are approximately the same as the impacts for a coal-fired plant using the closed-cycle system, with the exception of land use, aesthetics, ecology, and water use. For land use and aesthetics, the impacts would be less, while for ecology and water use the impacts would be greater. Table 8-3 summarizes the incremental differences.

Table 8-3. Summary of Environmental Impacts of Coal-Fired Generation at the PNPS Site with Once-Through Cooling System

Impact Category	Change in Impacts from Closed-Cycle Cooling System
Land Use	Impacts may be less (e.g., through elimination of cooling towers) or greater (e.g., if a reservoir is required).
Ecology	Impact would depend on ecology at the site. Possible impacts associated with entrainment of fish and shellfish in early life stages, impingement of fish and shellfish, and heat shock.
Water Use and Quality-Surface Water	Increased water withdrawal leading to possible water-use conflicts; thermal load higher than with closed-cycle cooling.
Water Use and Quality-Groundwater	No change.
Air Quality	No change.
Waste	No change.
Human Health	No change.
Socioeconomics	No change.
Socioeconomics (Transportation)	No change.
Aesthetics	Elimination of cooling towers and plume.
Historic and Archaeological Resources	No change.
Environmental Justice	No change.

8.2.2 Natural Gas-Fired Generation

The environmental impacts of constructing a natural gas-fired alternative are examined in this section for both the PNPS site and an alternate greenfield site. The staff assumed that a gas-fired plant at the PNPS site could have either a closed or open-cycle cooling system.

The assumptions and numerical values used in Section 8.2.2 are based on the staff’s independent assessment and on information provided by Entergy in the PNPS ER (Entergy 2006). Where information from the PNPS ER was used, it was independently reviewed by the staff and compared to environmental impact information in the GEIS. Impacts

Environmental Impacts of License Renewal

1 of a gas-fired alternative evaluated by the staff assume that the new plant would have a gross
2 electrical capacity of 715 MW(e); this differs from the assumption made in the ER.

3
4 Entergy assumed that a replacement natural gas-fired plant would use combined-cycle
5 technology (Entergy 2006). Furthermore, Entergy, uses a standard-sized gas-fired combined-
6 cycle plant with a net capacity of 585 MW(e) in their analysis. The staff considers the
7 combined-cycle technology to be a reasonable choice for the gas-fired replacement system but
8 that the capacity selected by Entergy underestimates impacts of this technology.

9 Consequently, the staff has evaluated impacts of a hypothetical 715 gross MW(e) gas-fired
10 combined-cycle facility which would essentially fully replace the capacity lost if the PNPS OL is
11 denied. While this approach may be hypothetical, air emissions calculated for a 715 MW(e)
12 gas-fired facility better represent, in the staff's opinion, the implications of denying the PNPS
13 OL.

14
15 The staff has assumed that approximately 50 ac would be needed to construct a new gas-fired
16 plant at either the PNPS site or at an alternate greenfield site. This would include land for the
17 power block and associated infrastructure. Since the PNPS site is not served by a natural gas
18 supply and the nearest significant gas supply line is approximately 5 to 6 mi from the site, it will
19 be necessary to construct a tie-in to that line from the PNPS site. Proximity to a natural gas
20 supply will also be a factor in the selection of a greenfield location for the gas-fired alternative.

21
22 Some of the existing infrastructure at PNPS can be used to serve operations of the gas-fired
23 alternative. Most significantly this would include the transmission lines that currently carry
24 electric power from the plant to the regional distribution system. At an alternate greenfield site,
25 new transmission lines would need to be constructed.

26
27 In performing the impact analysis in Section 8.2.2 the staff reviewed information provided by
28 Entergy, environmental information in the GEIS, and data available in the technical literature.
29 Although the OL renewal period is only 20 years, the impact of operating the natural gas-fired
30 alternative for 40 years is considered (as a reasonable projection of the operating life of a
31 natural gas-fired plant).

32 **8.2.2.1 Closed-Cycle Cooling System**

33
34
35 The overall impacts of the natural gas-fired system using closed-cycle cooling are discussed
36 below and summarized in Table 8-4, at the end of this section (Section 8.2.2.1). The extent of
37 impacts at an alternate greenfield site will depend on the actual location of the selected site.
38
39
40
41

1 • **Land Use**

2
3 For siting at PNPS, existing facilities and infrastructure would be used to the extent
4 practicable, limiting the amount of new construction that would be required. Specifically, the
5 staff assumed that the natural gas-fired replacement plant would use the switchyard,
6 offices, and transmission line ROW. Much of the land that would be used has been
7 previously disturbed. At PNPS, the staff assumed that approximately 50 ac would be
8 needed for the plant and associated infrastructure including cooling tower. There would be
9 an additional temporary impact of up to approximately 10 ac for construction of a gas
10 pipeline from the Plymouth tie-in to the PNPS site.

11
12 For construction at an alternate site, the staff assumed that 50 ac would also be needed for
13 the plant and associated infrastructure (NRC 1996). In addition, land would be needed for
14 construction of a transmission line and for a new gas line to supply fuel to the facility.

15
16 Regardless of where the plant is built, additional land would be required for natural gas
17 wells and collection stations. In the GEIS, the staff estimated that 3600 ac would be
18 needed for gas wells and collection stations to support a 1000 MW(e) plant or about 2600
19 ac for a 715 MW(e) facility (NRC 1996). Overall, land-use impacts of the gas-fired
20 alternative would be MODERATE at the PNPS site and MODERATE to LARGE at a
21 greenfield site.

22
23 • **Ecology**

24
25 The use of cooling towers would be expected to reduce aquatic ecological impacts below
26 those currently being experienced at PNPS. With regard to terrestrial ecological impacts of
27 building a gas-fired alternative, though the site is well built-out for the existing nuclear plant,
28 additional land clearing would be necessary. This could entail some loss of natural habitat
29 with a corresponding impact to terrestrial species. Also, bringing a natural gas pipeline onto
30 the PNPS site may result in some further disturbance to undeveloped areas but it is
31 expected that most of the pipeline construction would be in roadway ROW and, therefore,
32 would not be expected to impact terrestrial species. Overall, given that closed-cycle cooling
33 would be implemented for this alternative, the ecological impacts of developing a gas-fired
34 facility at the PNPS site are considered SMALL.

35
36 Ecological impacts at an alternate site would depend on the nature of the land converted to
37 energy generation and the possible need for a new gas pipeline and/or electric transmission
38 line. Construction of a transmission line and a gas pipeline would be expected to have
39 temporary ecological impacts. Ecological impacts at the plant site and along utility
40 easements could include impacts to threatened or endangered species, wildlife habitat loss
41 and reduced productivity, habitat fragmentation, and a local reduction in biological diversity.

Environmental Impacts of License Renewal

1 Some aquatic ecological impacts would also be expected due to withdrawal of surface water
2 for cooling tower makeup. Overall, the ecological impacts of developing a gas-fired facility
3 at a greenfield site are considered MODERATE.

4 5 • **Water Use and Quality**

6 7 Surface Water

8
9 The natural gas-fired facility described by Entergy in the ER would include a heat-recovery
10 boiler, using waste heat from gas turbines to generate steam. The steam would then turn a
11 turbine-generator. The net result would be an overall reduction in the amount of waste heat
12 that would need to be discharged to the environment in comparison to an equivalent
13 capacity nuclear plant. In addition, since a closed-cycle cooling system would be employed
14 under this alternative, the rate at which water would be withdrawn from Cape Cod Bay, for
15 cooling purposes, would be significantly reduced.

16
17 Plant discharges would consist mostly of cooling tower blowdown, with the discharge having
18 a higher temperature and increased concentration of dissolved solids relative to Cape Cod
19 Bay; there would also be intermittent low concentrations of biocides (e.g., chlorine) in the
20 discharge stream. In addition to the cooling tower blowdown, process waste streams could
21 be discharged as well. However, all discharges would be regulated through a Federally
22 issued National Pollutant Discharge Elimination System (NPDES) permit. Finally, some
23 erosion and sedimentation would probably occur during construction (NRC 1996). Overall,
24 the water quality impacts of implementing the natural gas-fired alternative at the PNPS site
25 are considered SMALL due to the relatively low water withdrawal from Cape Cod Bay.

26
27 A natural gas-fired plant at an alternate greenfield site is also assumed to use a closed-
28 cycle cooling system. The staff assumed that surface water would be used for cooling
29 tower make-up and that the withdrawal rate of make-up water would be small compared to
30 an open-cycle system. The impact on surface waters would depend on the volume of water
31 needed for make-up and the characteristics of the receiving water body. Intake from, and
32 discharge to, any surface body of water would be regulated by a Federal or State issued
33 discharge permit. The impacts would be SMALL. Water-quality impacts from
34 sedimentation during construction have been characterized in the GEIS as SMALL.

35 36 Groundwater

37
38 At the PNPS site, groundwater supplied by the Town of Plymouth would continue to be used
39 for potable water purposes and for certain plant operations requiring fresh water. However,
40 the quantity of groundwater required will be reduced under the gas-fired alternative since
41 the level of staffing would be less than that for current operations. Also, sanitary wastes

1 would continue to be discharged to groundwater, as is currently the case at PNPS, but at a
 2 reduced rate. At an alternate site, groundwater could be used for general plant operations
 3 and for potable water purposes as well. Any groundwater withdrawal would require a permit
 4 from the local permitting authority and impacts on groundwater would depend on the volume
 5 required and characteristics of the water source. Overall impacts to groundwater of a gas-
 6 fired alternative at either the PNPS site or an alternate greenfield site would be SMALL.

7
 8 • **Air Quality**

9
 10 Natural gas is a relatively clean-burning fuel. A new gas-fired generating plant located in
 11 New England would likely need a prevention of significant deterioration permit and an
 12 operating permit under the CAA. A new combined-cycle natural gas power plant would also
 13 be subject to the new source performance standards for such units at 40 CFR Part 60,
 14 Subparts Da and GG. These regulations establish emission limits for particulates, opacity,
 15 SO_x, and NO_x.

16
 17 In 1998, EPA issued a rule requiring 22 eastern states, including Massachusetts, to revise
 18 their state implementation plans to reduce NO_x emissions. NO_x emissions contribute to
 19 violations of the National Ambient Air Quality Standard (40 CFR 50.9) for ozone. The total
 20 amount of nitrogen oxides which can be emitted by each of the 22 states in the year 2007
 21 ozone season (May 1 - September 30) is set out in 40 CFR 51.121(e). For Massachusetts,
 22 the amount is 85,296 tons.

23
 24 EPA has various regulatory requirements for visibility protection in 40 CFR 51, Subpart P,
 25 including a specific requirement for review of any new major stationary source in an area
 26 designated attainment or unclassified under the CAA. Plymouth County has a non-
 27 attainment status for ozone but attains the National Ambient Air Quality Standards for other
 28 air pollutants. The air quality status of an alternate greenfield site would depend on where
 29 that site is located.

30
 31 Section 169A of the CAA establishes a national goal of preventing future and remedying
 32 existing impairment of visibility in mandatory Class I Federal areas when impairment results
 33 from man-made air pollution. EPA issued a new regional haze rule in on July 1, 1999
 34 (64 FR 35714 [EPA 1999]). The rule specifies that for each mandatory Class I Federal area
 35 located within a state, the State must establish goals that provide for reasonable progress
 36 towards achieving natural visibility conditions. The reasonable progress goals must provide
 37 for an improvement in visibility for the most impaired days over the period of the
 38 implementation plan and ensure no degradation in visibility for the least-impaired days over
 39 the same period (40 CFR 51.308[d][1]).
 40
 41

Environmental Impacts of License Renewal

1 If a natural gas-fired plant were located close to a mandatory Class I area, additional air
2 pollution control requirements could be imposed. There are no designated Class I areas in
3 Massachusetts. However, EPA's regional haze rule could apply to an alternate greenfield
4 site, depending on where that site is located.

5
6 EPA issued CAIR in May 2005 (70 FR 25162 [EPA 2005]). CAIR provides a Federal
7 framework requiring certain states to reduce emissions of SO₂ and No_x. EPA anticipates
8 that states will achieve this reduction primarily by limiting emissions from the power
9 generation sector. CAIR covers 28 eastern states and any new fossil-fired power plant sited
10 in Massachusetts would be subject to the CAIR limitations.

11
12 The staff projects the following emissions for the natural gas-fired alternative:

13
14 SO_x - 56 tons/yr
15 No_x - 180 tons/yr
16 CO - 38 tons/yr
17 PM₁₀ - 31 tons/yr
18

19 A natural gas-fired plant would also have unregulated CO₂ emissions that could contribute
20 to global warming. In December 2000, EPA issued regulatory findings on emissions of
21 hazardous air pollutants from electric utility steam-generating units (EPA 2000b). Natural
22 gas-fired power plants were found by EPA to emit arsenic, formaldehyde, and nickel (EPA
23 2000b). Unlike coal and oil-fired plants, EPA did not determine that emissions of hazardous
24 air pollutants from natural gas-fired power plants should be regulated under Section 112 of
25 the CAA.

26
27 The projected emissions would likely be the same whether the gas-fired facility were
28 operated at PNPS or at an alternate greenfield site. Impacts from the above emissions
29 would be clearly noticeable, but would not be sufficient to destabilize air resources overall.

30
31 Construction activities either at PNPS or an alternate greenfield site would result in
32 temporary fugitive dust emissions. Fugitive dust emissions would also occur along the
33 construction route for new gas lines (at either site) or along the route of a new transmission
34 line (greenfield site only). Exhaust emissions would also come from vehicles and motorized
35 equipment used during the construction process.

36
37 The overall air quality impact of a new natural gas-fired plant sited at PNPS or at an
38 alternate greenfield site is considered MODERATE.
39
40
41

1 • **Waste**

2
3 There will be spent SCR catalyst from NO_x emissions control and small amounts of solid-
4 waste products (i.e., ash) from burning natural gas fuel. In the GEIS, the staff concluded
5 that waste generation from gas-fired technology would be minimal (NRC 1996). Gas firing
6 results in very few combustion by-products because of the clean nature of the fuel. Waste-
7 generation impacts would be so minor that they would not noticeably alter any important
8 resource attribute. Construction-related debris would be generated during construction
9 activities.

10
11 In the winter, it may become necessary for a replacement baseload natural-gas fired plant
12 to operate on fuel oil due to lack of gas supply. Oil combustion generates waste in the form
13 of ash, and equipment for controlling air pollution generates additional ash and scrubber
14 sludge. The amount of ash and sludge generated would depend on the type and quantity of
15 fuel oil combusted (e.g. use of Number 2 fuel oil does not produce appreciable ash).

16
17 Overall, the waste impacts would be SMALL for a natural gas-fired plant sited at PNPS or at
18 an alternate greenfield site.

19
20 • **Human Health**

21
22 In Table 8-2 of the GEIS, the staff identifies cancer and emphysema as potential health
23 risks from gas-fired plants (NRC 1996). The risk may be attributable to NO_x emissions that
24 contribute to ozone formation, which in turn contribute to health risks. NO_x emissions from
25 any gas-fired plant would be regulated. For a plant sited in Massachusetts, NO_x emissions
26 would be regulated by the Massachusetts Department of Environmental Protection (MDEP).
27 Human health effects from gas-fired operations are not expected to be detectable and,
28 therefore, the impacts on human health of the natural gas-fired alternative sited at either
29 PNPS or an alternate greenfield site are considered SMALL.

30
31 • **Socioeconomics**

32
33 Construction of a natural gas-fired plant would take approximately 3 years. Peak
34 employment would be approximately 600 workers (NRC 1996). The staff assumed that
35 construction would take place while PNPS continues operation and would be completed by
36 the time it permanently ceases operations. During construction, the communities
37 surrounding the PNPS site would experience demands on housing and public services that
38 could have MODERATE impacts. After construction, nearby communities could be
39 impacted by the loss of jobs. The current PNPS work force (700 workers) would decline
40 through a decommissioning period to a minimal maintenance size.

41

Environmental Impacts of License Renewal

1 The gas-fired plant would introduce a replacement tax base at PNPS or a new tax based on
2 an alternate greenfield site and approximately 150 new permanent jobs.

3
4 In the GEIS (NRC 1996), the staff concluded that socioeconomic impacts from constructing
5 a natural gas-fired plant would not be very noticeable and that the small operational work
6 force would have the lowest socioeconomic impacts of any nonrenewable technology.
7 Compared to the coal-fired and nuclear alternatives, the smaller size of the construction
8 work force, the shorter construction time frame, and the relatively small operations work
9 force would mitigate socioeconomic impacts. For these reasons, socioeconomic impacts
10 associated with construction and operation of a natural gas-fired power plant would be
11 SMALL to MODERATE for siting at PNPS or at an alternate greenfield site.

12
13 Transportation impacts associated with construction and operating personnel commuting to
14 the plant site would depend on the population density and transportation infrastructure in the
15 vicinity of the site. The impacts can be classified as SMALL to MODERATE for siting at
16 PNPS and MODERATE at an alternate greenfield site, particularly if the greenfield site is in
17 a rural area.

18 19 • **Aesthetics**

20
21 If the gas-fired facility was built at the PNPS site, the turbine buildings (approximately 100 ft
22 tall) and exhaust stacks (approximately 125 ft tall) would be visible during daylight hours
23 from the immediately adjacent properties. The cooling tower plume can be expected to be
24 visible from the surrounding vicinity including, at times, the Town of Plymouth. Noise and
25 light from the plant would be detectable in the immediate area. Overall, the aesthetic
26 impacts associated with the gas-fired facility at PNPS are categorized as MODERATE.

27
28 At an alternate greenfield site, the buildings, cooling towers, cooling tower plumes, and the
29 associated transmission line and gas pipeline would be visible offsite. The visual impact of
30 a new transmission line could be especially significant at a greenfield site. Aesthetic
31 impacts would be mitigated if the plant were located in an industrial area adjacent to other
32 power plants. Overall, aesthetic impacts associated with an alternate greenfield site are
33 categorized as MODERATE to LARGE. The most significant contributor to the aesthetic
34 impacts is the new transmission line.

35 36 • **Historic and Archaeological Resources**

37
38 Before construction at PNPS or an alternate greenfield site, studies would likely be needed
39 to identify, evaluate, and address mitigation of the potential impacts of new plant
40 construction on cultural resources. The studies would likely be needed for all areas of
41 potential disturbance at the proposed plant site and along associated corridors where new

1 construction would occur (e.g., roads, transmission and pipeline corridors, or other ROWs).
 2 Impacts to cultural resources can be effectively managed under current laws and
 3 regulations and are likely to be SMALL.
 4

5 • **Environmental Justice**

6
 7 No environmental pathways or locations have been identified that would result in dispro-
 8 proportionately high and adverse environmental impacts on minority and low-income
 9 populations if a replacement natural gas-fired plant were built at the PNPS site. Some
 10 impacts on housing availability and prices during construction might occur, but it is not
 11 expected this would disproportionately affect minority and low-income populations. Closure
 12 of PNPS would result in a decrease in employment of approximately 550 operating
 13 employees (700 existing jobs versus 150 replacement jobs). This loss could possibly be
 14 offset by general economic growth in the eastern Massachusetts area and the loss is not
 15 expected to disproportionately impact low income or minority populations. Overall, impacts
 16 of terminating PNPS operations and replacing its output with a gas-fired facility at the same
 17 site are expected to be SMALL. Impacts at an alternate greenfield site would depend upon
 18 the site chosen and the nearby population distribution, but are likely to also be SMALL.
 19
 20

21 **Table 8-4.** Summary of Environmental Impacts of Natural Gas-Fired Generation at
 22 the PNPS Site and an Alternate Greenfield Site Using Closed-Cycle Cooling
 23

	PNPS Site		Alternate Greenfield Site	
Impact Category	Impact	Comments	Impact	Comments
28 Land Use	MODERATE	50 ac for powerblock, cooling tower(s), offices, roads, parking areas. Additional temporary impact of approximately 10 ac for construction of underground gas pipeline.	MODERATE to LARGE	50 ac for power- block, cooling towers, offices, roads, and parking areas. Additional area for electric and gas transmission lines.
29 Ecology	SMALL	Reduces water withdrawal from Bay but uses some undeveloped area at current PNPS.	MODERATE	Impact depends on location and ecology of the site, surface water body used for make-up and transmission and pipeline routes.

30
 31
 32

Environmental Impacts of License Renewal

Table 8-4. (contd)

	PNPS Site			Alternate Greenfield Site	
	Impact Category	Impact	Comments	Impact	Comments
6	Water Use and Quality-Surface Water	SMALL	Uses a closed-cycle cooling system with natural gas-fired combined-cycle units. This would result in relatively low water withdrawals.	SMALL	Impact depends on volume of water, withdrawal and discharge, and characteristics of surface water body.
9	Water Use and Quality-Groundwater	SMALL	Uses little groundwater beyond current potable water needs.	SMALL	Impact depends on volume of water withdrawal.
13	Air Quality	MODERATE	<ul style="list-style-type: none"> • Sulfur oxides (56 tons/yr) • Nitrogen oxides (180 tons/yr) • Carbon monoxide (38 tons/yr) • PM₁₀ particulates (31 tons/yr) Some hazardous air pollutants	MODERATE	Same emissions as PNPS site
14	Waste	SMALL	Small amount of ash produced.	SMALL	Same waste produced as at the PNPS site.
16	Human Health	SMALL	Impacts considered to be minor.	SMALL	Impacts considered to be minor.
18	Socioeconomics	SMALL to MODERATE	During construction, impacts would be MODERATE. Up to 600 additional workers during the peak of the 3-year construction period, followed by reduction from current PNPS work force of 700 to 150; tax base preserved. Impacts during operation would be SMALL.	MODERATE	During construction, impacts would be MODERATE. Up to 600 additional workers during the peak of the 3-year construction period.
19	Socioeconomics (Transportation)	SMALL to MODERATE	Transportation impacts associated with construction workers.	MODERATE	Transportation impacts associated with construction workers.
21	Aesthetics	MODERATE	Aesthetic impact due to impact of new plant and cooling towers.	MODERATE to LARGE	Potential impacts would be from the new plant, cooling towers, and new transmission line.

Table 8-4. (contd)

PNPS Site			Alternate Greenfield Site	
Impact Category	Impact	Comments	Impact	Comments
Historic and Archeological Resources	SMALL	Potential impacts can likely be effectively managed.	SMALL	Potential impacts can likely be effectively managed.
Environmental Justice	SMALL	Impacts on minority and low-income communities should be similar to those experienced by the population as a whole.	SMALL	Approximately same as for PNPS site.

8.2.2.2 Once-Through Cooling System

This section discusses the environmental impacts of constructing a natural gas-fired facility at the PNPS site using once-through cooling. The impacts of this option are generally the same as the impacts for a natural gas-fired plant using the closed-cycle system with some exceptions. The principal exceptions are that ecological and water quality impacts of once-through cooling would be greater than for closed-cycle cooling. Also, the aesthetic impacts of the cooling tower plume would be eliminated for the once-through cooling scenario. Table 8-5 summarizes the differences.

8.2.3 Nuclear Power Generation

Since 1997, the NRC has certified four new standard designs for nuclear power plants under 10 CFR Part 52, Subpart B. These designs are the 1300 MW(e) U.S. Advanced Boiling Water Reactor (10 CFR 52, Appendix A), the 1300 MW(e) System 80+ Design (10 CFR 52, Appendix B), the 600 MW(e) AP600 Design (10 CFR 52, Appendix C) and the 1000 MW(e) AP1000 Design (10 CFR Part 52, Appendix I). All of these plants are light-water reactors. Although no applications for a construction permit or a combined license based on these certified designs have been submitted to NRC, the submission of the design certification applications indicates continuing interest in the possibility of licensing new nuclear power plants. In addition, recent escalation in prices of natural gas and oil have made new nuclear power plant construction more attractive from a cost standpoint.

Environmental Impacts of License Renewal

Table 8-5. Summary of Environmental Impacts of Natural Gas-Fired Generation at the PNPS Site with Once-Through Cooling

Impact Category	Change in Impacts from Closed-Cycle Cooling System
Land Use	Impacts may be less through elimination of cooling towers.
Ecology	Potentially greater impacts associated with entrainment of fish and shellfish in early life stages, impingement of fish and shellfish, and heat shock.
Water Use and Quality-Surface Water	Increased water withdrawal leading to higher thermal load than with closed-cycle cooling.
Water Use and Quality-Groundwater	No change.
Air Quality	No change.
Waste	No change.
Human Health	No change.
Socioeconomics	No change.
Socioeconomics (Transportation)	No change.
Aesthetics	Elimination of cooling towers reduces visual impacts.
Historic and Archaeological Resources	No change.
Environmental Justice	No change.

As a result of the increased interest in new nuclear facilities, construction of a nuclear power plant at a greenfield site is considered in this section. The staff assumed that the new nuclear plant would have a 40-year lifetime. Consideration of a new nuclear generating plant at the PNPS site is not addressed in this section due to the lack of sufficient on-site area to support construction of a new generating station, with associated cooling towers, while maintaining operation of the existing plant.

NRC has summarized environmental data associated with the uranium fuel cycle in Table S-3 of 10 CFR 51.51. The impacts shown in Table S-3 are representative of the impacts that would be associated with a replacement nuclear power plant built to one of the certified designs, sited at a greenfield site. The impacts shown in Table S-3 are for a 1000 MW(e) reactor and would need to be adjusted to reflect impacts of a new 715 MW(e) nuclear facility. The environmental impacts associated with transporting fuel and waste to and from a light-water cooled nuclear

1 power reactor are summarized in Table S-4 of 10 CFR 51.52. The summary of NRC's findings
2 on NEPA issues for license renewal of nuclear power plants in Table B-1 of 10 CFR 51
3 Subpart A, Appendix B, is also relevant, although not directly applicable, for consideration of
4 environmental impacts associated with the operation of a replacement nuclear power plant.
5 Additional environmental impact information for a replacement nuclear power plant using
6 closed-cycle cooling is presented in Section 8.2.3.1 and in Section 8.2.3.2 for the once-through
7 cooling scenario.

8.2.3.1 Closed-Cycle Cooling System

10
11 The impacts of constructing a nuclear generating station at a greenfield site using closed-cycle
12 cooling are discussed in this section and summarized in Table 8-6, at the end of this section
13 (Section 8.2.3.1). It should be noted, however, that the scale of impacts at the greenfield site
14 will depend largely on characteristics of the site actually selected for the project.

- 16 • **Land Use**

17
18 Land-use impacts at a greenfield site would be significant since the new nuclear plant, with
19 its associated closed-cycle cooling system, would entail development on approximately 350
20 ac of land area. In addition, property would be needed to construct a transmission line from
21 the greenfield site to the nearest tie-in with the regional transmission system. Also, it may
22 be necessary to construct a rail spur or pier at the alternate site to bring in equipment during
23 construction. Depending particularly on transmission line routing, siting a new nuclear plant
24 at an alternate greenfield site could result in MODERATE to LARGE land-use impacts.

- 26 • **Ecology**

27
28 Ecological impacts at an alternate site would result from both construction and operation of
29 the replacement nuclear facility. Even assuming siting at a previously disturbed location,
30 the terrestrial ecological impacts could include wildlife habitat loss, reduced productivity,
31 habitat fragmentation, and a local reduction in biological diversity. Construction of a
32 transmission line would further exacerbate terrestrial impacts but would be highly dependent
33 on the length of line and the specific habitat conditions in that particular locale.

34
35 Drawing on a local surface water body for cooling tower make-up could have adverse
36 aquatic resource impacts. Additional impacts could occur from the discharge of cooling
37 tower blow-down to the surface water body. Overall, ecological impacts at an alternate site
38 are expected to range from MODERATE to LARGE with the principal issue likely to be the
39 loss of habitat resulting from onsite and offsite construction.

Environmental Impacts of License Renewal

- **Water Use and Quality**

Surface Water

Construction and operation of a nuclear facility on a greenfield site could potentially impact water use and quality in several ways. Construction of the plant would entail significant disruption to the greenfield site resulting in potential soil erosion and sediment discharge to adjoining waterways. In addition, construction activities involve substantial use of diesel driven equipment and lubricants and cleaning agents. While construction activities are regulated under various Federal and State stormwater management programs, some potential will exist for release of contaminants to nearby surface water bodies.

During operation, the facility's cooling tower(s) would draw on a local surface water resource for make-up of evaporative losses. In addition, other plant systems may use surface waters for supplemental cooling and plant potable water needs. These may also be obtained from a surface water body. Discharges to surface waters from plant operations would also occur. These could include cooling tower blowdown and possibly treated process and sanitary wastes.

All withdrawals from and discharges to surface waters would be regulated by Federal and State programs designed to protect water quality. The staff concludes that impacts to water quality of construction and operation at a greenfield site, would be SMALL.

Groundwater

It is possible that groundwater could be used as a source of potable water for a nuclear plant developed at a greenfield site and, depending on hydrogeologic conditions at the site, possibly as a source of water for general plant purposes. In addition, process and sanitary wastes could be discharged to groundwater after receiving the appropriate level of treatment. Discharges to, and withdrawals from, groundwaters are regulated by Federal and State environmental agencies under programs designed to protect such resources. Thus, the impacts of operating a nuclear facility on groundwater resources at a greenfield site are expected to be SMALL.

1 • **Air Quality**

2
3 Construction of a new nuclear plant sited at an alternate site would result in fugitive
4 emissions during the construction process. Exhaust emissions would also come from
5 vehicles and motorized equipment used during the construction process. An operating
6 nuclear plant would have minor air emissions associated with diesel generators and other
7 minor intermittent sources. Overall, air emissions and associated impacts resulting from
8 operation of a nuclear facility at an alternate greenfield site are considered SMALL.

9
10 • **Waste**

11
12 Siting a nuclear plant at an alternate greenfield site would not alter radwaste generation
13 rates currently occurring at PNPS. The waste impacts associated with operation of a
14 nuclear power plant are set out in Table B-1 of 10 CFR 51, Subpart A, Appendix B.
15 However, considerable debris would be generated during construction of the new facility,
16 resulting in the need to dispose of the material at an appropriate offsite disposal facility.
17 Overall, waste impacts of constructing and operating a nuclear facility at an alternate
18 greenfield site are considered SMALL.

19
20 • **Human Health**

21
22 Human health impacts for an operating nuclear power plant are set out in 10 CFR 51
23 Subpart A, Appendix B, Table B-1. Overall, the staff concludes that human health impacts
24 at an alternate greenfield site would be SMALL.

25
26 • **Socioeconomics**

27
28 The construction period peak work force associated with construction of a new nuclear
29 power plant is currently unquantified (NRC 1996). In the absence of quantitative data, the
30 staff assumed a construction period of 6 years and a peak work force of up to 2500 for a
31 715 gross MW(e) nuclear facility at a greenfield site.

32
33 The communities around the greenfield site would have to absorb the impacts of the large,
34 temporary construction work force and a permanent work force of approximately 700 that
35 would operate the 715 MW(e) nuclear facility. In the GEIS (NRC 1996), the staff indicated
36 that socioeconomic impacts of the temporary and permanent work forces would be larger at
37 a rural site than at an urban site because more of the peak construction work force would
38 need to move into the area to work.

Environmental Impacts of License Renewal

1 Consequently, the staff concludes that socioeconomic impacts of constructing and
2 operating a nuclear facility at a greenfield site would range from MODERATE to LARGE
3 depending on specific conditions at the greenfield location.

4
5 Transportation-related impacts associated with construction workers commuting to an
6 alternate greenfield site are site dependent, but could be MODERATE. Transportation
7 impacts related to commuting of plant operating personnel would also be site dependent,
8 but typically are characterized as SMALL to MODERATE.

9
10 • **Aesthetics**

11
12 Developing a greenfield site for a 715 MW(e) nuclear facility would result in aesthetic
13 impacts at that site from the new structures associated with the plant including buildings,
14 cooling towers, and the plume associated with the cooling towers. There would also be a
15 potentially significant aesthetic impact from construction of a new transmission line to
16 connect to the new plant to the regional transmission network.

17
18 Noise and light due to construction and plant operations would be detectable offsite. The
19 impact of noise and light would be mitigated if the plant is located in an industrial area
20 adjacent to other power plants. Overall, the aesthetic impacts associated with locating a
21 new nuclear facility at a greenfield site can be categorized as MODERATE to LARGE. The
22 greatest contributors to this categorization are the aesthetic impacts of cooling tower
23 plumes and the new transmission line.

24
25 • **Historic and Archaeological Resources**

26
27 A cultural resource inventory would be needed before construction could begin at a
28 greenfield site if that property has not been previously surveyed. Other lands, if any, that
29 are acquired to support the plant would also likely need an inventory of field cultural
30 resources, identification and recording of existing historic and archaeological resources, and
31 possible mitigation of adverse effects from subsequent ground-disturbing actions related to
32 plant construction. Impacts to cultural resources can be effectively managed under current
33 law, and are likely to be SMALL.

34
35 • **Environmental Justice**

36
37 Whether or not there would be disproportionate impacts to minority and low income
38 populations resulting from construction and operation of a nuclear facility at a greenfield site
39 would depend upon the site chosen and the nearby population distribution. Under a wide
40 range of site circumstances, it is expected that the impacts would range from SMALL to
41 MODERATE.

Environmental Impacts of License Renewal

Table 8-6. Summary of Environmental Impacts of New Nuclear Power Generation at an Alternate Greenfield Site Using Closed-Cycle Cooling

Alternate Greenfield Site		
Impact Category	Impact	Comments
Land Use	MODERATE to LARGE	Approximately 350 ac required onsite, plus additional land for transmission line.
Ecology	MODERATE to LARGE	Impact depends on location and ecology of the site, surface water body used for intake and discharge, and transmission line route; potential habitat loss and fragmentation; reduced productivity and biological diversity.
Water Use and Quality- Surface water	SMALL	Impact will depend on the volume of water withdrawn and discharged and the characteristics of the surface water body.
Water Use and Quality- Groundwater	SMALL	Impact will depend on the volume of water withdrawn and discharged and the characteristics of the local aquifers.
Air Quality	SMALL	Emissions from new nuclear plant expected to be minor.
Waste	SMALL	Debris waste will be generated during construction, and would be disposed at an appropriate off-site facility.
Human Health	SMALL	Human health impacts for nuclear facility considered small.
Socioeconomics	MODERATE to LARGE	Construction impacts depend on location. Impacts at a rural location could be LARGE.
Socioeconomics (Transportation)	MODERATE	Transportation impacts of construction workers could be MODERATE. Transportation impacts of commuting plant personnel could be SMALL to MODERATE.
Aesthetics	MODERATE to LARGE	Greatest impact is from cooling towers and new transmission line.
Historic and Archeological Resources	SMALL	Any potential impacts can likely be effectively managed.
Environmental Justice	SMALL to MODERATE	Impacts will vary depending on population distribution and make-up at the greenfield site.

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Environmental Impacts of License Renewal

8.2.3.2 Once-Through Cooling System

This section discusses the environmental impacts of constructing a replacement nuclear power plant at a greenfield site using once-through cooling. While many impacts (SMALL, MODERATE, or LARGE) of this option are generally the same as the impacts for a nuclear power plant using a closed-cycle system, there are environmental differences between the two cooling system alternatives. Table 8-7 summarizes the incremental differences.

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

Impact Category	Change in Impacts from Closed-Cycle Cooling System
Land Use	Impacts may be less (through elimination of cooling towers).
Ecology	Impacts would depend on ecology at the site. Potential impacts associated with entrainment of fish and shellfish in early life stages, impingement of fish and shellfish, and heat shock.
Water Use and Quality-Surface Water	Increased water withdrawal leading to possible water-use conflicts. Thermal load higher than with closed-cycle cooling.
Water Use and Quality-Groundwater	No change.
Air Quality	No change.
Waste	No change.
Human Health	No change.
Socioeconomics	No change.
Socioeconomics (Transportation)	No change.
Aesthetics	Elimination of cooling towers and plume will reduce visual impacts.
Historic and Archaeological Resources	No change.
Environmental Justice	No change.

8.2.4 Purchased Electrical Power

If available, purchased power could potentially obviate the need to renew the PNPS OL. However, while the concept of purchasing power is plausible, replacing the 715 MW(e) of capacity that would be lost if the PNPS OL were not renewed with purchased power, without any new generating facilities being built, is not a likely scenario. This is a result of the growing demand for power in New England and the fact that many of the region's power plants are close to retirement (DOE/EIA 2006a). As a result, DOE has stated that to meet demand, the region will have to invest in both new local generating capacity and new transmission capacity to bring purchased power into the area.

If power to replace PNPS capacity were to be purchased from sources within the U.S., the generating technology would likely be one of those described in this draft SEIS and in the GEIS (probably coal, natural gas, or nuclear). The description of the environmental impacts of other technologies in Chapter 8 of the GEIS is representative of the impacts of purchasing electrical power from a domestic source. Thus, the environmental impacts of imported power would still occur, but would be located elsewhere within the region or nation.

Beyond U.S. sources of purchased power, imported power from Canada or Mexico is unlikely to be available for replacement of PNPS capacity. In Canada, approximately 25 percent of the energy consumed within the country comes from renewable energy sources, principally hydropower (DOE/EIA 2005). Canada's output of electricity from nuclear power is projected to remain more or less flat between 2010 (114 billion kWh) and 2025 (112 billion kWh) (DOE/EIA 2005). EIA projects that total gross U.S. imports of electricity from Canada and Mexico will decrease from 42.3 billion kWh in 2010 to 29.4 billion kWh in year 2020 and to 26.9 billion kWh in year 2030 (DOE/EIA 2006a). Over the same period there is essentially no firm power projected to be exported from the U.S. to either Canada or Mexico. Consequently, it is unlikely that electricity imported from Canada or Mexico would be able to replace the PNPS lost capacity.

8.2.5 Other Alternatives

Other generation technologies considered by NRC are discussed in the following paragraphs.

8.2.5.1 Oil-Fired Generation

The EIA projects that oil-fired plants will account for very little of the new generating capacity in the U.S. during the 2004 to 2030 time frame because of continually rising fuel costs (DOE/EIA 2006a). Thus, an oil-fired replacement for the capacity that would be lost if PNPS ceases operation is not considered further in this draft SEIS.

1 **8.2.5.2 Wind Power**

2
3 Wind power, by itself, is not suitable for large base load capacity. As discussed in Section 8.3.1
4 of the GEIS, wind has a high degree of intermittency, and average annual capacity factors for
5 wind plants are relatively low (on the order of 30 percent). Wind power, in conjunction with
6 energy storage mechanisms, might serve as a means of providing base load power. However,
7 current energy storage technologies are too expensive for wind power to serve as a large base
8 load generator.

9
10 As a renewable resource, most regions of the U.S. have been classified according to wind
11 power classes, which are based on typical wind speeds. These classes range from Class 1
12 (the lowest) to Class 7 (the highest). In general, at 50 meters (m) (approximately 164 ft),
13 regions classified as being in wind power Class 4 or higher can be useful for generating wind
14 power with large turbines. Some locations in the Class 3 category could also generate useful
15 energy based on wind speeds at 80 meters rather than at 50 meters because of possibly high
16 wind shears. Given the advances in technology, a number of locations in the Class 3 areas
17 may be suitable for utility-scale wind development.

18
19 Massachusetts has wind resources consistent with utility-scale production. Excellent-to-
20 outstanding wind resources can be found on the northern part of Cape Cod and good-to-
21 excellent areas are found along the southern part of Cape Cod and along the shore of Martha's
22 Vineyard and Nantucket. In western Massachusetts, excellent wind resources can be found
23 along ridgelines of the Berkshires (DOE/NREL 2003).

24
25 As of July 31, 2006 there were 10,039 MW(e) of installed wind energy capacity in the U.S. of
26 this capacity, only about three MW(e) is installed in Massachusetts. However, several wind
27 energy projects are in the planning stages within the Commonwealth including Berkshire Wind
28 Farm (15 MW[e]), Hoosac Wind (30 MW[e]), and Cape Wind (468 MW[e]) (AWEA 2006).
29 Cape Wind planned for Nantucket Sound is the largest wind energy project contemplated for
30 Massachusetts. Cape Wind would take advantage of the strong prevailing winds occurring
31 along the New England coastline.

32
33 Construction of a new 715 MW(e) generating facility using New England's available wind
34 resources would disturb a significant land area. A reliable 715 MW(e) wind generating facility
35 would require placement of generators with two or three times as much capacity as the PNPS
36 facility, which operates with capacity factors over 85 percent typically, and in some years with
37 capacity factors of over 95 percent. Several thousand acres of land would be needed for the
38 alternate wind farm and the land would have to be situated in Class 3 or better wind resource
39 areas of Massachusetts or elsewhere in New England. Given the extensive land requirements
40 and the variability of energy output, developing a wind facility to replace PNPS is not considered
41 to be reasonable.

8.2.5.3 Solar Power

Solar technologies use the sun's energy and light to provide heat and cooling, light, hot water, and electricity for homes, businesses, and industry. In the GEIS, the staff noted that by its nature, solar power is intermittent. Therefore, solar power by itself is not suitable for base load capacity and is not a feasible alternative to license renewal of PNPS. The average capacity factor of photovoltaic cells is about 25 percent, and the capacity factor for solar thermal systems is about 25 to 40 percent. Solar power, in conjunction with energy storage mechanisms, might serve as a means of providing base load power. However, current energy storage technologies are too expensive to permit solar power to serve as a large base load generator. Therefore, solar power technologies (photovoltaic and thermal) cannot currently compete with conventional fossil-fueled technologies in grid-connected applications, due to high costs per kilowatt of capacity (NRC 1996).

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

The PNPS site receives approximately 3 to 3.5 kWh of solar radiation per square meter per day, compared to 6 to 8 kWh of solar radiation per square meter per day in areas of the western U.S., such as California, which are most promising for solar technologies. Because of the natural resource impacts (land and ecological), the area's relatively low rate of solar radiation, and high cost, solar power is not deemed a feasible baseload alternative to renewal of the PNPS OL. Some solar power may substitute for electric power in rooftop and building applications. Implementation of non-rooftop solar generation on a scale large enough to replace PNPS would likely result in LARGE environmental impacts.

8.2.5.4 Hydropower

In Section 8.3.4 of the GEIS, the staff points out hydropower's percentage of U.S. generating capacity is expected to decline because hydroelectric facilities have become difficult to site as a result of public concern about flooding, destruction of natural habitat, and alteration of natural river courses.

Environmental Impacts of License Renewal

1 The staff estimated in the GEIS that land requirements for hydroelectric power are
2 approximately 1 million ac per 1000 MW(e). Due to the relatively low amount of undeveloped
3 hydropower resource in Massachusetts and elsewhere in New England, and the large land use
4 and related environmental and ecological resource impacts associated with siting hydroelectric
5 facilities large enough to replace PNPS, the staff concludes that hydropower is not a feasible
6 alternative to PNPS OL renewal.

8 **8.2.5.5 Geothermal Energy**

9
10 Geothermal energy has an average capacity factor of 90 percent and can be used for baseload
11 power where available. However, geothermal technology is not widely used as baseload
12 generation due to the limited geographical availability of the resource and immature status of
13 the technology (NRC 1996). As illustrated by Figure 8.4 in the GEIS, geothermal plants are
14 most likely to be sited in the western continental U.S., Alaska, and Hawaii where hydrothermal
15 reservoirs are prevalent. There is no feasible eastern location for geothermal capacity to serve
16 as an alternative to PNPS. The staff concludes that geothermal energy is not a feasible
17 alternative to renewal of the PNPS OL.

18 **8.2.5.6 Wood Waste**

19
20
21 The use of wood waste to generate electricity is largely limited to those states with significant
22 wood resources, such as California, Maine, Georgia, Minnesota, Oregon, Washington, and
23 Michigan. Electric power is generated in these states by the pulp, paper, and paperboard
24 industries, which consume wood and wood waste for energy, benefitting from the use of waste
25 materials that could otherwise represent a disposal problem.

26
27 A wood-burning facility can provide baseload power and operate with an average annual
28 capacity factor of around 70 to 80 percent and with 20 to 25 percent efficiency (NRC 1996).
29 However, the fuels required are variable and site-specific. A significant barrier to the use of
30 wood waste to generate electricity is the high delivered-fuel cost and high construction cost per
31 MW of generating capacity. The larger wood-waste power plants are only 40 to 50 MW(e) in
32 size. Estimates in the GEIS suggest that the overall level of construction impact per MW of
33 installed capacity should be approximately the same as that for a coal-fired plant, although
34 facilities using wood waste for fuel would be built at smaller scales. Like coal-fired plants,
35 wood-waste plants require large areas for fuel storage and processing and involve the same
36 type of combustion equipment.

37
38 Due to uncertainties associated with obtaining sufficient wood and wood waste to fuel a base
39 load generating facility, ecological impacts of large-scale timber cutting (e.g., soil erosion and
40 loss of wildlife habitat), and low efficiency, the staff has determined that wood waste is not a
41 feasible alternative to renewing the PNPS OL.

8.2.5.7 Municipal Solid Waste

Municipal waste combustors incinerate the waste and use the resultant heat to generate steam, hot water, or electricity. The combustion process can reduce the volume of waste by up to 90 percent and the weight of the waste by up to 75 percent. Municipal waste combustors use two basic types of technologies: mass burn and refuse-derived fuel. Mass burning technologies are most commonly used in the United State (U.S.). These technologies process raw municipal solid waste “as is,” with little or no sizing, shredding, or separation before combustion. Growth in the municipal waste combustion industry slowed dramatically during the 1990s after rapid growth during the 1980s. The slower growth was due to three primary factors: (1) the Tax Reform Act of 1986, which made capital-intensive projects such as municipal waste combustion facilities more expensive relative to less capital-intensive waste disposal alternative such as landfills; (2) the 1994 Supreme Court decision (*C&A Carbone, Inc. v. Town of Clarkstown*), which struck down local flow control ordinances that required waste to be delivered to specific municipal waste combustion facilities rather than landfills that may have had lower fees; and (3) increasingly stringent environmental regulations that increased the capital cost necessary to construct and maintain municipal waste combustion facilities (DOE/EIA 2006a).

The decision to burn municipal waste to generate energy is usually driven by the need for an alternative to landfills rather than by energy considerations. The use of landfills as a waste disposal option is likely to increase in the near term; however, it is unlikely that many landfills will begin converting waste to energy because of unfavorable economics, particularly with electricity prices declining in real terms. EIA projects that between 2004 and 2030, the average price of electricity in constant dollars (2004) will rise in the near term, then decline and finally rise steadily resulting in a net modest decline over the entire study period (DOE/EIA 2006a).

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

Currently there are approximately 89 waste-to-energy plants operating in the U.S.. These plants generate approximately 2700 MW(e), or an average of approximately 30 MW(e) per plant (IWSA 2006), much smaller than needed to replace the 715 MW(e) of PNPS.

The initial capital costs for municipal solid-waste plants are greater than for comparable steam-turbine technology at wood-waste facilities. This is due to the need for specialized waste-separation and -handling equipment for municipal solid waste (NRC 1996). Furthermore, estimates in the GEIS suggest that the overall level of construction impact from a waste-fired

Environmental Impacts of License Renewal

1 plant should be approximately the same as that for a coal-fired plant. Additionally, waste-fired
2 plants have the same or greater operational impacts (including impacts on the aquatic
3 environment, air, and waste disposal). Some of these impacts would be moderate, but still
4 larger than the environmental effects of license renewal of PNPS. Therefore, municipal solid
5 waste would not be a feasible alternative to renewal of the PNPS OL, particularly at the scale
6 required.

8.2.5.8 Other Biomass-Derived Fuels

7
8
9
10 In addition to wood and municipal solid-waste fuels, there are several other concepts for fueling
11 electric generators, including burning crops, converting crops to a liquid fuel such as ethanol,
12 and gasifying crops (including wood waste). In the GEIS, the staff points out that none of these
13 technologies has progressed to the point of being competitive on a large scale, or of being
14 reliable enough to replace a baseload plant such as PNPS. For these reasons, such fuels do
15 not offer a feasible alternative to renewal of the PNPS OL.

8.2.5.9 Fuel Cells

16
17
18
19 Fuel cells work without combustion and its environmental side effects. Power is produced
20 electrochemically by passing a hydrogen-rich fuel over an anode and air over a cathode and
21 separating the two by an electrolyte. The only by-products are heat, water, and CO₂. Hydrogen
22 fuel can come from a variety of hydrocarbon resources by subjecting them to steam under
23 pressure. Natural gas is typically used as the source of hydrogen.

24
25 Phosphoric acid fuel cells are generally considered first-generation technology. These fuel cells
26 are commercially available at a cost of approximately \$4500 per kW of installed capacity
27 (DOE/NETL 2005). Higher-temperature second-generation fuel cells achieve higher fuel-to-
28 electricity and thermal efficiencies. The higher temperatures contribute to improved efficiencies
29 and give the second-generation fuel cells the capability to generate steam for cogeneration and
30 combined-cycle operations.

31
32 The DOE has an initiative to reduce fuel cell costs to as low as \$400 per kW of installed
33 capacity. For comparison, the installed capacity cost for a natural gas-fired combined-cycle
34 plant is about \$456 per kW (DOE/NETL 2005). As market acceptance and manufacturing
35 capacity increase, natural gas fuel cells plants in the 50- to 100-MW(e) range are expected to
36 become available. At the present time, however, fuel cells are not economically competitive
37 with other alternatives for base-load electricity generation. Fuels cells are, consequently, not a
38 feasible alternative to renewal of the PNPS OL.

8.2.5.10 Delayed Retirement

According to Entergy, delaying the retirement of existing plants they own would be unlikely to off set the loss of 715 MW(e) of PNPS capacity over the 20 year OL renewal period (Entergy 2006). Also, as stated by DOE (August 2006), New England depends on a number of older plants that are close to retirement. Thus, delaying retirement of older facilities is not considered to be a viable alternative to the reliable base load capacity of PNPS.

8.2.5.11 Conservation

Massachusetts, as have most other New England states, has initiated state-wide programs to reduce both peak demands and daily energy usage (Commonwealth of Massachusetts 2004). On a state-wide basis, energy savings ascribed to the Massachusetts Energy Efficiency Programs were estimated to be 241 million kWh in 2002 (Commonwealth of Massachusetts 2004). However, demand-side energy consumption reductions are incorporated in State and Federal load forecasts and continue to show an increase in energy demand, both nationally and for New England, over the next several decades (DOE/EIA 2006a). Thus, conservation alone cannot be used as an alternative to the PNPS facility; and demand-side management cannot be considered a reasonable alternative to replacement of the entire output of PNPS.

8.2.6 Combination of Alternatives

There are numerous possible combinations of alternatives that can be considered to replace the 715 gross MW(e) capacity of PNPS. However, many of these combinations would not be realistic based on the economics of developing central electric generating stations. For instance, it would be possible to consider a reduced scale coal or nuclear alternative to PNPS in combination with a technology based on renewable resources. However, the economics of owning and operating coal and nuclear plants largely preclude construction of intermediate size or small units. Thus, any realistic combination of alternatives would not include reduced scale coal or nuclear facilities.

It would, however, be plausible to consider a gas-fired system to replace a portion of PNPS output since gas-fired facilities are modular in nature and can be developed economically at output capacities well below 715 MW(e). The scale of a gas-fired system that would be installed at PNPS as part of a strategy to replace its 715 MW(e) output would be heavily dependent upon the generating capacity that could realistically be picked up by new systems based on renewable resources and by conservation. As presented in Section 8.2.5.11, conservation by means of DSM would appear to offer only a modest opportunity to replace

Environmental Impacts of License Renewal

1 some of PNPS output. Thus, a combination that considers a reduced scale gas-fired system
2 together with conservation would not have impacts significantly different than those presented
3 in Section 8.2.2 for a full scale gas-fired replacement, because conservation could not be
4 reasonably assumed to replace much of the PNPS output.

5
6 Therefore, the combination considered herein, for illustrative purposes, is to replace the output
7 of PNPS with 350 MW(e) of gas-fired capacity at the PNPS site, 250 MW(e) of renewable wind
8 capacity at upland locations in New England, and only 115 MW(e) of conservation derived from
9 DSM programs. Table 8-8 contains a summary of the environmental impacts of this assumed
10 combination of alternatives.

11 **8.3 Summary of Alternatives Considered**

12
13 The environmental impacts of the proposed action, renewal of the PNPS OL are SMALL or
14 MODERATE for all impact categories, except for collective offsite radiological impacts from the
15 fuel cycle and from high-level waste (HLW) and spent fuel disposal. Collective off-site
16 radiological impacts from the fuel cycle and from HLW and spent fuel disposal were not
17 assigned a single significance level but were determined by the Commission to be Category 1
18 issues nonetheless. The alternative actions, i.e., no-action alternative (discussed in Section
19 8.1), new generation alternatives (from coal, natural gas, and nuclear; discussed in Sections
20 8.2.1 through 8.2.3, respectively), purchased electrical power (discussed in Section 8.2.4),
21 alternative technologies (discussed in Section 8.2.5), and the combination of alternatives
22 (discussed in Section 8.2.6) were considered.

23
24 The no-action alternative would require the replacement of electrical generating capacity by
25 (1) DSM and energy conservation, (2) power purchased from other electricity providers, (3)
26 generating alternatives other than PNPS, or (4) some combination of these options. For each
27 of the new generation alternatives (coal, natural gas, and nuclear), the environmental impacts
28 would not be less than the impacts of license renewal, and in most cases would likely be
29 greater. For example, the land-disturbance impacts resulting from construction of any new
30 facility would be greater than the impacts of continued operation of PNPS. The impacts of
31 electrical power purchased outside the New England region would still occur, but would occur
32 elsewhere as well. Alternative technologies are not considered feasible at this time and it is
33 very unlikely that the environmental impacts of any reasonable combination of generation and
34 conservation options could be reduced to the level of impacts associated with renewal of the
35 PNPS OL.

36
37 In conclusion, the staff has determined that the alternative actions, including the no-action
38 alternative, may have environmental effects in at least some impact categories that reach
39 MODERATE or LARGE significance.
40

Environmental Impacts of License Renewal

Table 8-8. Summary of Environmental Impacts of 350 MW(e) of Natural Gas-Fired Generation, 250 MW(e) from Wind Generation, and 115 MW(e) from DSM Measures

Impact Category	PNPS Site		Wind Farm Site	
	Impact	Comments	Impact	Comments
Land Use	MODERATE	30 ac for powerblock, offices, roads, and parking areas. Additional impact of 10 ac for construction of an underground gas pipeline.	LARGE	1500 ac for wind farm exclusive of transmission lines.
Ecology	SMALL	Uses some undeveloped area at PNPS for cooling tower.	LARGE	Impact depends on location and ecology of the site, but significant habitat disruption likely.
Water Use and Quality-Surface Water	SMALL	Uses cooling towers.	MODERATE	May impact natural drainage patterns of 1500 ac site.
Water Use and Quality-Groundwater	SMALL	Uses less potable water than PNPS.	SMALL	Significant ground water use not anticipated.
Air Quality	MODERATE	Natural Gas-Fired Units at PNPS <ul style="list-style-type: none"> • Sulfur oxides (10 tons/yr) • Nitrogen oxides (148 tons/yr) • Carbon Monoxide (141 tons/yr) • PM₁₀ particulates (324 tons/yr) Some hazardous air pollutants	SMALL	None during operation. Fugitive dust during construction.
Waste	SMALL	Small amount of ash produced from gas-fired plant.	SMALL	No significant waste streams.

Environmental Impacts of License Renewal

Table 8-8. (contd)

	PNPS Site		Wind Farm Site	
Impact Category	Impact	Comments	Impact	Comments
Human Health	SMALL	Impacts considered to be minor.	SMALL	None.
Socioeconomics	SMALL to MODERATE	During construction, impacts would be MODERATE. Up to 500 additional workers during the peak of the 2-3-year construction period, followed by reduction from current PNPS work force of 700; tax base reduced.	MODERATE	Construction impacts depend on location, but could be significant since location is probably a rural area.
Socioeconomics (Transportation)	MODERATE	Transportation impacts associated with construction workers.	MODERATE	Potential impacts associated with construction workers at a rural greenfield location.
Aesthetics	MODERATE	MODERATE aesthetic impacts due to impacts of cooling tower plumes.	LARGE	Significant impact from wind generators and transmission line at a rural site.
Historic and Archeological Resources	SMALL	Any potential impacts at PNPS can likely be effectively managed.	SMALL to LARGE	Large area disturbed with potential significant impact to resources depending on site location.
Environmental Justice	SMALL	Impacts on minority and low-income communities should be similar to those experienced by the population as a whole.	SMALL to LARGE	Impacts vary depending on population distribution and makeup at rural site.

8.4 References

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

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

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

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

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

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

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9.0 Summary and Conclusions

1 By letter dated January 25, 2006, Entergy Nuclear Operations, Inc. (Entergy) submitted an
2 application to the U.S. Nuclear Regulatory Commission (NRC) to renew the operating license
3 (OL) for Pilgrim Nuclear Power Station (PNPS) for an additional 20-year period (Entergy
4 2006a). If the OL is renewed, State and Federal (other than NRC) regulatory agencies and
5 Entergy would ultimately decide whether the plant will continue to operate based on factors
6 such as the need for power, power availability from other sources, regulatory mandates, or
7 other matters within the agencies' jurisdictions or the purview of the owners. If the OL is not
8 renewed, then the plant must be shut down at or before the expiration of the current OL, which
9 expires on June 8, 2012.

10
11 Section 102 of the National Environmental Policy Act of 1969, as amended (NEPA) (42 USC
12 4321), directs that an environmental impact statement (EIS) is required for major Federal
13 actions that significantly affect the quality of the human environment. The NRC has
14 implemented Section 102 of NEPA in Title 10 of the Code of Federal Regulations (CFR) Part
15 51. Part 51 identifies licensing and regulatory actions that require an EIS. In
16 10 CFR 51.20(b)(2), NRC requires preparation of an EIS or a supplement to an EIS for renewal
17 of a reactor OL; 10 CFR 51.95(c) states that the EIS prepared at the OL renewal stage will be a
18 supplement to the *Generic Environmental Impact Statement for License Renewal of Nuclear
19 Plants* (GEIS), NUREG-1437, Volumes 1 and 2 (NRC 1996; 1999).^(a)

20
21 Upon acceptance of the PNPS application, the NRC began the environmental review process
22 described in 10 CFR Part 51 by publishing a notice of intent to prepare an EIS and conduct
23 scoping (NRC 2006a; 71 FR 19554) on April 14, 2006. The staff visited the PNPS site in March
24 2006 and held public scoping meetings on May 17, 2006, in Plymouth, Massachusetts (NRC
25 2006b). The staff reviewed the PNPS Environmental Report (ER) (Entergy 2006b) and
26 compared it to the GEIS, consulted with other agencies, and conducted an independent review
27 of the issues following the guidance set forth in NUREG-1555, Supplement 1, the *Standard
28 Review Plans for Environmental Reviews for Nuclear Power Plants, Supplement 1: Operating
29 License Renewal* (NRC 2000). The staff also considered the public comments received during
30 the scoping process for preparation of this draft Supplemental Environmental Impact Statement
31 (SEIS) for PNPS. The public comments received during the scoping process that were
32 considered to be within the scope of the environmental review are provided in Appendix A, Part
33 1, of this draft SEIS.

34
35 The staff will hold two public meetings in Plymouth, Massachusetts, in January 2007 to describe
36 the preliminary results of the NRC environmental review and to answer questions to provide
37 members of the public with information to assist them in formulating their comments on this

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

Summary and Conclusions

1 draft SEIS. When the comment period ends, the staff will consider and address all of the
2 comments received. These comments will be addressed in Appendix A, Part 2, of the final
3 SEIS.

4
5 This draft SEIS includes the NRC staff's preliminary analysis that considers and weighs the
6 environmental effects of the proposed action (including cumulative impacts), the environmental
7 impacts of alternatives to the proposed action, and mitigation measures available for reducing
8 or avoiding adverse effects. This draft SEIS also includes the staff's preliminary
9 recommendation regarding the proposed action.

10
11 The NRC has adopted the following statement of purpose and need for license renewal from
12 the GEIS:

13
14 The purpose and need for the proposed action (renewal of an operating license) is to
15 provide an option that allows for power generation capability beyond the term of a
16 current nuclear power plant operating license to meet future system generating needs,
17 as such needs may be determined by State, utility, and, where authorized, Federal
18 (other than NRC) decisionmakers.

19
20 The evaluation criterion for the staff's environmental review, as defined in 10 CFR 51.95(c)(4)
21 and the GEIS, is to determine:

22
23 . . . whether or not the adverse environmental impacts of license renewal are so great
24 that preserving the option of license renewal for energy planning decisionmakers would
25 be unreasonable.

26
27 Both the statement of purpose and need and the evaluation criterion implicitly acknowledge that
28 there are factors, in addition to license renewal, that would contribute to NRC's ultimate
29 determination of whether an existing nuclear power plant continues to operate beyond the
30 period of the current OL.

31
32 NRC regulations (10 CFR 51.95[c][2]) contain the following statement regarding the content of
33 SEISs prepared at the license renewal stage:

34
35 The supplemental environmental impact statement for license renewal is not required to
36 include discussion of need for power or the economic costs and economic benefits of
37 the proposed action or of alternatives to the proposed action except insofar as such
38 benefits and costs are either essential for a determination regarding the inclusion of an
39 alternative in the range of alternatives considered or relevant to mitigation. In addition,
40 the supplemental environmental impact statement prepared at the license renewal stage
41 need not discuss other issues not related to the environmental effects of the proposed

1 action and the alternatives, or any aspect of the storage of spent fuel for the facility
2 within the scope of the generic determination in § 51.23(a) and in accordance with §
3 51.23(b).^(a)
4

5 The GEIS contains the results of a systematic evaluation of the consequences of renewing an
6 OL and operating a nuclear power plant for an additional 20 years. It evaluates 92 environmen-
7 tal issues using the NRC's three-level standard of significance—SMALL, MODERATE, or
8 LARGE—developed using the Council on Environmental Quality guidelines. The following
9 definitions of the three significance levels are set forth in the footnotes to Table B-1 of 10 CFR
10 Part 51, Subpart A, Appendix B:
11

12 SMALL - Environmental effects are not detectable or are so minor that they will neither
13 destabilize nor noticeably alter any important attribute of the resource.
14

15 MODERATE - Environmental effects are sufficient to alter noticeably, but not to
16 destabilize, important attributes of the resource.
17

18 LARGE - Environmental effects are clearly noticeable and are sufficient to destabilize
19 important attributes of the resource.
20

21 For 69 of the 92 issues considered in the GEIS, the staff analysis in the GEIS shows the
22 following:
23

- 24 (1) The environmental impacts associated with the issue have been determined to apply either
25 to all plants or, for some issues, to plants having a specific type of cooling system or other
26 specified plant or site characteristics.
27
- 28 (2) A single significance level (i.e., SMALL, MODERATE, or LARGE) has been assigned to the
29 impacts (except for collective off-site radiological impacts from the fuel cycle and from high-
30 level waste and spent fuel disposal).
31
- 32 (3) Mitigation of adverse impacts associated with the issue has been considered in the analysis,
33 and it has been determined that additional plant-specific mitigation measures are likely not
34 to be sufficiently beneficial to warrant implementation.
35

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

Summary and Conclusions

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

5
6 Of the 23 issues that do not meet the criteria set forth above, 21 are classified as Category 2
7 issues requiring analysis in a plant-specific supplement to the GEIS. The remaining two issues,
8 environmental justice and chronic effects of electromagnetic fields, were not categorized.
9 Environmental justice was not evaluated on a generic basis and must also be addressed in a
10 plant-specific supplement to the GEIS. Information on the chronic effects of electromagnetic
11 fields was not conclusive at the time the GEIS was prepared.

12
13 This draft SEIS documents the staff's consideration of all 92 environmental issues identified in
14 the GEIS. The staff considered the environmental impacts associated with alternatives to
15 license renewal and compared the environmental impacts of license renewal and the alterna-
16 tives. The alternatives to license renewal that were considered include the no-action alternative
17 (not renewing the OL for PNPS), alternative methods of power generation, and conservation.
18 These alternatives were evaluated assuming that the replacement power generation plant is
19 located at either the PNPS site or some other unspecified location.

21 **9.1 Environmental Impacts of the Proposed Action - License** 22 **Renewal**

23
24 Entergy and the staff have established independent processes for identifying and evaluating the
25 significance of any new information on the environmental impacts of license renewal. Neither
26 Entergy nor the staff has identified information that is both new and significant related to
27 Category 1 issues that would call into question the conclusions in the GEIS. With the exception
28 of the requirement for an essential fish habitat (EFH) consultation (see Appendix E for the EFH
29 assessment), the staff has not identified any new issue applicable to PNPS that has a
30 significant environmental impact. Therefore, the staff relies upon the conclusions of the GEIS
31 for all Category 1 issues that are applicable to PNPS.

32
33 Entergy's license renewal application presents an analysis of the Category 2 issues that are
34 applicable to PNPS, plus environmental justice and chronic effects from electromagnetic fields.
35 The staff has reviewed the Entergy analysis for each issue and has conducted an independent
36 review of each issue plus environmental justice and chronic effects from electromagnetic fields.
37 Six Category 2 issues are not applicable because they are related to plant design features or
38 site characteristics not found at PNPS. Four Category 2 issues are not discussed in this draft
39 SEIS because they are specifically related to refurbishment. Entergy (Entergy 2006b) has
40 stated that its evaluation of structures and components, as required by 10 CFR 54.21, did not

1 identify any major plant refurbishment activities or modifications as necessary to support the
2 continued operation of PNPS for the license renewal period. In addition, any replacement of
3 components or additional inspection activities are within the bounds of normal plant component
4 replacement and, therefore, are not expected to affect the environment outside of the bounds of
5 the plant operations evaluated in the *Final Environmental Statement Related to Operation of*
6 *Pilgrim Nuclear Generating Station* (AEC 1972).

7
8 Eleven Category 2 issues (including 10 Category 2 issues plus the severe accident mitigation
9 alternatives (SAMAs) issue from Chapter 5) related to operational impacts and postulated
10 accidents during the renewal term, as well as environmental justice and chronic effects of
11 electromagnetic fields, are discussed in detail in this draft SEIS. Five of the Category 2 issues
12 and environmental justice apply both to refurbishment and to operation during the renewal term
13 and are only discussed in this draft SEIS in relation to operation during the renewal term. For
14 eight of the Category 2 issues and environmental justice, the staff concludes that the potential
15 environmental effects would be of SMALL significance in the context of the standards set forth
16 in the GEIS. For entrainment of the local winter flounder (*Pseudopleuronectes americanus*)
17 population and impingement of Jones River population of rainbow smelt (*Osmerus mordax*), the
18 NRC staff concludes that the potential environmental impacts would be MODERATE. For all
19 other marine aquatic species, the staff concludes that potential environmental impacts due to
20 entrainment and impingement would be SMALL to MODERATE. In addition, the staff
21 determined that appropriate Federal health agencies have not reached a consensus on the
22 existence of chronic adverse effects from electromagnetic fields. Therefore, no further
23 evaluation of this issue is required. For SAMAs, the staff concludes that a reasonable,
24 comprehensive effort was made to identify and evaluate SAMAs. Based on its review of the
25 SAMAs for PNPS, and the plant improvements already made, the staff concludes that Entergy
26 identified five potentially cost-beneficial SAMAs. The staff concludes that two additional SAMAs
27 are potentially cost-beneficial. However, these SAMAs do not relate to adequately managing
28 the effects of aging during the period of extended operation. Therefore, they need not be
29 implemented as part of license renewal pursuant to 10 CFR Part 54.

30
31 Cumulative impacts of past, present, and reasonably foreseeable future actions were
32 considered, regardless of what agency (Federal or non-Federal) or person undertakes such
33 other actions. The staff concludes that cumulative impacts of PNPS license renewal would be
34 SMALL for most potentially affected resources, with the exception of the local winter flounder
35 population and the Jones River population of rainbow smelt, for which impacts would be
36 MODERATE. Overall, the cumulative impacts on marine aquatic resources within the Cape
37 Cod Bay ecosystem would be SMALL to MODERATE.

38
39 Mitigation measures were considered for each Category 2 issue. For most issues, current
40 measures to mitigate the environmental impacts of plant operation were found to be adequate.
41 However, due to the potential for impacts to marine aquatic resources, additional mitigation

Summary and Conclusions

1 measures for the cooling system components and operations may further reduce entrainment
2 and impingement impacts. The applicant is currently conducting a comprehensive
3 demonstration study as part of the 316(b) evaluation required by the U.S. Environmental
4 Protection Agency. It is expected that any additional mitigation measures would be evaluated
5 further in the development of this study.
6

7 The following sections discuss unavoidable adverse impacts, irreversible or irretrievable
8 commitments of resources, and the relationship between local short-term use of the
9 environment and long-term productivity.
10

11 **9.1.1 Unavoidable Adverse Impacts**

12
13 An environmental review conducted at the license renewal stage differs from the review
14 conducted in support of a construction permit because the plant is in existence at the license
15 renewal stage and has operated for a number of years. As a result, adverse impacts
16 associated with the initial construction have been avoided, have been mitigated, or have
17 already occurred. The environmental impacts to be evaluated for license renewal are those
18 associated with refurbishment and continued operation during the renewal term.
19

20 Most adverse impacts of continued operation identified would be of SMALL significance with the
21 exception of impacts of the cooling system, which would have MODERATE impacts on the local
22 population of winter flounder and rainbow smelt, and SMALL to MODERATE impacts on other
23 marine aquatic species. The adverse impacts of likely alternatives if PNPS ceases operation at
24 or before the expiration of the current OL would not be smaller than those associated with
25 continued operation of this unit, and they may be greater for some impact categories in some
26 locations.
27

28 **9.1.2 Irreversible or Irretrievable Resource Commitments**

29
30 The commitment of resources related to construction and operation of PNPS during the current
31 license period was made when the plant was built. The resource commitments to be
32 considered in this draft SEIS are associated with continued operation of the plant for an
33 additional 20 years. These resources include materials and equipment required for plant
34 maintenance and operation, the nuclear fuel used by the reactors, and ultimately, permanent
35 off-site storage space for the spent fuel assemblies.
36

37 The most significant resource commitments related to operation during the renewal term are
38 the fuel and the permanent storage space. PNPS replaces a portion of its fuel assemblies
39 during every refueling outage, which occurs on a 24-month cycle (Entergy 2006b).
40

1 The likely power generation alternatives if PNPS ceases operation on or before the expiration of
2 the current OLs would require a commitment of resources for construction of the replacement
3 plants as well as for fuel to run the plants.
4

5 **9.1.3 Short-Term Use Versus Long-Term Productivity**

6
7 An initial balance between short-term use and long-term productivity of the environment at
8 PNPS was set when the plant was approved and construction began. That balance is now well
9 established. Renewal of the OL for PNPS and continued operation of the plant would not alter
10 the existing balance, but may postpone the availability of the site for other uses. Denial of the
11 application to renew the OL would lead to shutdown of the plant and would alter the balance in
12 a manner that depends on subsequent uses of the site.
13

14 **9.2 Relative Significance of the Environmental Impacts of** 15 **License Renewal and Alternatives**

16
17 The proposed action is renewal of the OL for PNPS. Chapter 2 describes the site, power plant,
18 and interactions of the plant with the environment. As noted in Chapter 3, no refurbishment and
19 no refurbishment impacts are expected at PNPS. Chapters 4 through 7 discuss environmental
20 issues associated with renewal of the OL. Environmental issues associated with the no-action
21 alternative and alternatives involving power generation and use reduction are discussed in
22 Chapter 8.
23

24 The significance of the environmental impacts from the proposed action (approval of the
25 application for renewal of the OL), the no-action alternative (denial of the application),
26 alternatives involving coal, gas, or nuclear-fired generating capacity at an unspecified greenfield
27 site, gas-fired generation of power at PNPS, and a combination of alternatives are compared in
28 Table 9-1. Continued use of open-cycle cooling is assumed for PNPS. All fossil fueled
29 alternatives presented in Table 9-1 are assumed to use closed-cycle cooling systems.
30

31 Substitution of once-through cooling for the recirculating cooling system in the evaluation of the
32 nuclear and gas and coal-fired generation alternatives would result in greater environmental
33 impact to categories related to water use and aquatic ecology. Alternatively, land use and
34 aesthetic impacts are somewhat reduced with open-cycle cooling.
35

36 Table 9-1 shows that the significance of the plant specific environmental effects of the proposed
37 action would be SMALL for all impact categories except for the following:
38

Summary and Conclusions

- 1 • entrainment and impingement of the local winter flounder population and Jones River
2 population of rainbow smelt, for which MODERATE levels of significance were assigned,
3 and entrainment and impingement of the other marine aquatic species, for which SMALL to
4 MODERATE levels of significance were assigned (see Chapter 4);
5
- 6 • collective offsite radiological impacts from the fuel cycle and from high-level radioactive
7 waste, for which a single significance level was not assigned (see Chapter 6); and
8
- 9 • spent fuel disposal, for which a single significance level was not assigned (see Chapter 6).
10

11 Cumulative impacts on the proposed action would be SMALL with the exception of impacts to
12 marine aquatic resources.
13

14 The alternative actions, excluding the no-action alternative, may have environmental effects in
15 at least some impact categories that reach MODERATE or LARGE significance.
16

17 **9.3 Staff Conclusions and Recommendations**

18
19 Based on (1) the analysis and findings in the GEIS (NRC 1996), (2) the ER submitted by
20 Entergy, (3) consultations with Federal, State, and local agencies, (4) the staff's own
21 independent review, and (5) the staff's consideration of public comments received, the
22 preliminary recommendation of the staff is that the Commission determine that the adverse
23 environmental impacts of license renewal for PNPS are not so great that preserving the option
24 of license renewal for energy planning decisionmakers would be unreasonable.
25

26 **9.4 References**

27
28 10 CFR Part 51. Code of Federal Regulations, Title 10, *Energy*, Part 51, "Environmental
29 Protection Regulations for Domestic Licensing and Related Regulatory Functions."
30

31 10 CFR Part 54. Code of Federal Regulations, Title 10, *Energy*, Part 54, "Requirements for
32 Renewal of Operating Licenses for Nuclear Power Plants."
33

34 Atomic Energy Commission (AEC). 1972. *Final Environmental Statement Related to Operation*
35 *of Pilgrim Nuclear Generating Station*, Docket No. 50-293, Washington, D.C.
36

37 Entergy Nuclear Operations, Inc. (Entergy). 2006a. *License Renewal Application, Pilgrim*
38 *Nuclear Power Station*, Docket No. 50-293, Facility Operating License No. DPR-35. Plymouth,
39 Massachusetts.
40

1 Entergy Nuclear Operations, Inc. (Entergy). 2006b. *Applicant's Environmental Report –*
2 *Operating License Renewal Stage, Pilgrim Nuclear Power Station.* Docket No. 50-293,
3 Plymouth, Massachusetts.

4
5 National Environmental Policy Act of 1969, as amended (NEPA) 42 USC 4321, et seq.

6
7 Nuclear Regulatory Commission (NRC). 1996. *Generic Environmental Impact Statement for*
8 *License Renewal of Nuclear Plants.* NUREG-1437, Volumes 1 and 2, Washington, D.C.

9
10 Nuclear Regulatory Commission (NRC). 1999. *Generic Environmental Impact Statement for*
11 *License Renewal of Nuclear Plants: Main Report, Section 6.3, Transportation, Table 9.1,*
12 *Summary of findings on NEPA issues for license renewal of nuclear power plants, Final Report.*
13 NUREG-1437, Volume 1, Addendum 1, Washington, D.C.

14
15 Nuclear Regulatory Commission (NRC). 2000. *Standard Review Plans for Environmental*
16 *Reviews for Nuclear Power Plants, Supplement 1: Operating License Renewal.* NUREG-1555,
17 Supplement 1, Washington, D.C.

18
19 Nuclear Regulatory Commission (NRC). 2006a. "Notice of Acceptance for Docketing of the
20 Application and Notice of Opportunity for a Hearing Regarding Renewal of Facility Operating
21 License No. DPR-35 and for an Additional 20-Year Period." *Federal Register.* Vol. 71, No. 58,
22 pp. 15222-15223. March 27, 2006.

23
24 Nuclear Regulatory Commission (NRC). 2006b. "Notice of Intent to Prepare an Environmental
25 Impact Statement and Conduct Scoping Process." *Federal Register.* Vol. 71, No. 72,
26 pp. 19554-19556. April 14, 2006.

Summary and Conclusions

Table 9-1. Summary of Environmental Significance of License Renewal, the No Action Alternative, and Alternative Methods of Generation Using Once-Through Cooling^(a)

Impact Category	Proposed Action	No Action Alternative	Coal-Fired Generation ^(b)	Natural-Gas-Fired Generation ^(b)	New Nuclear Generation ^(b)	Combination of Alternatives	
	License Renewal	Denial of Renewal	Alternate Greenfield Site	PNPS Site	Alternate Greenfield Site	Alternate Greenfield Site Gas-Fired at PNPS Site ^(b) , Wind Farm, Conservation	
Land Use	<u>SMALL</u>	<u>SMALL</u>	<u>MODERATE to LARGE</u>	<u>MODERATE</u>	<u>MODERATE to LARGE</u>	<u>MODERATE to LARGE</u>	
Ecology	<u>SMALL to MODERATE</u>	<u>SMALL</u>	<u>MODERATE to LARGE</u>	<u>SMALL</u>	<u>MODERATE</u>	<u>MODERATE to LARGE</u>	<u>SMALL to LARGE</u>
Water Use and Quality-Surface Water	<u>SMALL</u>	<u>SMALL</u>	<u>SMALL to MODERATE</u>	<u>SMALL</u>	<u>SMALL</u>	<u>SMALL</u>	<u>SMALL to MODERATE</u>
Water Use and Quality-Groundwater	<u>SMALL</u>	<u>SMALL</u>	<u>SMALL to MODERATE</u>	<u>SMALL</u>	<u>SMALL</u>	<u>SMALL</u>	<u>SMALL</u>
Air Quality	<u>SMALL</u>	<u>SMALL</u>	<u>MODERATE</u>	<u>MODERATE</u>	<u>MODERATE</u>	<u>SMALL</u>	<u>SMALL to MODERATE</u>
Waste	<u>SMALL</u>	<u>SMALL</u>	<u>MODERATE</u>	<u>SMALL</u>	<u>SMALL</u>	<u>SMALL</u>	<u>SMALL</u>
Human Health	<u>SMALL^(c)</u>	<u>SMALL</u>	<u>SMALL</u>	<u>SMALL</u>	<u>SMALL</u>	<u>SMALL</u>	<u>SMALL</u>
Socio-economics	<u>SMALL</u>	<u>MODERATE</u>	<u>MODERATE to LARGE</u>	<u>SMALL to MODERATE</u>	<u>MODERATE</u>	<u>MODERATE to LARGE</u>	<u>SMALL to MODERATE</u>
Transportation	<u>SMALL</u>	<u>SMALL</u>	<u>MODERATE to LARGE</u>	<u>SMALL to MODERATE</u>	<u>MODERATE</u>	<u>MODERATE</u>	<u>MODERATE</u>
Aesthetics	<u>SMALL</u>	<u>SMALL</u>	<u>MODERATE to LARGE</u>	<u>MODERATE</u>	<u>MODERATE to LARGE</u>	<u>MODERATE to LARGE</u>	<u>MODERATE to LARGE</u>
Historic and Archaeological Resources	<u>SMALL</u>	<u>SMALL</u>	<u>SMALL</u>	<u>SMALL</u>	<u>SMALL</u>	<u>SMALL</u>	<u>SMALL to LARGE</u>
Environmental Justice	<u>SMALL</u>	<u>SMALL</u>	<u>SMALL to MODERATE</u>	<u>SMALL</u>	<u>SMALL</u>	<u>SMALL to MODERATE</u>	<u>SMALL to LARGE</u>

(a) The majority of impacts shown are negative; however, several impacts are positive. See Chapters 4 and 8 for details.

(b) Analyses based on use of a closed-cycle cooling system.

(c) Except for collective offsite radiological impacts from the fuel cycle and from high-level waste and spent-fuel disposal, for which a significance level was not assigned. See Chapter 6 for details.

Appendix A

Comments Received on the Environmental Review

Appendix A

Comments Received on the Environmental Review

1 Part I - Comments Received During Scoping

2
3 On April 14, 2006, the U.S. Nuclear Regulatory Commissions (NRC) published a Notice of
4 Intent in the *Federal Register* (Volume 71, page 19554) to notify the public of the staff's intent
5 to prepare a plant-specific supplement to the *Generic Environmental Impact Statement for*
6 *License Renewal of Nuclear Plants* (GEIS), NUREG-1437, Volumes 1 and 2, regarding the
7 renewal application for the Pilgrim Nuclear Power Station (PNPS) operating license. The plant-
8 specific supplement to the GEIS will be prepared in accordance with the National Environmental
9 Policy Act of 1969, as amended (NEPA), Council on Environmental Quality (CEQ) guidelines,
10 and Title 10 of the Code of Federal Regulations (CFR) Part 51. As outlined by NEPA, the NRC
11 initiated the scoping process with the issuance of the *Federal Register* Notice of Intent. The
12 NRC invited the applicant; Federal, State, local, and tribal government agencies; local
13 organizations; and individuals to participate in the scoping process by providing oral comments
14 at the scheduled public meetings and/or submitting written suggestions and comments no later
15 than June 16, 2006.

16
17 The scoping process included two public scoping meetings, which were held at the Radisson
18 Hotel Plymouth Harbor Ballroom, 180 Water Street, Plymouth, Massachusetts, on May 17,
19 2006. The NRC issued press releases, placed local newspaper ads, and distributed flyers
20 locally. Approximately 160 people attended the meetings. Both sessions began with NRC staff
21 members providing a brief overview of the license renewal process and the NEPA process.
22 Following the NRC's prepared statements, the meetings were open for public comments.
23 Thirty-three attendees provided either oral comments or written statements that were recorded
24 and transcribed by a certified court reporter. The transcripts of the meetings can be found as
25 an attachment to the meeting summary, which was issued on July 13, 2006. The meeting
26 summary is available for public inspection in the NRC Public Document Room (PDR), located at
27 One White Flint North, 11555 Rockville Pike, Rockville, Maryland, 20852, or from the NRC's
28 Agencywide Documents Access and Management System (ADAMS). The ADAMS Public
29 Electronic Reading Room is accessible at [http://www.nrc.gov/reading-rm/adams/web-](http://www.nrc.gov/reading-rm/adams/web-based.html)
30 [based.html](http://www.nrc.gov/reading-rm/adams/web-based.html). The meeting summary as well as all written comments can be found in ADAMS
31 under Accession Nos. ML061700040 and ML062400368, respectively. In addition to the
32 comments received during the public meetings, six comment letters and one e-mail message
33 were received by the NRC in response to the Notice of Intent.

34
35 At the conclusion of the scoping period, the NRC staff and its contractor reviewed the tran-
36 scriptions and all written material to identify specific comments and issues. Each set of comments
37 from a given commenter was given a unique identifier (Commenter ID), so that each set of

Appendix A

1 comments from a commenter could be traced back to the transcript or letter by which the
2 comments were submitted. Several commenters submitted comments through multiple sources
3 (e.g., afternoon and evening scoping meetings, and/or written comments).

4 Table A.1 identifies the individuals who provided comments applicable to the environmental
5 review and the Commenter ID associated with each person's set(s) of comments. For oral
6 comments, the individuals are listed in the order in which they spoke at the public meeting.

7
8 Specific comments were categorized and consolidated by topic. Comments with similar specific
9 objectives were combined to capture the common essential issues raised by the commenters.

10 The comments fall into one of the following general groups:

- 11
12 • Specific comments that address environmental issues within the purview of the
13 NRC environmental regulations related to license renewal. These comments
14 address Category 1 or Category 2 issues or issues that were not addressed in
15 the GEIS. They also address alternatives and related federal actions.
- 16
17 • General comments (1) in support of or opposed to nuclear power or license
18 renewal or (2) on the renewal process, the NRC's regulations, and the regulatory
19 process. These comments may or may not be specifically related to the PNPS
20 license renewal application.
- 21
22 • Questions that do not provide new information.
- 23
24 • Specific comments that address issues that do not fall within or are specifically
25 excluded from the purview of NRC environmental regulations related to license
26 renewal. These comments typically address issues such as the need for power,
27 emergency preparedness, security, current operational safety issues, and safety
28 issues related to operation during the renewal period.

29
30 Comments applicable to this environmental review and the NRC staff's responses are
31 summarized in this appendix. The parenthetical identifier after each comment refers to the
32 comment set (Commenter ID). This information, which was extracted from the PNPS Scoping
33 Summary Report, is provided for the convenience of those interested in the scoping comments
34 applicable to this environmental review. The comments that are general or outside the scope of
35 the environmental review for PNPS are not included here. More detail regarding the disposition
36 of general or inapplicable comments can be found in the scoping summary report. The ADAMS
37 accession number for the PNPS Scoping Summary Report is ML062710517.

Table A-1. Individuals Providing Comments During Scoping Comment Period

Committer ID	Committer	Affiliation (If Stated)	Comment Source
PNPS-A	Mary Lampert	Town of Duxbury Nuclear Advisory Committee	Afternoon Scoping Meeting
PNPS-B	Keith Maxwell	Local Resident	Afternoon Scoping Meeting
PNPS-C	Corwne Young	District Representative for Congressman Bill Delahunt	Afternoon Scoping Meeting
PNPS-D	Mark Sylvia	Town Manager, Plymouth	Afternoon Scoping Meeting
PNPS-E	Alba Thompson	Citizen, Plymouth	Afternoon Scoping Meeting
PNPS-F	Joyce McMahon	Massachusetts Affordable Reliable Electricity Alliance (Mass AREA)	Afternoon Scoping Meeting
PNPS-G	Pine du Bois	Jones River Watershed Association	Afternoon Scoping Meeting
PNPS-H	Robert Ruddock	Associated Industries in Massachusetts (AIM)	Afternoon Scoping Meeting
PNPS-I	Jim O'Connell	Citizen, Chatham	Afternoon Scoping Meeting
PNPS-J	Frank Collins	Precinct Six Town Meeting Member	Afternoon Scoping Meeting
PNPS-K	Rick Anderson	Carpenters Local 624	Afternoon Scoping Meeting
PNPS-L	Andre Martecchini	Selectman from the Town of Duxbury	Evening Scoping Meeting
PNPS-M	Mary Lampert	Massachusetts Public Interest Research Group (Mass PIRG)	Evening Scoping Meeting
PNPS-N	Mary Lampert	Pilgrim Watch	Evening Scoping Meeting
PNPS-O	Mary Ellen Burns	Town Meeting Representative, Precinct 13, W. Plymouth	Evening Scoping Meeting
PNPS-P	Jeff Berger	Chairman, Nuclear Matters Committee, Town of Plymouth	Evening Scoping Meeting
PNPS-Q	Becky Chin	Vice Chairman, Duxbury Nuclear Advisory Committee	Evening Scoping Meeting
PNPS-R	Peter Curley	Local Resident	Evening Scoping Meeting
PNPS-S	Joyce Mahon	Communications Director, Mass AREA	Evening Scoping Meeting
PNPS-T	Arthur Powers	Local Resident	Evening Scoping Meeting
PNPS-U	Leonard Curcuru	Local Resident, Mass AREA Member	Evening Scoping Meeting
PNPS-V	William Stone	Local Resident	Evening Scoping Meeting
PNPS-X	Sandra Woods	Local Resident	Evening Scoping Meeting
PNPS-Y	Janet Humes	Local Resident	Evening Scoping Meeting
PNPS-Z	Bob Smith	Local Resident	Evening Scoping Meeting
PNPS-AA	Jerry Benezra	Local Resident	Evening Scoping Meeting
PNPS-AB	Tom Belcher		Written Comments
PNPS-AC	Mary Lampert	Pilgrim Watch	Written Comments
PNPS-AD	Frank Gorkey	Energy Advocate, Mass PIRG	Written Comments
PNPS-AE	Sheila Hollis	Attorney for Town of Plymouth	Written Comments

Appendix A

Table A-1. (contd)

Commenter ID	Commenter	Affiliation (If Stated)	Comment Source
PNPS-AF	Rebecca Chin	Vice Chairman, Duxbury Nuclear Advisory Committee	Written Comments
PNPS-AG	Elizabeth Huggins	Director, Office of Environmental Review, U.S. Environmental Protection Agency	Written Comments
PNPS-AH	Diane Curran	Harmon, Curran, Spielberg & Eisenberg, LLP; For the Office of the Massachusetts Attorney General	Written Comments

Comments in this section are grouped in the following categories:

- A.1.1 Comments Concerning Water Quality
- A.1.2 Comments Concerning Aquatic Ecology
- A.1.3 Comments Concerning Socioeconomic Impacts
- A.1.4 Comments Concerning Human Health
- A.1.5 Comments Concerning Uranium Fuel Cycle and Waste Management
- A.1.6 Comments Concerning Postulated Accidents
- A.1.7 Comments Concerning Alternative Energy Sources
- A.1.8 Comments Concerning Monitoring Programs

A.1 Comments and Responses

A.1.1 Comments Concerning Water Quality

Comment: Given the plant's coastal location, the importance of the coastal waters to the region's economy, and the use of the coastal water for recreational purposes, it is essential to confirm that Pilgrim will not violate applicable water quality standards during the renewal period and jeopardize aquatic life or the health of those using the waters. (PNPS-AE)

Comment: This plant has been over here for 20 years, the water had been coming, the water has been going, and there has got to be a heck of a lot more water in that ocean out there than what they are putting out every day to filter it out. (PNPS-T)

Response: *The comments are related to water quality issues. Water quality, water use, and other water issues were evaluated in the GEIS and determined to be Category 1 issues. The*

1 *comments provide no new and significant information on water quality; therefore, the comments*
2 *will not be evaluated further. Water quality will be discussed in Chapters 2 and 4 of the SEIS.*
3

4 **Comment:** Marine impact is a huge area and it doesn't make any sense to say, well, let's not
5 consider it because they have made an application to EPA for their water discharge permit,
6 which is overdue, so, hence, they can rely on 1996 data that they have provided and got a
7 permit back then. We are talking about 2012. It would be like myself saying, you know, I've
8 applied for a license to drive so, therefore, I have the right to drive and nobody should question
9 me, so that doesn't make any sense. (PNPS-A)
10

11 **Comment:** In the ER, Entergy claims to be in "continued compliance with applicable [Clean
12 Water Act "CWA"] standards." Entergy states that the plant received water quality certifications
13 from the relevant Massachusetts authorities in the early 1970s (as set forth in Attachment A to
14 the ER) and the National Pollutant Discharge Elimination System ("NPDES") permit for Pilgrim
15 reflects continued compliance with relevant CWA standards, excerpts of which are also
16 included in Attachment A. The NPDES permit included in Attachment A, however, appears to
17 have expired in 1996. While Entergy states elsewhere in the ER that EPA Region I, the
18 NPDES permitting authority for Massachusetts, is reviewing an Entergy application for renewal
19 of the NPDES permit with respect to Pilgrim (see ER, Chapter 4.2.5), Entergy should be
20 required to provide further evidence (besides excerpts from Attachment A) documenting its
21 alleged continued compliance with the CWA standards and/or the conclusions of EPA Region I
22 regarding the plant's continued compliance with appropriate CWA standards. (PNPS-AE)
23

24 **Comment:** EPA is currently reviewing Entergy's application for issuance of its NPDES permit.
25 While we encourage the NRC to fully analyze the issues described in this letter in its EIS for the
26 twin purposes of satisfying NEPA and supporting appropriate licensing decisions under the
27 Atomic Energy Act and NRC regulations, the EIS should not draw conclusions regarding
28 whether changes to the plant operations or existing NPDES permit conditions would be
29 necessary or appropriate to satisfy the Clean Water Act, as responsibility for those
30 determinations rests with the EPA. (PNPS-AG)
31

32 **Response:** *The comments are noted. The NRC does not have authority over matters*
33 *concerning discharge permits or compliance with the Clean Water Act. To operate PNPS, NRC*
34 *regulations require Entergy to comply with the Clean Water Act and its associated requirements*
35 *imposed by the USEPA, Region I, as part of the NPDES permit. The SEIS will evaluate the*
36 *impacts related to impingement and entrainment of organisms, discharges to the aquatic*
37 *environment, the thermal plume, and other potential or actual aquatic impacts. In addition, the*
38 *status of PNPS's NPDES permit application will be discussed in Chapters 2 and 4 of the SEIS.*

Appendix A

1 **Comment:** In the past, Pilgrim Station has needed to dredge the areas in front of its cooling
2 water intake to prevent siltation from interfering with plant operations. The dredged material
3 must then be disposed of or used in an appropriate way. There have been issues, however,
4 regarding contamination of that dredged material, presumably as a result of the plant's
5 wastewater discharges. While these issues were resolved for past dredging, it would be
6 appropriate for the EIS to assess whether the facility will have future dredging needs and what
7 environmental issues would be associated with any such dredging. The U.S. Army Corps of
8 Engineers and EPA are both likely to have information on this topic in their files. (PNPS-AG)

9
10 **Response:** *The comment is noted. The impacts of dredging will be evaluated and*
11 *incorporated, as appropriate, in Chapters 2 and/or 4 of the SEIS.*

12
13 **Comment:** There are no monitoring wells to test for radioactive contaminated water flowing
14 off-site. The water on-site is not used for drinking; therefore the facility is not required by
15 regulation to have monitoring wells.

16
17 However radioactive waste is buried on site and leaks from buried pipes and tanks and from
18 other components can leak into the ground and migrate, as occurred at Braidwood and other
19 sites discussed in Pilgrim Watch's Motion to Intervene. Absent monitoring wells, there is no
20 reasonable assurance that radioactive material will not, or has not, migrated into Cape Cod
21 Bay, Duxbury Bay, Kingston Bay and/or Plymouth Bay. Pilgrim's original Environmental Impact
22 Statement makes it clear that wells must be placed along the shoreline of Cape Cod Bay.

23
24 Surface topography is such that drainage from the Station is seaward and surface water will not
25 leave the property otherwise. Subsurface water follows the surface topography, resulting in
26 overall movement of water toward the Bay.

27
28 Also they should be placed at any other appropriate on-site locations [such as property along
29 and off the Access Road] to protect workers, inadvertent intruders and prevent buried
30 radionuclides from being uncovered and airborne and affecting the neighborhood. (PNPS-AC)

31
32 **Comment:** The potential for tritium leaks at the Pilgrim plant poses a unique hazard to the
33 public health of the residents if the Town and neighboring areas because the Town and it's
34 neighbor, Carver, Massachusetts, rely almost totally on the Plymouth-Carver aquifer (the
35 "Aquifer") for drinking water, and the Aquifer partially supplies neighboring communities as well.
36 The Aquifer covers approximately 140 square miles in area with an estimated 500 billion gallons
37 of potable water. Composed of saturated glacial sand and gravel, the Aquifer ranges in depth
38 from 20 feet to over 200 feet. The Aquifer is designated by the Environmental Protection
39 Agency as a "Sole Source Aquifer" - that is, one which provides at least fifty percent of the
40 water supply given to a community - it is the second largest Aquifer in Massachusetts and one
41 of only 70 Sole Source Aquifers in the United States.

1 Of course, while the Aquifer has large reserves, it is not a closed system. The Aquifer is
2 recharged through the natural seepage of precipitation, septic system discharges, and
3 agricultural water. Accordingly, any leakage of tritiated water from the Pilgrim plant into the
4 groundwater could infiltrate the Aquifer, and thereby contaminate the drinking water supplies for
5 the Town as well as for the heavy agricultural use of the Aquifer, with potentially serious health
6 implications for those consuming the water or the farm products grown with it.

7
8 The Aging Management Plan for Pilgrim provides that underground pipes and tanks will be
9 inspected when excavated during maintenance and that a focused inspection will be performed
10 within ten years unless an opportunistic inspection occurs within this period. However, in light
11 of the increasing frequency of leakage events at analogous nuclear plants in recent years, a
12 more frequent and thorough inspection of all components that contain radioactive water at the
13 Pilgrim plant is warranted to avoid the risk of leakages going undetected and to better
14 safeguard the public health of the residents of the Town and neighboring areas. (PNPS-AE)

15
16 **Comment:** A number of leaks in recent years from underground pipes and tanks releasing
17 tritiated water from spent fuel pools into the groundwater gives rise to concerns about the
18 potential for the similar release of radioactive materials at the Pilgrim plant. Leaks from a spent
19 fuel pool are not uncommon. Indeed, there were leaks reported from three nuclear power
20 plants in 2005. The Indian Point plant in New York (also owned by Entergy) experienced a
21 tritium leakage into groundwater likely due to a crack in the spent fuel pool concrete support.
22 The Braidwood nuclear power station in Illinois also has leaking tritium and its owners, Exelon
23 Nuclear, recently agreed to a court order to force it to begin clean-up. The NRC also was
24 informed that the spent fuel pool at the Connecticut Yankee plant in Haddam, Connecticut was
25 leaking into the ground at the rate of several gallons per day. Other instances of groundwater
26 contamination have been reported at nuclear facilities in Arizona, California, and Florida. The
27 NRC itself has acknowledged the severity of the problem associated with tritium contamination
28 of groundwater associated with equipment degradation and is assessing what changes, if any,
29 are needed to the agency's rules and regulations to better protect the public health and safety.
30 (PNPS-AE)

31
32 **Comment:** Older plants, such as Pilgrim, are more likely to experience corrosion and leakage
33 problems that can result in the release of amounts of radioactive materials into the
34 groundwater. Exposure to radiation from any such leaks represents a threat to human health
35 and it is a violation of NRC regulations. Adequate inspection and monitoring of and systems
36 and components that carry radioactive water should be a critical part of Pilgrim's Aging
37 Management Plan to minimize the likelihood of leakage and associated danger to the safety
38 and welfare of the public. (PNPS-AE)

39
40 **Response:** *Although NRC regulations require licensees to make surveys, as necessary, to*
41 *evaluate the potential hazard of radioactive material released in order to assess doses to*

Appendix A

1 *members of the public and workers, recent discoveries of releases at other plants indicate that*
2 *undetected leakage to groundwater from facility structures, systems, or components can occur*
3 *resulting in unmonitored and unassessed exposure pathways to members of the public.*
4

5 *The NRC has identified several instances of unintended tritium releases, and all available*
6 *information shows no threat to the public. Nonetheless, the NRC is inspecting each of these*
7 *events to identify the cause, verify the impact on public health and safety, and review licensee*
8 *plans to remediate the event. The NRC also established a lessons learned task force to*
9 *address inadvertent, unmonitored liquid radioactive releases from U.S. commercial nuclear*
10 *power plants. This task force reviewed previous incidents to identify lessons learned from*
11 *these events and determine what, if any, changes are needed to the regulatory program.*
12 *Detailed information and updates on these liquid releases can be found on the NRC public*
13 *website at <http://www.nrc.gov/reactors/operating/ops-experience/grndwtr-contam-tritium.htm>.*
14 *These comments provide no new and significant information and, therefore, will not be*
15 *evaluated further.*
16

17 **A.1.2 Comments Concerning Aquatic Ecology**

18
19 **Comment:** And also, I would hope that you and EPA DEP would work together to come up
20 with a number of how many fish, what is it, per acre, can be damaged, as opposed to a more
21 general statement of what is or is not acceptable. (PNPS-A)
22

23 **Comment:** EPA recommends that the EIS use documented impacts to the marine environment
24 from the thirty-four years that Pilgrim Station has been in operation to evaluate the direct,
25 indirect, and cumulative impacts associated with the requested twenty year license extension.
26 (PNPS-AG)
27

28 **Comment:** It also affects the plant life in the sea that supports nursery habitats. We are
29 seeing, through Kingston, Duxbury, Plymouth bays, that our eel grass beds are vanishing. We
30 don't necessarily know the reason why and we are not in a position to blame the nuclear power
31 station, but I can say that those kinds of impacts are real, are logical and should be looked at
32 and addressed with a great deal of diligence, especially in view of what Mary was saying
33 before. (PNPS-G)
34

35 **Comment:** I'm sure the NRC doesn't know, if they are not from this area, but most of the
36 people in the room do know that there is a northeast fishing crisis going on, the fishermen
37 cannot go fishing, there is no cod, there is no haddock, there is no flounder out there.
38

39 And this has nothing to do with the nuclear power plant, it has to do with the management of
40 the species but, anyway, we thought we would try and develop the means to replace the fish in

1 the oceans, to allow the fishermen to go fishing for more than 50, or 48 or 30 days a year,
2 which is what they are at right now. (PNPS-I)

3
4 **Comment:** And when they proposed the building of the plant, Boston Edison funded a study
5 and it was funded by Boston Edison and carried out by the Division of Marine Fisheries, and
6 they studied what impact the warmer water had on lobsters for a period of three years before
7 the plant opening and probably about three years after it opened, and the conclusion of that
8 study was that lobsters came in a little earlier in the spring and stayed there a little later in the
9 fall, with the warm water. (PNPS-J)

10
11 **Comment:** The area of marine and environmental concerns, the Town of Duxbury and I know
12 the Town of Plymouth, we have a thriving, and aquaculture and marine fisheries business going
13 on, and not to mention the recreational sailing, and fishing and everything. We are very
14 concerned. As we see today, we've had to close the bay, up and down the coast, because of
15 the flooding and rain. What is the effect of the heat of the discharge that's being dumped into
16 the bay? How does that effect our environment for our marine industries? (PNPS-L)

17
18 **Response:** *The comments are related to aquatic ecology. Aquatic ecology issues will be*
19 *discussed in Chapters 2 and 4 of the SEIS.*

20
21 **Comment:** To identify species of interest, the EIS should determine the presence of particular
22 species within general proximity of the project location. The EIS should include species for
23 which Essential Fish Habitat under the Magnuson-Stevens Act is listed near the proposed
24 project location. The EIS should cross-reference this list with NOAA's ECOMON and MARMAP
25 datasets with information from stations around the project area. A final list of species of interest
26 should be developed in consultation with EPA, NMFS, and Massachusetts Department of
27 Marine Fisheries. The EIS should also assess any potential impacts to endangered species
28 from Pilgrims Station's operations. (PNPS-AG)

29
30 **Comment:** The EIS should address relevant issues under other applicable laws, such as
31 compliance with the Endangered Species Act, the essential fish habitat provisions of the
32 Magnuson-Stevens Act, and the Coastal Zone Management Act. (PNPS-AG)

33
34 **Response:** *In order to determine the potential species of interest to be evaluated in the SEIS,*
35 *the NRC has consulted with the US Environmental Protection Agency (USEPA), US Fish and*
36 *Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), and Massachusetts*
37 *Department of Marine Fisheries (MA DMF). These agencies have provided information on*
38 *specific species of interest that should be addressed in the impact assessment. Regarding the*
39 *essential fish habitat provisions of the Magnuson-Stevens Act, NRC has consulted with the*
40 *Habitat Protection Division of the NMFS. Based on discussions with the NMFS and review of*
41 *the databases described in the comment, a list of species to be addressed in the analysis will*

Appendix A

1 *be developed and discussed in the Essential Fish Habitat Assessment and in Chapter 4 of the*
2 *SEIS.*

3
4 *Regarding endangered species, the NRC has consulted with the US FWS and the NMFS-*
5 *Protection Resources Division regarding potential impacts to terrestrial and aquatic species.*
6 *The results of this assessment will be reported in a Biological Assessment (as required by*
7 *Section 7 of the Endangered Species Act) and in Chapter 4 of the SEIS.*

8
9 *To evaluate the effects of the proposed action as it relates to the Coastal Zone Management*
10 *Act, the NRC has consulted with the Massachusetts Office of Coastal Zone Management (MA*
11 *CZM). The analysis of PNPS's Coastal Zone Management Federal Consistency Certification will*
12 *be addressed in Chapters 2 and 4 of the SEIS.*

13
14 **Comment:** Other issues were mitigation, adding, you know, fish to the bay to make up for
15 those that happen to get chopped up in the system, do they breed with native stock? Does that
16 make a difference? (PNPS-A)

17
18 **Comment:** Evaluation of the effectiveness of various mitigation strategies needs to be
19 performed with stakeholder input. Stocking: We understand that Entergy has contracted with a
20 Cape Cod company to provide substitute stock into Cape Cod Bay. However, we understand
21 that these are a different genetic grouping and that they do not breed with the native stocks. If
22 this is the case, then this method does not solve the problem. An analysis of this issue is
23 required. (PNPS-AC)

24
25 **Comment:** The applicant supports an on-going winter flounder hatchery study and claims that
26 the hatchery activities for winter flounder are providing stock enhancement that can be relied
27 upon as an effective form of mitigation for entrainment losses of the wild winter flounder
28 population. If this remains a reasonably feasible option for Pilgrim Station, the EIS should
29 explore this issue more fully. At present, we are not aware of convincing evidence that the
30 stocked fish survive to reproduce in these habitats. Moreover, there has not been a study of
31 the potential impacts of hatchery-related fish on the native population. The genetic and
32 behavioral implications should also be studied in order to determine if this hatchery is a true
33 mitigation mechanism for winter flounder or simply another ecological disturbance. (PNPS-AG)

34
35 **Comment:** Entergy, the owners of the plant, is also involved in a number of valuable
36 environmental initiatives, perhaps one of the most interesting is that they did a great deal of
37 study in the waters of Cape Cod and the indigenous fish populations. That result, excuse me,
38 that resulted in their working with Llenoco, a fish hatchery in Chatham, down on the Cape,
39 which every year hatches, rears and releases 25,000 winter flounder into Plymouth Harbor for
40 the benefit of the state and the local fishing industry. Entergy also contributes a large amount

1 of money, in the form of grants, to several local environmental groups working with aquatic and
2 other environmental issues. (PNPS-F)

3
4 **Comment:** One of the previous speakers concerns was that the fish that were added back,
5 she was wondering whether they were normal and we find, and seven years of experience has
6 proven, that they are normal, just like the every day fish, the young of the native fish that are
7 out there now. Not only did we find that they were normal but we found out that they flourish
8 out there ... And I'm again oversimplifying but we found that now that we found we can do it, we
9 can also do it with cod and we can do it with haddock. In other words, we are on the verge of
10 actually being able to make a difference and we are doing this because Entergy actually helped
11 us, they supported us and helped us build this pilot facility for their own reasons, I'm sure.

12 (PNPS-I)

13
14 **Response:** *The comments are related to mitigation of potential impacts to winter flounder*
15 *populations through the addition of hatchery-reared fish to the local population. This issue will*
16 *be discussed in Chapter 4 of the SEIS.*

17
18 **Comment:** As far as impingement goes, fish that are smacked against the grate and then
19 removed, have they been permanently damaged so that they do not have a survival affect, has
20 that been studied? Would we be better off having a grate at the mouth of the canal that might
21 decrease the number of fish impinged or increase their survivorability and, at the same time,
22 have a security effect by catching any explosive that a bad guy wanted to put up the intake
23 canal? (PNPS-A)

24
25 **Comment:** And I think you should look carefully at a memo prepared by Jerry Szal, S-Z-A-L, of
26 the DEP, specifically on the marine effect of Pilgrim on our environment, the once through
27 cooling system. In it, he mentions some very important items. One is it appropriate to average
28 the temperature discharge or is it more important to be required to have an instantaneous
29 discharge so the maximum number is always adhered to? (PNPS-A)

30
31 **Comment:** And I think that what Mary Lampert said about adjusting the screening and the
32 intake makes a lot of sense in term of trying to mitigate further the ongoing damage in the
33 intake structure to those populations. (PNPS-G)

34
35 **Comment:** Impingement: Because impinged fish from the intake screens are shunted back
36 into the intake, there is a concern that these fish, weakened from impingement, will simply be
37 re-impinged. Permitting and resource agencies should consider requiring an assessment of re-
38 impingement rates to select species of concern. These studies should also assess the need to
39 re-locate the discharge point for impinged fish in order to minimize re-impingement. (PNPS-
40 AC)

Appendix A

1 **Comment:** Discharge Effects Thermal Discharge: Discharge temperature is now averaged
2 over an hour; instantaneous measurement should be required.

3
4 Thermal backwash: In summary, during a thermal backwash, about 155,000 gpm of heated
5 water (F) is sent into the intake embayment for a period of about 1.5-2 hrs. Studies to evaluate
6 potential impacts of the thermal backwash have not been performed to the knowledge of DEP's
7 Gerry Szal. >105 (PNPS-AC)

8
9 **Comment:** Wet Land refurbishment or other unrelated environmental measure: These
10 measures are all well and good but do not address the issue at hand. See following
11 attachment, Marine Attachment Pilgrim Nuclear Power Station: review of intake and discharge
12 effects to finfish - Technical Memorandum For The Record, Gerald M. Szal [Department
13 Environmental Protection, MA.], August 30, 2005. (PNPS-AC)

14
15 **Comment:** Pilgrim Station operations have resulted in a range of impacts to marine life in
16 Cape Cod Bay. Because the facility annually entrains large quantities of fish eggs and larvae
17 and impinges large quantities of juvenile and adult fish, we recommend that the EIS pay
18 particular attention to this impact of the plant's cooling system, especially with respect to winter
19 flounder, Atlantic cod, and rainbow smelt. Winter flounder is a species of particular interest due
20 to its commercial, recreational and ecological importance. Estimated of winter flounder age -3
21 adult equivalent losses due to entrainment and impingement as reported by Pilgrim in annual
22 monitoring reports have ranged from <1% of the Cape Cod Bay population to almost 30% of
23 the population annually. Entrainment and impingement losses of Atlantic cod and rainbow
24 smelt are of particular concern as well. Atlantic cod have historically supported a large
25 commercial fishery in New England, but their numbers have declined to the point that
26 commercial fishing for this species has almost been completely eliminated in Massachusetts
27 Bay. The EIS should discuss entrainment and impingement losses of Atlantic cod at Pilgrim
28 Station within the context of a collapsed commercial fishery. Pilgrim Station also impinges
29 rainbow smelt, whose numbers have plummeted due to problems such as the loss of spawning
30 habitat. It is our understanding that Rainbow smelt are now being studied for potential listing as
31 a threatened or endangered species under the Endangered Species Act. The entrainment and
32 impingement losses of this species at Pilgrim Station should be assessed within that context.
33 (PNPS-AG)

34
35 **Comment:** Pilgrim station currently controls macro-fouling by periodically re-routing heated
36 condenser cooling water back through the system and out through each intake embayment
37 separately. This process, called thermal backwashing, is performed about four to five times per
38 year at full thermal load and three to four times per year at 50% thermal load. Backwashing
39 both sides of each condenser can take up to four hours within one day and the temperature
40 may reach as high as 120F. EPA encourages the NRC to include an evaluation of the impacts
41 of the thermal backwash on aquatic organisms in the EIS. (PNPS-AG)

1 **Comment:** It should also be noted that two fish kill events resulting from gas bubble disease
2 occurred in the Station's discharge canal during the 1970's. Subsequently, Pilgrim was
3 required to install a barrier net in the discharge canal to prevent fish from entering and residing
4 there. However, in 1996 Pilgrim was allowed to remove the net because no significant fish kill
5 events had occurred for some time. There also have been no documented large fish kill events
6 since the net was removed. Nevertheless, there is a risk that a large year class of menhaden,
7 for example, will detect the thermal plume of Pilgrim Station and possibly take residence in the
8 plume or canal. This would once again subject fish to gas bubble disease. The EIS should
9 consider options for preventing this impact when a strong year class is projected, including the
10 possibility of requiring that Pilgrim Station deploy a barrier net during appropriate periods to
11 reduce impacts and implement a biological surveillance program to effectively determine when
12 the impact minimization measures should be triggered. (PNPS-AG)
13

14 **Comment:** EPA is concerned about repeated impingement events at Pilgrim Station. Historic
15 data for Pilgrim shows high impingement numbers for several fish species including Atlantic
16 silversides, Atlantic menhaden, blueback herring, grubby, alewife, Atlantic cod, and rainbow
17 smelt. The majority of rainbow smelt impinged at Pilgrim Station are believed to have
18 originated from the nearby Jones River population. However, without quantitative evaluation of
19 the size of the Jones River population, it is not possible to fully assess the impact of Pilgrim
20 Station. The EIS should assess the potential impacts of impingement on all native fish species
21 affected, as well as provide a discussion of potential measures that can be taken to reduce
22 these impacts. (PNPS-AG)
23

24 **Comment:** This EIS should assess Pilgrim Station's current fish return system and document
25 any problems with it. We currently recognize at least three shortcomings of the current fish
26 return system that contribute to an increase on impingement mortality at Pilgrim. First,
27 chlorinated service water from the intake is de-chlorinated and used to spray fish and debris
28 from screens. There have been several documented occasions when the de-chlorination
29 system failed to operate correctly and fish were subjected to a chlorinated salt-water spray.
30 Second, the screens are normally only rotated once every 8- hour shift, thereby increasing the
31 length of time that fish are held against the screens. Third, fish are returned back to the intake
32 embayment of the Station, about 100 yards upstream of the intake structure, which may result
33 in high re-impinging rates.
34

35 In response to these three issues, we believe the EIS should discuss the benefits of installing a
36 chlorine measuring and malfunction system, evaluate the feasibility of continuous screen
37 rotation and assess re-impingement rates and whether there may be a more appropriate
38 relocation point for the fish return. In addition, the EIS should evaluate other options for
39 improving the fish return system to minimize impingement mortality. (PNPS-AG)

Appendix A

1 **Comment:** The EIS should discuss reasonable alternative ways to reduce impingement,
2 impingement mortality, entrainment and thermal discharges at the Pilgrim Station. Specifically,
3 EPA supports thorough evaluation of (1) alternative protection technologies including
4 substratum intake structure, various screening technologies (including wedgewire screens, fine-
5 mesh barrier nets or screens (e.g., "Gunderbooms")), cooling towers, variable speed pumps,
6 and fish return system upgrades; (2) alternative operational schemes including seasonal flow
7 restrictions, continuous screen operation, scheduling plant outages to minimize environmental
8 impacts and the installation of a chlorine measuring and malfunction notification system; and (3)
9 potential mitigation measures. In assessing these alternatives, the EIS should not only
10 evaluate their environmental ramifications, but should also address the nuclear power plant
11 safety implications of the alternatives. (PNPS-AG)

12
13 **Comment:** The EIS should also assess the effects of the thermal plume on the marine
14 environment, including effects on water quality and marine organisms. This analysis should
15 consider possible acute and chronic effects to marine organisms, such as causing mortality,
16 habitat avoidance, interrupted spawning, or increased prediction of threats, based on an
17 evaluation of the temperatures at which effects on health and behavior of the relevant
18 organisms may occur. Possible ecological effects should be considered (e.g., has warm water
19 attracted non-native species that drive out the native species). Effects on the benthic
20 community, including physical effects from scouring by the discharge, should also be
21 addressed. Adverse benthic effects have been documented in the past, primarily from
22 scouring, over an area of one to two acres. (PNPS-AG)

23
24 **Comment:** Pilgrim Station discharges a maximum of 510 million gallons per day (MGD) of
25 heated non-contact condenser cooling water to Cape Cod Bay. Pilgrim's current National
26 Pollutant Discharge Elimination System (NPDES) permit specifies a maximum daily
27 temperature limit of 102F. The EIS should assess the scope of the thermal plume across the
28 tidal cycle in terms of area and depth of the water body impacted, the amount of heat added to
29 the water (in British Thermal Units) and the extent to which the discharge alters ambient water
30 temperatures. (PNPS-AG)

31
32 **Comment:** Several other fish species, besides winter flounder, also suffer substantial
33 entrainment losses at the Pilgrim facility. These include cunner, mackerel, menhaden, Atlantic
34 cod and Atlantic herring. The EIS should assess the potential impacts of entrainment on all the
35 native fish species affected, along with means to reduce these impacts, including the use of the
36 alternate cooling water intake system technologies discussed below. (PNPS-AG)

37
38 **Comment:** In addition, we recommend that the EIS explore alternative modes of operation that
39 would avoid and minimize environmental impacts associated with the current mode of
40 operation. These impacts include effects on water quality and marine life from the facility's

1 pollutant discharges (e.g., any discharges of heat, chemicals, radionuclides, etc.) and
2 withdrawals of water from Cape Cod Bay for cooling. (PNPS-AG)
3

4 **Comment:** There is apparently significant influence by the plant on the bay area, people that
5 are familiar with the area do say that it is relatively barren. The problem that results from that
6 and the raising of the temperature is that there are various impacts on the ecosystem that we
7 are seeing today, for instance, in the ongoing concern about red tide. If our bay temperature
8 rises, like, for instance, Mt. Hope Bay where Brayton Point, the Cole Power Station, has
9 significantly raised the temperature of the bay, there is a lot of changing of the population to
10 fish, the aquatic life in the system. We lose fish, like sturgeon, we lose the larger fish that we
11 ourselves depend on for our survival and begin to have problems with algae, we begin to have
12 problems with low oxygen levels. (PNPS-G)
13

14 **Comment:** We believe that you have to do much, much, much more examination of the impact
15 of the heated water going into the bay than has been done and you have to do much, much
16 more than have a hatchery for winter flounder. (PNPS-G)
17

18 **Comment:** Finally, the Pilgrim Plant's cooling system causes significant damage to the
19 environment of Cape Cod Bay. Pilgrim uses a once through cooling system, taking in nearly
20 one half billion gallons of water a day and setting it into the bay at 25 or more degrees hotter.
21

22 An additional 20 years of operations at Pilgrim, using this cooling system, could kill billions of
23 aquatic plants and animals, this cooling system also violates Chapter 316B of the Federal
24 Clean Water Act which requires the plant to use the best available technology to minimize
25 environmental impact.
26

27 We believe that the plant must be held to the highest standards under the Clean Water Act and
28 a closed cycle cooling system should be installed as soon as possible, and certainly before the
29 license extension is granted. (PNPS-M)
30

31 **Comment:** Thermal discharge temperature is now averaged, there should be a cap and
32 required instantaneous measurement. (PNPS-N)
33

34 **Comment:** The second comment from DEP was because impinged fish from the intake
35 screens are shunted back into the intake, there is concern that these fish, weakened from
36 impingement, will simply be reimpinged. Permitting the resource, permitting resource agencies
37 should consider requiring an assessment of reimpingement rates to select species of concern.
38 These studies should also assess the need to relocate the discharge point for impinged fish in
39 order to minimize reimpingement. (PNPS-N)

Appendix A

1 **Response:** *The comments, in general, express concern regarding the impacts on aquatic*
2 *organisms resulting from operation of the existing PNPS once-through cooling system. To*
3 *operate PNPS, NRC Regulations require Entergy to comply with the Clean Water Act and its*
4 *associated requirements imposed by USEPA, Region I, as part of the NPDES permit. The*
5 *SEIS will evaluate the impacts related to impingement and entrainment of organisms,*
6 *discharges to the aquatic environment, the thermal plume, and other potential or actual aquatic*
7 *impacts. Additionally, a brief discussion of potential mitigation measures to limit impingement*
8 *and entrainment impacts will be presented in Chapter 4 of the SEIS.*

9
10 **Comment:** Marine impact can not be assessed at present because definite numbers have not
11 been set on what constitutes “significant impact.” A yardstick has to be firmly established for
12 each species (plant and animal) with appropriate federal, state and independent partners and
13 rationales provided to the public.

14
15 For example: There appear to be many methods used to determine impact, each with
16 drawbacks. It must be determined before going forward with the re-licensing process what
17 methods provide the most reliable estimates of impact, with a detailed rationale; a requirement
18 that these methods are followed by the licensee unless better methods are established and
19 independently approved.

20
21 We understand that no policy statement regarding losses on a square mile basis has been
22 issued by any state or federal agency. NRC must in its review process determine what percent
23 loss is a significant detriment to any population [figure depending on population], with a detailed
24 rationale. (PNPS-AC)

25
26 **Response:** *This comment relates to aquatic ecology and the determination of significant*
27 *impact. The NRC developed a three-level standard of significance (Small, Moderate, Large) for*
28 *assessing environmental issues. These levels of significance were established using the*
29 *Council of Environmental Quality’s regulations (40 CFR 1508.27) to systematically evaluate the*
30 *consequences of likely environmental impacts of renewing the operating license for a nuclear*
31 *power plant for an additional 20 years. Significance indicates the importance of likely*
32 *environmental impacts and is determined by considering two variables: context and intensity.*
33 *Context is the geographic, biophysical and social context in which the effects will occur, or the*
34 *in the case of license renewal, the environment surrounding the facility. Intensity refers to the*
35 *severity of the impact.*

36
37 **Comment:** Winter Flounder: DEP’s Gerry Szal recommended that resource agencies, in
38 concert with the permitting agencies, should consider further evaluation of the intake effects to
39 winter flounder. If effects are found to be substantial, these agencies should determine what
40 steps need to be taken to reduce the impacts of the facility on the winter flounder population.
41 (PNPS-AC)

1 **Comment:** Intake Effects Entrainment: Winter Flounder - methods used by Entergy to
2 determine impact.

3
4 1. Equivalent adult method: "researchers conducting this work have assumed an otter trawl
5 efficiency of 50%, but the actual efficiency may be much lower (or higher), which would alter the
6 number of fish in the study area per square mile and the apparent impact. Second, entrainment
7 sampling results are quite variable. Third, it is difficult to determine the accuracy, and therefore,
8 the applicability, of the survival matrix used in estimating equivalent adults."

9
10 Whether or not these levels of impact are a "significant" detriment to the population, and will
11 result in slowing the return to much higher population densities, is currently unknown and a
12 policy statement regarding losses on a square mile basis has not been issued by any of the
13 state or federal agencies. EPA Region 1 has stated in the past that population impacts of 5%
14 or greater are typically of concern. However, to DEP's Gerry Szal's knowledge, the geographic
15 bounds of this particular population have not been agreed upon by state or federal agencies.

16
17 2. 2nd method - estimate the percentage of the total larval population passing in front of the
18 facility that is entrained.

19
20 3. The third method used by the facility to evaluate impact was the RAMAS (Risk Analysis
21 Management Alternative System; Ferson, 1993) winter flounder model. It was used from 1999-
22 2001 to further evaluate the effects of the facility on the Cape Cod Bay winter flounder
23 population. Results suggested that stock reductions from 2.3 to 5.2% might occur as the direct
24 result of entrainment at the facility.

25
26 It should be determined and agreed upon by NRC, appropriate state agencies and independent
27 analysts what method or methods actually provide accurate information needed to assess
28 impact. (PNPS-AC)

29
30 **Comment:** Rainbow Smelt: "Brad Chase, DMF (pers. comm. to G. Szal, August 29, 2005)
31 estimates that there has been a sharp decline in the rainbow smelt population in the Jones
32 River since the time when the Lawton, et al. (1990), studies were conducted. Unfortunately,
33 without a quantitative evaluation of the rainbow smelt population size in the Jones River, Mr.
34 Chase felt it was not possible to assess the potential impact of Pilgrim's impingement events on
35 the Jones River smelt population." Until studies performed by the state and the Jones River
36 Watershed Association, we should not finalize a re-licensing decision. (PNPS-AC)

37
38 **Comment:** In addition, the Town is concerned about the economic impact of an accident, as
39 well as routine operations at the plant, on commercial fisheries in the area. The local
40 population of winter flounder, in particular, is of significant concern because it provides an
41 important commercial fishery and because the area around the plant serves as spawning,

Appendix A

1 nursery, and feeding grounds for the species. A moderate or severe accident at the plant
2 would have a deleterious effect on the flounder population, and therefore commercial fishery in
3 the region. While the ER concludes that plant operations "have not had a significant effect on
4 local and regional populations of fish and shellfish," (ER, Chapter 2.2.5) the Town submits that
5 additional evaluation of the intake effects to winter flounder are warranted to assess accurately
6 the long-term implications on this species of continued operations at Pilgrim during the renewal
7 period. (PNPS-AE)
8

9 **Comment:** In the past, Entergy has used the following three methods to evaluate the Station's
10 entrainment impacts to the local winter flounder population:(1) the "equivalent adult" method;
11 (2) estimating the percentage of the total larval population passing by the facility that is
12 entrained; and (3) the RAMAS (Risk Analysis Management Alternative System: winter flounder
13 model. We believe these three methods, and others as appropriate, should be discussed in the
14 EIS based on coordination with the EPA and other interested state and federal agencies. In
15 coordination with EPA and other interested resource agencies, the EIS should include an
16 analysis of the accuracy and applicability of these methods. (PNPS-AG)
17

18 **Comment:** What we have learned, over time, and I was trained as a psychologist, I was not
19 trained as an environmentalist, so we had a lot of learning to do and what we learned, over
20 time, was that the importance of the Jones River, as the largest river in Cape Cod Bay, relates
21 to the larger Gulf of Maine ecosystem, and the Gulf of Maine is one of those very few and rare
22 systems in the world, globally, that provide us with all of our ocean fish. What we are learning
23 is that if the Jones River's fish populations are lost, then the Gulf of Maine health is impacted.
24 (PNPS-G)
25

26 **Comment:** The Jones River, being the largest river in Cape Cod Bay, is important to the
27 ecosystem, not only to itself, but to the bay and to the entire Gulf of Maine. What we have
28 noticed in the Jones River is that the fish are diminishing and while it is true that Pilgrim and
29 Entergy have contributed to our work, that contribution has not overcome what we believe is a
30 growing lessening of the populations of fish, particularly herring and smelt, in the system.
31 Herring and smelt have both a history of entrainment at the plant. (PNPS-G)
32

33 **Comment:** DEP stated that the resource agencies, in concert with the permitting agencies,
34 should consider further evaluation of the intake effects to winter flounder. If effects are found to
35 be substantial, these agencies should determine what steps should be taken next. They
36 particularly pointed out that winter flounder that is dumped in from a Chatham laboratory, that
37 we heard from this afternoon, that these are fish that go in, but they are different, genetically,
38 and they don't breed with the current stock. (PNPS-G)
39

40 **Comment:** Rainbow smelt, as you heard today, they are considering putting on the
41 endangered species list because of their low numbers in the Jones River Watershed. There

1 should be a policy statement regarding losses on a square mile basis, this has not been done
2 by any federal agency and, if you don't have a real standard, then what are you doing? Also,
3 there appear to be many methods used to determine impact, each with drawbacks. What
4 methods would provide the most reliable results? This should be clearly stated in the analysis
5 provided. (PNPS-N)
6

7 **Response:** *The comments are related to the potential impacts of continued operation of the*
8 *plant on winter flounder, rainbow smelt, and other aquatic species populations. Assessment of*
9 *these species, in addition to other aquatic organisms, will be presented in Chapters 2 and 4 of*
10 *the SEIS.*
11

12 **A.1.3 Comments Concerning Socioeconomic Impacts**

13

14 **Comment:** When the plant came on line in 1972, it was equal in value to all the other
15 assessed property in the Town of Plymouth, so it effectively halved our tax rate. We were the
16 next town, that was South of Boston, that was probably going to experience some strong
17 growth and, coupled by our large land area, 103 square miles, and relatively cheap land prices,
18 and dirt cheap real estate prices, the savings that, at that time, the Boston Edison Plant brought
19 us was soon surpassed by the demands of the burgeoning population on the infrastructure ...
20 We built new elementary schools, new high schools, new middle schools, a lot of roads were
21 developed, some at the expense of developers and often they were maintained at the expense
22 of the town. We're in a position now that we are dependent on the town for a significant portion
23 of our tax, the plant, rather, for a significant portion of our tax revenue. (PNPS-J)
24

25 **Response:** *The comment is related to the socioeconomic impacts specific to PNPS.*
26 *Socioeconomic impacts such as taxes, employment, and land use are Category 2 issues.*
27 *These issues will be addressed in Chapters 2 and 4 of the SEIS.*
28

29 **Comment:** Speaking of work, Pilgrim is also an important source of jobs, there is more than
30 700 permanent, full time employees, most of whom live in Plymouth and the surrounding
31 communities. Indeed, Pilgrim supports the local economy to the tune of \$135 million a year in
32 local economic activity. (PNPS-F)
33

34 **Response:** *The comment is noted. Socioeconomic issues specific to the plant are Category 2*
35 *issues and will be discussed in Chapter 4 of the SEIS.*
36

37 **Comment:** The Town was founded in 1620 by the Pilgrims escaping religious persecution in
38 England and is known as "America's Hometown." As such, the Town is the cornerstone of
39 American freedom and values. Every year thousands of visitors come to the Town to visit not
40 only Plymouth Rock, but also the other historical sites in and around the Plymouth area.
41 Typically, tourists travel not only to the Town, but also to Boston or out to Cape Cod and other

Appendix A

1 coastal areas. In 2003, for example, travel expenditures for Plymouth County were \$353 million
2 (excluding payroll, state tax and local tax receipts), with the Town receiving a significant portion
3 of those amounts. The contribution of tourism to the health of the local economy, therefore, is
4 central. (PNPS-AE)

5
6 **Response:** *The comment is related to socioeconomic impacts, specifically tourism, recreation,*
7 *or historic appeal. Public services involving tourism and recreation were evaluated in the GEIS*
8 *and were determined to be Category 1 issues. Historic and archaeological resources and*
9 *socioeconomic issues were evaluated in the GEIS and were determined to be Category 2*
10 *issues and will be addressed in Chapters 2 and 4 of the SEIS, as appropriate.*

11
12 **Comment:** The total population within a 50-mile radius of PNPS was estimated by Entergy for
13 the year 2032 by combining total resident population projections with transient population data
14 from Massachusetts and Rhode Island...

15
16 The region is expected to add 465,000 people by 2030. The region will be aging with a
17 dramatic spike in the over 55 population. The largest population increases are expected in
18 urban centers such as Boston and Cambridge and in a half-dozen suburban towns, such as
19 Plymouth and Weymouth with very large housing developments on the horizon. (MAPC Metro
20 Future projections brief #1)

21
22 According to the report the area south of Boston is expected to grow faster in population and
23 jobs than any other section of Greater Boston through the year 2030. Jobs are important
24 because they factor into projecting the transient population.

25
26 Communities south of Boston will grow 13%. Plymouth is expected to add the most, about
27 10,000 residents - a population jump over 20%.

28
29 The population is expanding because there is more open land and large projects are planned in
30 Plymouth and on the Weymouth Navel Air Station land ---located just off Route 3, the
31 evacuation route for Duxbury and Marshfield. (PNPS-AC)

32
33 **Response:** *Socioeconomic issues, including demographics, that are considered to be*
34 *Category 2 issues, will be addressed as appropriate in Chapters 2 and 4 of the SEIS.*

35 36 **A.1.4 Comments Concerning Human Health**

37
38 **Comment:** We hope you will also be looking at the new information, since `72, of health
39 impacts in our communities. There has been a case controlled study of adult leukemia, there
40 has been review that has been done of the cancer, of the Massachusetts Cancer Registry,
41 since it started in `82, showing a consistent rise in thyroid and leukemia cancers in the seven

1 towns that the meteorological '82 study said would be most likely to be impacted. And also,
2 you would consider, in your health analysis, the projected demographic changes, from 2012
3 forward, of a one in three people in this area over 55 and tie that to the BEIR VII which indicates
4 that older and very young people are more susceptible to damage. (PNPS-A)

5
6 **Comment:** ...there is new and significant information supporting our contention that twenty
7 additional years of "normal" operations will be harmful to public health. Pilgrim releases
8 radiation as part of its standard operations. Radiation-linked diseases are documented in
9 communities around Pilgrim. This fact and projected demographic data indicate that this
10 population will be at an increased risk. The National Academy of Sciences (NAS) latest report
11 on low-dose radiation risk, Health Risks from Exposure to Low Levels of Ionizing Radiation:
12 BEIR VII Phase 2 (June, 2005) concluded that no amount of radiation is safe. The documented
13 radionuclide releases from Pilgrim in the past have long half-lives and bio-accumulate in the
14 environment. We submit that if the Applicant disputes a causal link between the radiation
15 released by Pilgrim and the cancers seen in its neighboring towns, the current systems in place
16 to monitor releases are inadequate and must be improved. We further submit that if the NRC
17 or State disputes elevated radiation-linked diseases rates or a causal connection that they have
18 not taken into account the unreliability of Pilgrim's monitoring data and reports.

19
20 Mitigation ER must consider if Pilgrim is allowed to continue operations:

21
22 • Reduction of allowable radioactive emissions into our air and water so that the
23 biological impact is no greater than that allowed from the releases from a chemical plant
24 licensed today and allowable dose reduced to be in synch with current scientific
25 knowledge on the effects of low-dose radiation on health, National Academy of
26 Sciences' Biological Effects of Ionizing Radiation, BEIR VII report.

27
28 • Verification of releases by combination radiation and weather monitors – computer
29 linked to state and local authorities – at all points where radiation is released from
30 Pilgrim and at appropriate off-site locations in the seven most impacted towns and on
31 Cape Cod. (PNPS-AC)

32
33 **Comment:** The National Academies Committee to Assess Health Risks from Exposure to Low
34 Levels of Ionizing Radiation, the National Research Council, published Health Risks from
35 Exposure to Low Levels of Ionizing Radiation: BEIR VII Phase 2 in 2005. Drawing upon new
36 data in both epidemiologic and experimental research, they concluded that no amount of
37 radiation is safe. There is a linear no threshold response to radiation, and exposure to low
38 levels of radiation is approximately three-times more dangerous than previously thought. BEIR
39 VII: Health Risks from Exposure to Low Levels of Ionizing Radiation, Report in Brief, June 2005.
40 Therefore it is not surprising that radiation-linked disease rates are higher than expected in
41 communities exposed to Pilgrim's past releases.

Appendix A

1 A summary of cancer deaths estimated at NRC's permissible dose release is provided in the
2 BEIR VII Report. The report shows the number of cancer cases and deaths expected to result
3 in 100,000 persons (with an age distribution similar to that of the entire U.S. population)
4 exposed to 100mSv per year over a 70 year lifetime. On average, assuming a sex and age
5 distribution similar to that of the entire U.S. population, the BEIR VII lifetime risk model predicts
6 approximately one individual in 100 persons would be expected to develop cancer (solid cancer
7 or leukemia) and approximately one in 175 would be expected to die from cancer from a the
8 permissible dose of 100 mSv.

9
10 Lower doses would produce proportionately lower risks. For example one in 1000 would
11 develop cancer from an exposure to 10 mSv. This new report validates concerns raised by us
12 and helps explain the radiation-linked disease observed near Pilgrim NPS. When the standards
13 were set by the NRC for permissible release of off-site radiation, low levels of radiation were
14 considered harmless. However, the BEIR VII report now reveals that any exposure is
15 potentially dangerous. Therefore it is not surprising that radiation-linked disease rates are
16 higher than expected in communities exposed to Pilgrim's past radiological releases.

17
18 This new information is particularly relevant to the issue of re-licensing Pilgrim because twenty
19 additional years of exposure will harm an already damaged population. Both BEIR VII and
20 previous nuclear worker studies show that the health effects of radiation are cumulative.
21 Effects of Radiation and Chemical Exposures on Cancer Mortality Among Rocketdyne Workers:
22 A Review of Three Cohort Studies. Morgenstern, H and Ritz, B., Journal: Occupational
23 Medicine: State of the Art Reviews, Vol. 16, No. 2, April-June 2001, pages 219-238. And as
24 shown previously, there is a growing and aging population in the area immediately surrounding
25 the plant. This population has already been harmed by the effects of radiation from Pilgrim and
26 as a result is more susceptible to even permissible levels of off-site radiation. An additional
27 twenty years of operations would put a group that is already damaged at further risk. (PNPS-
28 AC)

29
30 **Comment:** In its Final Environmental Impact Statement, the 1972 owners of Pilgrim stated in
31 the Summary of Environmental Impacts and Effects, Chapter 5-c. that, "The effluents from the
32 facility, if operated as described by the Applicant and in accordance with the technical
33 specifications and rules and regulations of the Commission, will not endanger the public health
34 or the natural environs of the station." Final Environmental Impact Statement, Pilgrim Nuclear
35 Power Station, Boston Edison Company, Docket 50-293, 5-c, p. iii, US Atomic Energy
36 Commission Division of Radiological and Environmental Protection, (May 1972). In its current
37 Application, Appendix E, Applicant states "Very low levels of radioactivity may be released in
38 plant effluents if they meet the limits specified in NRC's regulations. These releases are closely
39 monitored and evaluated for compliance with the NRC restrictions in accordance with the PNPS
40 Offsite Dose Calculation Manual." ER Appendix E.3.2.3.1. Essentially the same was stated
41 regarding solid and gaseous releases. Therefore the assumption is that there will be no danger

1 to public health from routine releases since they will be monitored and will not exceed federal
2 limits. However, despite this confidence written into the Application, we bring forward new and
3 significant information that demonstrates that there has already been documented radiation
4 linked disease in the communities near PNPS. In addition, a recent report was published by the
5 National Academy of Sciences that demonstrates that there is no safe dose of radiation for
6 humans. (PNPS-AC)

7
8 **Comment:** Epidemiological studies of cancer rates in the communities around Pilgrim show an
9 increase of radiation-linked disease that can be attributed to past operations of the plant. The
10 demographics of the population immediately surrounding the plant, including its age and
11 geographical distribution, make this population more susceptible to more radiation-linked
12 damage than was contemplated when the plant was licensed.

13
14 If Pilgrim is allowed to continue operations this should only be allowed under the following
15 conditions so that public health would be better protected.

16
17 • Reduction of allowable radioactive emissions into our air and water so that the
18 biological impact is no greater than that allowed from the releases from a chemical plant
19 licensed today and limits that are in synch with BEIR VII.

20
21 • Verification of releases by radiation and weather monitors computer linked to state and
22 local authorities at all points where radiation is released from Pilgrim and at appropriate
23 off-site locations - appropriate sites chosen by meteorological analyses. (PNPS-AC)

24
25 **Comment:** Health Impact: Projected age distributions will affect the expected health impact to
26 the population from radiation exposure – both routine and above routine. This must be
27 analyzed – the licensee’s filing failed to do so.

28
29 By 2030, (1) in (3) people will be over the age of 55, compared to 1 in 5 now.

30
31 We know from new research that radiation affects the most vulnerable – the young and the old.
32 This makes intuitive sense – for example, the older we get, the more vulnerable we become
33 and this is borne out by research. (PNPS-AC)

34
35 **Comment:** The population directly abutting Pilgrim is increasing substantially and the
36 population is older and thus more susceptible to radiation damage. Changing demographics in
37 communities impacted by Pilgrim are such that the dose effect on the population will be far
38 greater than originally anticipated when the plant was licensed – a larger/denser population and
39 older population.

Appendix A

1 When Pilgrim was licensed and built in 1972, its location was in an area that was remote and
2 undeveloped. The population around the plant has changed drastically in the last 30 years, and
3 this aging plant is now located in the fastest growing region in Massachusetts. In Pilgrim's
4 backyard, Pine Hills, the largest housing development in New England, is under construction.
5 The build-out includes 2,877 homes on 3,060 acres, and Pine Hills, Inc. is actively trying to
6 acquire more land to build in this area. The distance from Pilgrim to Pine Hills is < 3 ½ miles.
7 The current Pine Hills household size is 1.95 people per building. Based on these numbers,
8 there will soon be 5,850 people living just a few miles from this nuclear plant.

9
10 The region is expected to add 465,000 people by 2030 and this group will be aging with a
11 dramatic spike in the over 55 population. The largest population increases are expected in
12 urban centers such as Boston and Cambridge and in a half-dozen suburban towns, such as
13 Plymouth and Weymouth which have very large housing developments on the horizon. The
14 Boston Metropolitan Area Planning Council Report on Population and Employment Projections
15 2010 -2030, [http://www.mapc.org/2006 projections.html](http://www.mapc.org/2006%20projections.html). The methodology used by MAPC is
16 described in the report. (see Exhibit F-1). According to the report the area south of Boston is
17 expected to grow faster in population and jobs than any other section of Greater Boston
18 through the year 2030. Communities south of Boston will grow 13% and Plymouth is expected
19 to add the most, about 10,000 residents a population jump of over 20%. By 2030, 1 in 3 people
20 will be over the age of 55, compared to 1 in 5 now. This is relevant to any analysis of health
21 impacts, as studies have shown an increased sensitivity to low levels of ionizing radiation in
22 older populations. Greater Sensitivity to Ionizing Radiation At Older Age: follow-up of workers
23 at Oak Ridge National Laboratory through 1990. Richardson, D.B. and Wing, S. Int. J.
24 Epidemiol., 1999, 28:428-436; The Hanford Data: Issues of Age at Exposure and Dose.
25 Stewart, A.M., Kneale, G.W., PSR Quarterly Vol. 3, No.3 (Sept. 1993) 3:101-111; and
26 Leukaemia near nuclear power plant in Massachusetts, Richard Clapp, Sidney Cobb, C K
27 Chan, Bailus Walker, 924 , Lancet, 1987. (PNPS-AC)

28
29 **Comment:** There is new information since Pilgrim began operations in 1972 that shows
30 increases in radiation-linked diseases in the communities around Pilgrim. The increases were
31 in part attributed to operating with defective fuel; operating without the off-gas treatment system
32 in the first years; poor management and practices culminating in the releases in June 1982 that
33 coincided with weather conditions that held the releases over the area. Southeastern
34 Massachusetts Health Study 1978-1986, Morris, Martha and Knorr, Robert, Commonwealth of
35 Massachusetts Executive office of Human Services, Department of Public Health, 1990 and
36 Meteorological Analysis of Radiation Releases For the Coastal Areas of The State of
37 Massachusetts For June 3rd to June 20th, 1982, William T. Land. (PNPS-AC)

38
39 **Comment:** The cancers found in the communities around the power station initially were
40 studied by Dr. Sidney Cobb and Dr. Richard Clapp and their results were published in a peer
41 reviewed journal in 1987. They included elevated rates of Myelogenous Leukemia – a type of

1 cancer most likely to be triggered by exposure to radiation. This led to a case- control study
2 carried out by the Massachusetts Department of Public Health that showed a four fold increase
3 in adult Leukemia between 1978 and 1983. The report stated "a dose-response relationship
4 was observed in that the relative risk of leukemia increased as the potential for exposure to
5 plant emissions also increased." (PNPS-AC)
6

7 **Comment:** The Southeastern Massachusetts Health Study was conducted, peer -reviewed,
8 and made public during the Dukakis Administration. However, there was a complete about face
9 in November 1990 when Governor Weld took office that has continued through successive
10 Massachusetts Republican Administrations. December 1990, Governor Weld sent his
11 Executive Secretary to accompany Pilgrim's Vice President, Ralph Bird, and Pilgrim's Health
12 Physicist, Tom Sowden, to visit Massachusetts' Interim Commissioner of Public Health, David
13 Mulligan. At that meeting Pilgrim presented their "wish list" and obviously they had the
14 Governor's blessing. Pilgrim, the implicated industry, would be allowed to appoint a second
15 peer review panel to re-review the Southeastern Massachusetts Health Study; and, until the
16 industry's peer review panel decided whether the study was credible all the study's
17 recommendations would be put on hold. The second peer review panel could find nothing
18 wrong with the study's methodology. The re-review panel stated clearly in their report, Review
19 of the Southeastern Massachusetts Health Study by Hoffman, Lyon, Mase, Pastides, Sandler,
20 Trichopoulos, submitted to the Commissioner of Public Health, October 1992 in the Executive
21 Summary that, "The [original SMHS] study team adhered to generally accepted epidemiologic
22 principles..." and "the findings of the SMHS cannot be readily dismissed on the basis of
23 methodology errors or proven biases..." But somehow they just couldn't believe it - given
24 Pilgrim's emissions. However for emissions data, the re-review committee relied on data
25 collected and provided by Pilgrim - not surprisingly it indicated that Pilgrim hardly emitted any
26 radiation – and one offsite monitor located in South Boston, well outside the EPZ and outside
27 the geographic area likely to pick up routine emissions.
28

29 The story gets worse. Massachusetts Department of Public Health allowed Pilgrim, the
30 implicated industry, to provide all the sound bites, press releases and public announcements
31 about the re-reviews' findings and refused to let their employees, who conducted the original
32 study, speak to the press. No subsequent studies have been performed. MDPH has chosen to
33 protect the industry's health over the public's health. Once again, we see political science used
34 to re-write real science on behalf of industry. At the May 17, 2006 NRC Public Environmental
35 Scoping Meeting, an NRC official stated that they had visited MDPH and were told by MDPH's
36 Suzanne Condon and the department that there were no negative impacts from PNPS's
37 operations. Our message to you is that MDPH's statements are politically-driven and have little
38 to no resemblance to fact.
39

40 Evidence of radiation-linked disease continued. In a statement before the Southeastern
41 Massachusetts Health Study Review Committee [June 26, 1992] Dr. Richard W. Clapp, the

Appendix A

1 founder and former director of the Massachusetts Cancer Registry and Professor of
2 Environmental Health at Boston University School of Public Health, presented a graphical
3 assessment of the pattern of leukemia and thyroid cancer in the towns closest to Pilgrim during
4 the period 1982-1989. Analysis of 1974-1989 Massachusetts Cancer Registry for Leukemia &
5 Thyroid Cancer, Dr. Richard Clapp, DSc, MPH (2006), personal communication.
6

7 The incidence of leukemia peaked in 1982 and subsequently declined until 1986. Then there
8 was a second, smaller peak in 1987 and 1988 while declined in 1989. The number of cases
9 exceeded the number expected in 1982-85 and 1987-88. The second graph depicts the pattern
10 of thyroid cancer in the same set of towns. It shows a peak in the years 1987-1988. These
11 patterns of cancer incidence are consistent with the predicted health effects of the radiation
12 released in the early 1980s.
13

14 The graph shows the predicted health effects. A statistically significant increase in childhood
15 leukemia was noted in communities near Pilgrim, too. Although Massachusetts Department of
16 Public Health recommended a state sponsored case controlled childhood leukemia study, it was
17 not done.
18

19 The Massachusetts Cancer Registry also shows, for the years 1998-2002, a continuing
20 increase of leukemia and thyroid cancer in the towns around PNPS. Specifically, there were 83
21 cases of leukemia reported to the Massachusetts Cancer Registry (MCR), where 72.9 would
22 have been expected based on statewide rates. This results in a Standardized Incidence Ratio
23 (SIR) of 114 (95% conf. int. = 91-143). In addition, there was excess thyroid cancer in these
24 same towns for the same time period. The thyroid cancer SIR was 122 (95% conf. int. = 96-
25 155). In other words, leukemia was 14% elevated over the statewide rate and thyroid cancer
26 was 22% elevated. Neither of these calculations were statistically significantly elevated by the
27 usual convention ($P < .05$), but there were more cases than expected nevertheless. This means
28 there is a continuing excess of these two radiation-related cancers in the population, as there
29 was in the 1980s. Analysis of 1998-2002 Massachusetts Cancer Registry for Leukemia &
30 Thyroid Cancer, Dr. Richard Clapp, 2006, personal communication.
31

32 Prostate cancer and multiple myeloma, both radiation-linked diseases, are also elevated and
33 statistically significant for the years 1998-2002 in the seven towns most likely to be impacted
34 near Pilgrim (Carver, Duxbury, Kingston, Marshfield, Pembroke, Plymouth, and Plympton).
35 Health Risks from Exposure to Low Levels of Ionizing Radiation: BEIR VII Phase 2 (2006).
36 Occupational Radiation Studies, Chapter 8, National Academies Press, 2006. Specifically, data
37 from the Massachusetts Cancer Registry indicates 613 cases of prostate cancer vs. 513.5
38 expected, SIR=119 (95% C.I.=110-129); multiple myeloma: 47 cases vs. 31.7 expected,
39 SIR=148 (95% C.I.=108-198). Analysis of 1998-2002 Massachusetts Cancer Registry for
40 Leukemia & Thyroid Cancer, Dr. Richard Clapp, 2006, personal communication. (PNPS-AC)

1 **Comment:** The population of the Town is approximately 14,000 families, with tens of
2 thousands of children who would be highly vulnerable to a radioactive leak or other event which
3 could expose them to radioactive material above federally acceptable levels. In addition, there
4 is a sizable retirement community, many members of which also would be vulnerable to
5 overexposure to radioactive material. (PNPS-AE)
6

7 **Comment:** Given that the population in and around the Town has increased dramatically in the
8 last 30 years, the radiological dose effect on the population will be far more significant than
9 originally anticipated. When the plant was built in the 1970s, Plymouth was a quiet rural
10 community with a small population that grew seasonally with tourism. Today, Plymouth's year-
11 round population has more than tripled and it has become a year-round "city." Pilgrim now is
12 located in the fastest growing region of Massachusetts, which raises considerable implications
13 for postulated radiological dose effects. (PNPS-AE)
14

15 **Comment:** We have heard various studies have been performed and I would like to make sure
16 that the scope does take into account an examination of various studies of cancer. I know I
17 have anecdotally seen, in Duxbury, people with breast cancer, with various types of cancers,
18 that I'm not sure, and I don't know the answer, and I'm not accusing anyone of anything, but I
19 would like to make sure that if there is any evidence that does link health effects from radiation
20 to these various cancers, that that be studied and, if there is obviously a causal effect, that, to
21 me, would be grounds for not relicensing the plant. (PNPS-L)
22

23 **Comment:** We urge the NRC to consider, in depth, all the significant environmental impacts
24 which we believe are grounds for denying the relicense of the plant. The National Academy of
25 Sciences BEIR VII report, biological effects of ionizing radiation, June, 2005, stated that there is
26 no safe dose of radiation. Pilgrim emits radiation daily and these radiation releases have been
27 linked to increased rates of leukemia and thyroid cancers in the towns around Pilgrim.
28 (PNPS-M)
29

30 **Comment:** Another piece of new information is the BEIR VII report which found exposure to
31 low level radiation at least three times more damaging than heretofore thought. Also, we have,
32 as new information, the demographic changes projected from 2012 to 2032 of a one out of
33 three being over 55 and older people are susceptible to radiation damage than younger. Also,
34 the BEIR VII report pointed out the synergistic effect of radiation with other toxins, each
35 magnifying the other's mischief, if you will, and no one can doubt the fact that, between 2012
36 and 2032, there will be more, not less, pollution. (PNPS-N)
37

38 **Comment:** Health is another issue that should be considered on a site specific basis, again
39 because of new and significant information. There have been studies of health damage in this
40 community, there were studies done by Dr. Sidney Cobb and Dr. Richard Clapp in the '70s,
41 there was a case controlled leukemia study showing a fourfold increase the closer you lived or

Appendix A

1 worked to Pilgrim. Then there has been a statistical or simply significant increase in thyroid
2 cancer and leukemia in all seven impacted communities because both Pembroke and Plympton
3 are effected by the sea breeze effect and get these emissions. (PNPS-N)
4

5 **Comment:** We do need to find out whether there is any statistically significant amount of
6 radiation in the communities surrounding this plant and we need to find out whether there is any
7 relationship between that and incidents of cancer that are statistically significant in being higher
8 than should normally be expected. I have a certain kind of cancer and so do the four people
9 that live next to me on my street, we need to find out why. I'm not casting dispersions on the
10 plant or suggesting that it's cause, that it's the cause of this, but we do need to find out what the
11 cause is. (PNPS-P)
12

13 **Comment:** I heard a lot about thyroid cancer, ...and I would be interested to see if, on those
14 studies, they also did genetic studies ...I wonder how much of it is genetic and how much of it is
15 environmental too, so I would like to see, on those studies, if they also followed that up with
16 genetics too. (PNPS-X)
17

18 **Comment:** I'm interested in what kind of epidemiological studies have been conducted on
19 cancer rates related specifically to Pilgrim, as well as other areas with nuclear plants, and I'm
20 hoping somebody can help distribute that information. (PNPS-Y)
21

22 **Response:** *The comments are related to human health issues. Human health issues were*
23 *evaluated in the GEIS and were determined to be Category 1 issues. The GEIS evaluated*
24 *radiation exposures to the public for all plants including PNPS, and concluded that the impact*
25 *was small. During the plant-specific environmental review of PNPS, the NRC will determine*
26 *whether there is any new and significant information bearing on the previous analysis in the*
27 *GEIS. The information provided by the comments will be reviewed as part of that search.*
28 *Human health effects from radiation exposure due to operation of the plant during the renewal*
29 *period will be addressed in Chapter 2 and 4 of the SEIS. In addition, evaluation of new studies*
30 *and analyses of the health effects of radiation exposure is an ongoing effort at the NRC.*
31

32 *In spring 2006, the National Research Council of the National Academies published, "Health*
33 *Risks from Exposure to Low Levels of Ionizing Radiation, BEIR VII Phase 2." A prepublication*
34 *version of the report was made public in June 2005. The major conclusion of the report is that*
35 *current scientific evidence is consistent with the hypothesis that there is a linear, no threshold*
36 *dose response relationship between exposure to ionizing radiation and the development of*
37 *cancer in humans. This conclusion is consistent with the system of radiological protection that*
38 *the NRC uses to develop its regulations. Therefore, the NRC's regulations continue to be*
39 *adequately protective of public health and safety and the environment. None of the findings in*
40 *the BEIR VII report warrant changes to the NRC regulations. The BEIR VII report does not say*
41 *there is no safe level of exposure to radiation; it does not address "safe versus not safe." It*

1 *does continue to support the conclusion that there is some amount of cancer risk associated*
2 *with any amount of radiation exposure and that the risk increases with exposure and exposure*
3 *rate. It does conclude that the risk of cancer induction at the dose levels in the NRC's and*
4 *EPA's radiation standards is very small. Similar conclusions have been made in all of the*
5 *associated BEIR reports since 1972 (BEIR I, III, and V); the BEIR VII report does not constitute*
6 *new and significant information.*

7

8 **A.1.5 Comments Concerning Uranium Fuel Cycle and Waste Management**

9

10 **Comment:** The other item, of course, is waste, that supposedly it's off the table but I think,
11 quite clearly, you cannot have a severe accident mitigation analysis without including what
12 could happen by accident, and accidents can happen, to the spent fuel pool. That seems like a
13 logical place to pull the issue of spent waste, high level waste, into the SAMA, and I hope also
14 that you would consider and analyze buried waste that was allowed to be buried on site until
15 1981. I assume that when it was allowed to be buried, there was an assumption and analyses
16 of the time that it would remain stable, until the license ended in 2012 and decommissioning
17 would begin. What will another 20 years do to it? Will it remain stable for another 20 years? Do
18 you even know what is buried there, what the packaging is, etcetera? There should be a
19 complete inventory of what's there, curies, volume, packaging, a map where it is and whether
20 the six feet of soil is still over it, and whether you would recommend, for mitigation, monitoring
21 wells so we can see whether it is going into the bay, which is the only other place it can go
22 because of the topography. (PNPS-A)

23

24 **Comment:** According to Entergy, the facility will run out of space in its spent fuel pool by 2012
25 and there are no prospects for off-site storage in the foreseeable future. The ER states simply
26 and cryptically with respect to spent fuel storage during the 20-year renewal period: "[t]he spent
27 fuel assemblies are then stored for a period of time in the spent fuel pool in the reactor building
28 and may later be transferred to dry storage, if needed, at an onsite interim spent fuel storage
29 installation provided necessary regulatory approvals are obtained. Thus, a significant amount
30 of "hot" spent fuel will remain in the spent fuel pool at Pilgrim, which represents a long-term risk
31 to the Town that is not adequately addressed in the license renewal application. (PNPS-AE)

32

33 **Comment:** On-site storage of spent fuel assemblies which, already densely [packed in the
34 cooling pool, will be increased by fifty percent during the renewal period. The spent fuel will
35 remain on-site longer than was anticipated and is more vulnerable than previously known to
36 accidental fires and malicious attacks. The Pilgrim plant operator recently has stated that "[the
37 plant] will run out of space in 2012. This was never intended to be a repository for any length of
38 time." Accordingly, the ER should address the likely impacts of on-site storage in the years to
39 come. (PNPS-AE)

Appendix A

1 **Comment:** Even if present plans for establishing a federal waste repository at Yucca
2 Mountain move forward on schedule, that facility would reach maximum capacity long before a
3 relicensed Pilgrim stops generating its waste. Plant owners and the NRC need to have a clear
4 and safe plan for storage of radioactive waste before the extension is granted. (PNPS-M)
5

6 **Comment:** Over 1.2 million pounds of high level radioactive nuclear waste is stored on site at
7 the Pilgrim Plant, this waste poses a risk to the health of humans and ecosystems for centuries
8 to come, but there are currently no clear disposal options outside of the state. (PNPS-M)
9

10 **Comment:** ...on spent fuel, that this should be considered in this relicensing process because
11 there is significant new information which is the standard, the new information that is significant
12 is that excluding spent fuel from the review was based on a feeling there would be off site
13 options. However, we know there are no off site options in any period of time that we will be
14 talking about in the license extension. (PNPS-N)
15

16 **Comment:** The Waste Confidence Act, which exists and was the underpinning of why spent
17 fuel is not looked at, does not hold water, so the new information is Yucca is not going to
18 happen any time soon, reprocessing is not going to happen any time soon, nor is the Gashuti
19 Indian Tribe place going to happen any time soon, so we'll be here. Therefore, we must be told
20 beforehand what the options will be for safer storage. The Town of Duxbury, on two occasions,
21 has stated that we want safer interim storage, meaning low density pool storage, and secured,
22 hardened dry cast storage until there is an off site option. (PNPS-N)
23

24 **Comment:** The radioactive waste problem was another issue which the nuclear energy
25 industry would have to solve in the future. When the plant was originally commissioned, we
26 were promised that this was a problem that would be resolved. This problem has not been
27 solved, the radioactive waste produced by Pilgrim sits on the site of the plant and will continue
28 to increase in quantity for another 20 years if the plant is relicensed. Maybe it could be shipped
29 to Yucca Mountain in Nevada where it would have to remain safely contained for over a million
30 years. Take a trip to Las Vegas and ask the officials there if they have faith in the nuclear
31 industry. (PNPS-Z)
32

33 **Response:** *Onsite storage of spent nuclear fuel is a Category 1 issue. The safety and*
34 *environmental effects of long-term storage of spent fuel onsite have been evaluated by the*
35 *NRC and, as set forth in the Waste Confidence Rule (10 CFR 51.23), the NRC generically*
36 *determined that such storage could be accomplished without significant environmental impact.*
37 *In the Waste Confidence Rule, the Commission determined that spent fuel can be stored onsite*
38 *for at least 30 years beyond the plants life, including license renewal. At or before the end of*
39 *that period, the fuel would be moved to a permanent repository. The GEIS, NUREG-1437 is*
40 *based upon the assumption that storage of the spent fuel onsite is not permanent. The plant-*

1 *specific supplement to the GEIS that will be prepared regarding license renewal for PNPS will*
2 *be based on the same assumption.*

3
4 **Comment:** In 2008, North Carolina has stated they will not be taking waste from
5 Massachusetts. We are not a member of any compact state. There was a determination that
6 we were not going to be a low level radioactive waste site, so what would the future be, having
7 both high level waste and low level waste, which isn't necessarily low in toxicity or longevity, on
8 site? What should we be doing for that? (PNPS-A)

9
10 **Comment:** Waste containers and forms will not last as long as some waste remains
11 hazardous. Therefore, we want to know what Entergy's plans are for storing LLRW; monitoring
12 the releases; and what are the "acceptable" public radiation exposures and health risks.
13 (PNPS-AC)

14
15 **Comment:** LLRW should be looked at on a site specific basis because of new and significant
16 information since Pilgrim's initial license, 1972.

17
18 • Pilgrim had off site options in 1972 and reasonably expected them to continue. Not so,
19 now. Barnwell S.C. announced that it will close to Massachusetts generators June 20,
20 2008.

21
22 • Massachusetts is not a member of any compact; in order to join Massachusetts would
23 have to agree to be a host community; Massachusetts indicated clearly in the mid
24 1990's that it would not be a host community.

25
26 • Texas may open, no guarantees, and if it does open there is no assurance that non-
27 Texas Compact members will be able to send their waste there and if allowed whether
28 fees would be prohibitive. The Massachusetts Department of Public Health Radiation
29 Control stated, "As a result of the above, on July 1, 2008 Massachusetts generators will
30 have no treatment option other than decay on site unless Texas opens a new LLRW site
31 for Class B and C wastes. Texas has not decided yet whether non Texas compact
32 members may use their site."

33
34 • Terrorism or acts of malice were not considered a threat in 1972. Not so, post 9/11 -
35 nuclear facilities/materials are known to be attractive targets.

36
37 • Pilgrim is located on Cape Cod Bay and the property slopes towards the Bay so that
38 any leaking contaminants from waste storage facilities will flow towards and eventually
39 into the Bay. There are no monitoring wells lining the shoreline.

Appendix A

1 • The undisputed recognition of global warming is new and brings with it increased
2 severity of coastal storms, erosion, and increased sea levels. Hence this must be
3 factored into on-site waste storage options.

4
5 • PNPS is located on the coast -- a salt corrosive environment on concrete and waste
6 packaging must be analyzed.

7
8 Storage of LLRW is important for our community's health and safety because there is nothing
9 low level about the waste. Waste is characterized "high" or "low" depending on where it comes
10 from, how it is generated, not according to its' toxicity and longevity. Our community's health
11 has been compromised by radiation exposure – discussed above.

12
13 We deserve to know what the LLRW storage plans are before the application is decided; so
14 that the re-licensing decision does not prejudice any LLRW storage decision. (PNPS-AC)

15
16 **Comment:** The Licensee's filing discusses Low Level Radioactive Waste in Appendix E,
17 Applicant's Environmental Report Operating Renewal Stage Pilgrim Nuclear Power Station,
18 Chapter, 3.23. The discussion covers a brief overview of what they do with waste now. The
19 application makes one mention of low level radioactive waste which does not bear on the
20 subject- Applicant's Environmental Report 6.4.2 "land required to dispose of spent nuclear fuel
21 and low-level radioactive wastes generated as a result of plant operations." What is not
22 discussed, but needs to be analyzed, is what Entergy plans to do with LLRW from 2012-2032.
23 (PNPS-AC)

24
25 **Comment:** The environmental impacts of so-called "low level" radioactive waste storage,
26 2012-2032, should be analyzed in a site specific SEIS. Because: there is no guarantee that off
27 site options will exist after June, 2008; Pilgrim's coastal location is not suitable for waste
28 storage - a salt corrosive environment; increased intensity and frequency of storms predicted
29 for the future; topography is such that contaminants that have leaked will migrate/flow towards
30 and perhaps into Cape Cod Bay; the threat of terrorism. All of these factors could work
31 together to increase the probability that stored nuclear wastes could contaminate the
32 environment and endanger public health and safety. (PNPS-AC)

33
34 **Response:** *The comments are related to the environmental impacts associated with the*
35 *uranium fuel cycle and Low Level Radioactive Waste Management (LLRW), which were*
36 *evaluated in the GEIS and determined to be Category 1 issues. The GEIS evaluated impacts*
37 *associated with the uranium fuel cycle and LLRW management for all plants including PNPS,*
38 *and determined that the impact was small. During the plant-specific environmental review of*
39 *PNPS, the NRC will determine whether or not there is any new and significant information*
40 *bearing on the previous analysis in the GEIS.*

1 **Comment:** The Aging Management Program does not include an analysis of the potential
2 contamination from buried waste on site. We understand that until 1981 so-called low-level
3 radioactive waste was allowed to be buried at reactor sites. We asked the NRC if Pilgrim
4 buried waste on site up until that date and were informed by Cliff Anderson that they did not.
5 However, there have been persistent rumors that waste indeed had been buried on site and we
6 request that this be investigated.

7
8 Cliff Anderson, Branch Chief, USNRC, Region I, May 31, 2006 sent to us the following email.
9 The licensee for the Pilgrim station did not conduct any burials of radioactive material prior to
10 1981 in accordance with the former NRC regulation 10 CFR 20.304, which governed such
11 burials at that time. Notwithstanding, the Pilgrim station did conduct an "alternate disposal"
12 under 10 CFR 20.302 (now cited as 10 CFR 20.2002). That disposal option was requested per
13 10 CFR 20.302 in a letter, dated January 15, 1993, from Boston Edison Company, and
14 consisted of onsite disposal (i.e., burial) of soil that contained residual contamination from
15 several events. (The events are described in licensee event reports (LERs) 77-29, 82-19 and
16 88-26.) The licensed material covered by the request included 79,000 cubic feet of excavated
17 construction soil that contained a total radionuclide inventory of 0.636 millicuries of cobalt-60
18 and Cesium-137. The NRC staff approved the request by letter dated May 4, 1993, with the
19 provision that the NRC Safety Evaluation (SE), enclosed with the May 4, 1993 letter, be
20 permanently incorporated in the Offsite Dose Calculation Manual.

21
22 The NRC SE concluded the maximum dose from the disposal area would be less than 0.1
23 millirem/year during the year of disposal; and that doses during subsequent years through the
24 time of site decommissioning would be less than 0.01 mrem/year. The total dose was well
25 within the staff's guideline of 1 millirem per year, and is a small fraction of the 300 millirem
26 received annually by a member of the public from natural background sources of radioactivity.

27
28 The location of the LLRW and the burial method are described in the NRC SE enclosed with
29 the May 4, 1993 letter. The NRC found the disposal location acceptable because of its distance
30 from wetlands and Cape Cod Bay, and because any surface runoff would be entirely within the
31 Pilgrim owner controlled area. We are forwarding the NRC SE to you by regular mail (USPS).
32 The results of NRC inspection of this area were described in NRC Integrated Inspection Report
33 1999-01, which also will be forwarded by USPS mail.

34
35 The onsite spill and burial information is maintained in the licensee's 10 CFR50.75(g) file in
36 accordance with regulatory requirements. Such residual contamination is acceptable per the
37 rule and, as noted above, the public dose consequences are negligible in comparison with the
38 dose from natural background radiation.

39
40 Pilgrim Watch has not received the NRC SE or the NRC Integrated Inspection Report 1999-01.
41 These documents should be reviewed by the ER and made public. Regarding the material

Appendix A

1 buried referred to by Cliff Anderson we assume that when permission was granted to bury the
2 waste that it was assumed that decommissioning would occur in 2012 and the contamination
3 would be cleaned up; so-called "low-level" waste was indeed low level in its health impact; and
4 the Radiological Environmental Monitoring Program would detect off site contamination at levels
5 of concern. However these assumptions are no longer tenable if the application is approved.
6

7 Cliff Anderson ignored the burial onsite of contaminated materials from the 1987-1990 repairs
8 for which we believe there is no official record; these burials are well known. Those burials
9 must be responsibly dealt with - monitored and remediated, not continue to be ignored for an
10 additional 30 years.
11

12 Decommissioning, if the application is approved, will not begin until 2032 or later. We assume
13 that the licensee and NRC determined that burying waste on site would not harm the
14 environment based on a definite time frame – a 40 year license. What would happen after 60
15 years was not considered nor analyzed. It needs to be to provide reasonable assurance that
16 public health and safety will not be negatively impacted. For example erosion of the top soil will
17 be affected by the passage of time, increasing frequency and severity of coastal storms; and
18 the topography of the site that slants down into Cape Cod Bay. Migration of contaminants
19 underground is currently not monitored. Migration of contaminants from so-called low level
20 waste has happened at other sites - for example, at Barnwell SC, TVA, Hanford and Starmet.
21 Hence there is no reason to believe that the same could not happen here. (PNPS-AC)
22

23 **Response:** *The comment is related to the environmental impacts associated with Low Level*
24 *Radioactive Waste Management (LLRW), which were evaluated in the GEIS and determined to*
25 *be Category 1 issues. As part of the environmental review of PNPS, the NRC will determine*
26 *whether or not there is any new and significant information bearing on the previous analysis in*
27 *the GEIS. This determination will include a review and evaluation of this comment submitted*
28 *during the scoping period.*
29

30 **A.1.6 Comments Concerning Postulated Accidents**

31
32 **Comment:** We know assessments, number one, are low and, more importantly, we know that
33 a piece of property, like a business, the businesses on Court Street, are not only the value of
34 the bricks and the roof but the value of a business. The value of this area involves its tourist
35 appeal, historical value, etcetera, etcetera, and none of those inputs have been put into the
36 model in the SAMA. (PNPS-A)
37

38 **Comment:** For the SAMA, I hope that you will look at mitigation means to diminish the effect
39 on the public. I think somehow, in reading it, and I don't mean to, you know, sound flip, but it
40 seems to be more mitigating the damage to the licensee's pocketbook. That you would look,
41 for example, in the economic damage, that they only seem to consider, they have put, they

1 have two buckets, farm wells and non-farm, but they don't differentiate for business, for
2 example, and what you see there is a determination of valuation based on assessed value, in a
3 county, divided by the population. (PNPS-A)
4

5 **Comment:** The Town also would lose travel expenditures associated with travelers on their
6 way to Cape Cod, Nantucket, and Martha's Vineyard; travel through Plymouth County is
7 necessary to reach those destinations. Travel to those areas clearly would be restricted in the
8 event of a severe accident at Pilgrim (taking into account that winds often blow toward Cape
9 Cod at the islands), reducing travel expenditures not only in the Town but also in surrounding
10 areas. The loss of economic infrastructure and tourism should be considered in the SAMA
11 analysis to ensure that "realistic" mitigation alternatives are explored, taking such factors into
12 account. (PNPS-AE)
13

14 **Comment:** The economic model used in the SAMA analysis does not take into account the
15 loss of economic activity in the Town as an economic cost of a moderate or severe accident at
16 Pilgrim. The tourism sector is critically important to the economic vitality of the Town and
17 Plymouth County. A multitude of historical sites (e.g., Plymouth Rock, the Mayflower, Plymouth
18 Plantation) are located in close proximity to Pilgrim and attract thousands of visitors to the area.
19 Assuming appropriate clean-up and decontamination of these sites, it is unlikely that tourism
20 would ever fully recover after a severe accident, which would be devastating for the Town's
21 economy. (PNPS-AE)
22

23 **Response:** *The comments are related to the impacts of postulated accidents, including design
24 basis and severe accidents. The environmental impacts of design basis accidents is located in
25 Chapter 5 of the GEIS, which contains a detailed discussion of the possible environmental
26 effects of postulated accidents, including socioeconomic impacts. The Commission concluded
27 that consideration of design basis and severe accidents are Category 1 issues. However,
28 alternatives to mitigate severe accidents must be considered for all plants that have not
29 considered such alternatives. The applicant provided a severe accident mitigation alternatives
30 (SAMA) analysis as part of the license renewal application for PNPS. The NRC staff's review of
31 the SAMA analysis will be discussed in Chapter 5 and Appendix G of the plant-specific SEIS for
32 PNPS.*
33

34 **Comment:** Adding a filter to the direct Torus vent system, they come up with that it would cost
35 \$3 million and it would only reduce the amount of radiation released by half but, somehow, it's
36 not worthwhile. And so I think that that really speaks to the community and I hope it speaks to
37 you that the emphasis does not seem to be on mitigating effect public health, safety and
38 property, but rather to protect their own wallets. (PNPS-A)
39

40 **Comment:** The Direct Torus Vent System (DTVS) was installed because it was recognized
41 that there was something like a 90% probability of that containment failing. In order to protect

Appendix A

1 the Mark I containment from a total rupture it was determined necessary to vent any high
2 pressure buildup. The DTVS does not have a filter; therefore unfiltered material will be vented
3 into the neighborhoods. The DTVS provides reason to add additional monitoring to better
4 assess what was released after its use. (PNPS-AC)
5

6 **Comment:** The faulty SAMA analysis used by Entergy in the Environmental Report caused it
7 to wrongly dismiss mitigation alternatives such as adding a filter to the Direct Torus Vent. The
8 purpose of a SAMA review is to ensure that any plant changes that have a potential for
9 significantly improving severe accident safety performance are identified and addressed. Duke
10 Energy Corp., supra at 5. For its SAMA analysis, the Pilgrim Environmental Report explains
11 that, "A cost benefit analysis was performed on each of the remaining SAMA candidates. If the
12 implementation cost of a SAMA candidate was determined to be greater than the potential
13 benefit (i.e. there was a negative net value) the SAMA candidate was considered not to be cost
14 beneficial and was not retained as a potential enhancement. . . "The benefit of implementing a
15 SAMA candidate was estimated in terms of averted consequences." One example of how a
16 poorly performed SAMA analysis can lead to erroneous conclusions is the ER's look at the
17 costs and benefits of installing a Direct Torus Vent filter at Pilgrim.
18

19 The Direct Torus Vent System (DTVS) is a method to relieve the high pressure which is
20 generated during a severe accident. In 1986, Harold Denton, then the NRC's top safety official,
21 told an industry trade group that the "Mark I containment, especially being smaller with lower
22 design pressure, in spite of the suppression pool, if you look at the WASH 1400 safety study,
23 you'll find something like a 90% probability of that containment failing." Hazards of Boiling
24 Water Reactors in the United States, Paul Gunter, Nuclear Information Resource Service,
25 Washington, D.C. (March 1996). In order to protect the Mark I containment from a total rupture
26 it was determined necessary to vent a high pressure buildup. As a result, an industry
27 workgroup designed and installed the "Direct Torus Vent System" at all Mark I reactors,
28 including Pilgrim. Operated from the control room, the vent is a reinforced pipe installed in the
29 torus and designed to release radioactive high pressure steam generated in a severe accident
30 by allowing the unfiltered release directly to the atmosphere through the 300 foot vent stack.
31 Use of the vent discharges steam and radioactive material directly to the atmosphere bypassing
32 the standby gas treatment system (SBGTS) filters normally used to process releases via the
33 containment ventilation pathway. There is no radiation monitor on the pipe and valves that
34 comprise the DTV line. William J. Raymond, Senior Resident Inspector, Pilgrim Nuclear Power
35 Station, USNRC, Region I, Branch 5, email correspondence, May 11, 2006.
36

37 In response to a question posed by the Town of Plymouth at a public meeting on June 21, 1990
38 about the decontamination factors for the torus pool of various isotopes, the NRC
39 spokesperson responded that, "Except for the noble gases (consisting of the isotopes of Xenon
40 and Krypton), which are not retained in the pool to any significant degree, the suppression pool
41 is highly effective in scrubbing out and retaining particulate and volatile fission products.

1 Calculations as well as tests indicate that the suppression pool would be expected to have a
2 realistic decontamination factor (DF) for particulate and volatile fission products of about 100,
3 depending upon the accident sequence and the temperature of the water. This means that
4 about 1% of the particulate and volatile radioactivity entering the pool would be released to the
5 atmosphere, and about 99% would be retained within the pool.” Although the NRC spokesman
6 appeared to dismiss this as a trivial release, Dr. Frank von Hippel analyzed the applicant’s
7 response and stated that there is an internal contradiction in what we are being told. “The NRC
8 believes that the release from a severe core-melt accident would be reduced [by the
9 suppression pool] by a factor of one hundred. This is considerably more optimistic than
10 estimated in the NRC’s first study on the subject. WASH-1400, The Reactor Safety Study,
11 WASH-1400 (1975). Also known as The Rasmussen Report. Also, the contention is that the
12 reduction by a filtration system would have zero benefit. Here the contenders seem to be
13 assuming that a factor of one hundred equals 100%. That is false. Even a release of on the
14 order of 1 percent of the core’s radioactive iodine and cesium would be a very severe event.”
15 Frank Von Hippel, Program of Science and Global Security, Princeton University, e-mail
16 correspondence, March, 19, 2006.

17
18 In its Environmental Report, Entergy analyzes the benefits of installing a filter to the torus vent
19 in the course of reviewing possible severe accident mitigation alternatives. The Pilgrim ER
20 states, “Filtered Vent: This analysis case was used to evaluate the change in plant risk from
21 installing a filtered containment vent to provide fission product scrubbing. A bounding analysis
22 was performed by reducing the successful torus venting accident progression source terms by
23 a factor of 2 to reflect the additional filtered capability. Reducing the releases from the vent
24 path resulted in no benefit. This analysis case was used to model the benefit of phase II
25 SAMAs 2 and 19.” (E.2-5). The Report then states, “Basis for Conclusion: Successful torus
26 venting accident progressions source terms are reduced by a factor of 2 to reflect the additional
27 filtered capability. The cost of implementing SAMA at Peach Bottom was estimated to be \$3
28 million. Therefore this SAMA is not cost effective for [Pilgrim].” (E.2-24). (emphasis added) In
29 other words, as they show in Table E.2-1, Entergy has determined that in return for a cost of
30 \$3,000,000.00, there will be no (0.00%) benefit to public health and safety.

31
32 It is not clear to Petitioners how it is possible to find zero (0.00%) benefit from installing a filter
33 that would reduce by a factor of two the radioactive venting to the public in the case of a severe
34 accident. Unfiltered venting has been judged unsafe by all regulatory agencies outside the
35 United States. David C. Dixon, Pilgrim Direct Torus Vent System, Presentation to
36 Massachusetts Joint Committee on Energy (February 27, 1990). In its analysis of several risk
37 contributors to Core Damage Frequency in Chapter E.1, the disposition of those events in Table
38 E.1-3 frequently included “venting via DTV path to reduce containment pressure.” In other
39 words, a filter in the torus vent could reduce the impact in many possible severe accidents. The
40 only conclusion to draw from the outcome of the DTV filter SAMA analysis is that, as discussed
41 above, Entergy has used the MACCS2 code to downplay the health and economic costs of

Appendix A

1 severe accidents and used the Probabilistic Safety Analysis (PSA) model to make the benefits
2 of mitigation appear to be zero.

3
4 We respectfully request the ER to include a review of Entergy's analysis. In addition we
5 request the studies that NRC is currently depending to support NRC's assertion that the release
6 from a severe core melt accident would be reduced by a factor of one hundred. This is
7 considerably more optimistic than estimated in NRC's first study on the subject (WASH-1400,
8 1975). Last, if the NRC agrees with Entergy's analysis that a filter's benefit is not worth the cost
9 to present to the public both NRC's and Entergy's complete calculations and supporting studies.
10 (PNPS-AC)

11
12 **Comment:** My comments tonight are on the direct Torus vent system that Pilgrim, as a Mark
13 One boiling water reactor, was built with a faulty containment system and, in order to protect
14 that containment from total rupture, it was determined it was necessary to vent any high
15 pressure build up.

16
17 So the result was the direct Torus vent system was installed at Pilgrim, as well as all Mark One
18 reactors, this system is an extension of the containment ventilation system installed as a plant
19 upgrade in the 1980s, but it bypasses the standby gas treatment system filters normally used to
20 process releases via the containment ventilation pathway. Operated from the control room, the
21 vent is a reinforced pipe installed in the Torus and designed to release radioactive, high
22 pressure steam generated in a severe accident by allowing the unfiltered release directly to the
23 atmosphere through a 300 foot vent stack. There is no radiation monitor on the pipe and valves
24 that compromise the direct Torus vent line. So venting can result in a significant radioactive
25 release, even a release on the order of one percent of the core's radioactive iodine and cesium
26 would be a very severe event. Reactor operators now have the option, by direct action, to
27 expose the public and the environment to unknown amounts of harmful radiation in order to
28 save containment. The purpose of the containment is to provide a barrier between the lethal
29 radiation inside the reactor and the public.

30
31 As a result of the GE design deficiency, the original idea for a passive containment system has
32 been dangerously compromised and given over to human control with all its associated risks of
33 error and technical failure. We want indirect venting, that is allowing the steamer air to escape
34 only after it's passed through filters. The wet well pool will not scrub out or eliminate highly
35 radioactive fission products. Unfiltered venting has been judged unsafe by all regulatory
36 agencies outside the United States, the only advantage of direct venting is saving money for the
37 industry at the expense of the population. (PNPS-Q)

38
39 **Comment:** The EPA has an acceptable standard for exposure but, in the real world, there is
40 no safe level of exposure to radiation. Under the severe accident mitigation analysis, Pilgrim's
41 application stated that a filter would reduce by half the amount of radiation that would be

1 released in an accident. I think half is a major benefit for public health and safety. The
2 consequences should be calculated and compared with the cost of the filtration system and
3 mitigation should be focused on the protection of public health, safety and the regional
4 economy, not a cost benefit for a multi billion dollar industry trying to save dollars. (PNPS-Q)
5

6 **Comment:** The Pilgrim site is located on the western shore of Cape Cod Bay in the Town of
7 Plymouth, Plymouth County, Massachusetts (the "Town"). As such, the Town is in direct
8 proximity to any nuclear incidents that may occur. With a current estimated population of
9 approximately 59,000, an incident at Pilgrim that emits radioactive material could have
10 devastating impacts on the health of the Town residents. In addition, the Town economy is
11 heavily reliant on tourism. Any nuclear incident would deal a severe blow to tourism and the
12 related economy for the years to come and have a potentially ruinous effect on the local
13 economy. Thus, the Town urges the Commission to fully review all aspects of the Pilgrim plant
14 to assure that the citizens of Plymouth and surrounding areas are fully protected from negative
15 or dangerous environmental impacts associated with the plant's relicensing. (PNPS-AE)
16

17 **Response:** *The comments are related to the impacts of design basis accidents and severe*
18 *accidents. The impacts of design basis accidents and severe accidents were evaluated in the*
19 *GEIS and determined to be small for all plants; therefore, they are Category 1 issues.*
20 *However, alternatives to mitigate severe accidents must be considered for all plants that have*
21 *not considered such alternatives. During the plant-specific environmental review of PNPS, the*
22 *NRC will determine whether there is any new and significant information bearing on the*
23 *previous analysis in the GEIS. Chapter 5.1.2 of the plant-specific SEIS for PNPS will address*
24 *severe accidents. The applicant provided a severe accident mitigation alternatives (SAMA)*
25 *analysis as part of the license renewal application for PNPS. The NRC staff's review of the*
26 *SAMA analysis will be discussed in Chapter 5 and Appendix G of the plant-specific SEIS for*
27 *PNPS.*
28

29 **Comment:** The Environmental Report included in Entergy's license renewal application sets
30 forth a flawed SAMA analysis that misstates the consequences of a severe accident at Pilgrim.
31 Specifically, the SAMA analysis uses inaccurate input data that underestimated the economic
32 consequences of severe accidents at the plant. (PNPS-AE)
33

34 **Response:** *The comment is related to the severe accident mitigation alternatives analysis.*
35 *This analysis will be discussed in Chapter 5 and Appendix G of the SEIS.*
36

37 **Comment:** ...the National Academy of Sciences' study on the vulnerability of spent fuel storage
38 and they stated, unequivocally, that reactors designed like Pilgrim, Mark One BWRs, that have
39 the pool high up in the attic, if you will, of the reactor building, are the most vulnerable to loss of
40 water, whether by accident or attack, and there would be a consequence, fire, in a dense pool

Appendix A

1 that could not be put out and could contaminate 500 miles. Therefore, for at least these two
2 pieces of new and significant information, it should be considered. (PNPS-AC)
3

4 **Comment:** The SAMA analysis fails to address the environmental impacts of the on-site
5 storage of spent fuel assemblies which will be significantly increased during the renewal period;
6 it does not contemplate a severe accident in the spent fuel pool, but should. (PNPS-AE)
7

8 **Comment:** The ER should address the risk of an accidental spent fuel fire at the plant. The
9 risk of fire is increased because the spent fuel is densely packed in "high-density" storage
10 racks. In the event that water in the fuel pool were lost (due to an intentional attack on the
11 plant, for example), cooling of the fuel assemblies would be inhibited and the assemblies could
12 ignite rapidly and spread within the pool, leading to a significant atmospheric release of
13 radioactive isotopes with great threat to public health and the environment. (PNPS-AE)
14

15 **Comment:** The Attorney General seeks consideration in the Supplemental GEIS of the
16 environmental impacts of a severe accident in the Pilgrim fuel pool, including accidents caused
17 by equipment failures, natural disasters, and intentional malicious acts. The Attorney General
18 also seeks consideration of a reasonable array of alternatives for avoiding or mitigating the
19 impacts of a severe pool fire, including combined low-density pool storage and dry storage of
20 spent fuel. (PNPS-AH)
21

22 **Comment:** The Environmental Report is inadequate because it fails to address the
23 environmental impacts of the on-site storage of spent fuel assemblies which, already densely
24 packed in the cooling pool, will be increased by fifty percent during the renewal period. A
25 severe accident in the spent fuel pool should have been considered in Applicant's SAMA review
26 just as accidents involving other aspects of the uranium fuel cycle were. Applicant has included
27 other accidents involving the Uranium Fuel Cycle in its SAMA analysis demonstrating it agrees
28 that these are within the Scope of these proceedings. In addition, new information shows spent
29 fuel will remain on-site longer than was anticipated and is more vulnerable than previously
30 known to accidental fires and acts of malice and insanity. The ER should address Severe
31 Accident Mitigation Alternatives that would substantially reduce the risks and the consequences
32 associated with on-site spent fuel storage.
33

34 Mitigation strategies include: requiring low density pool storage and secured (hardened) dry
35 cask storage. These measures are requested by the Massachusetts Attorney General in his
36 petition to intervene and by the Town of Duxbury at Annual Town Meeting, 2005 and 2004.
37 Other strategies were analyzed by Dr. Gordon Thompson and found not to be effective.
38 Reconfiguring the assemblies in the pool will yield a small reduction in risk; however it will do no
39 good if there is partial drainage of water or if debris blocks air flow in a drained pool. The
40 National Academy of Sciences recommended installing a spray cooling system and specified
41 that the system must be capable of operation even when the pool is drained (which would result

1 in high radiation fields and limit worker access to the pool) and the pool or overlying building,
2 including equipment attached to the roof or walls, are severely damaged.” NAS Safety and
3 Security Report, supra at 6 and 57. This is unlikely to be achievable at Pilgrim and once
4 ignition had occurred, spraying water into the pool would feed the fire through the exothermic
5 steam-zirconium reaction. A massive and probably impractical flow of water would be needed
6 to overcome the effect. Doing nothing, as is the present situation, must be weighed against the
7 consequences.

8
9 The Massachusetts Attorney General’s Request for a Hearing and Petition for Leave to
10 Intervene includes a report on the potential consequences of a spent fuel pool fire at Pilgrim by
11 Jan Beyea, PhD., May 25, 2006...

12
13 Beyea stated that, “releases lower than 10% of the Cesium-137 inventory, even releases too
14 low to justify remediation, could have costs associated with loss in property value in the range
15 of 10 to 100 billion dollars (Beyea, page 8)...

16
17 Beyea notes that the cancer estimates . . . are lower limits, because they only include cancers
18 from Cesium-137. This approximation ignores shorter isotopes in the fresh fuel in the pool,
19 especially Cesium-134 (Benjamin 2003), page 11. Beyea goes on to say that, “Releases from
20 Pilgrim headed initially out to sea will remain tightly concentrated due to turbulence until winds
21 blow the puffs back over land (Zagar et al.), (Angevine et al., 2006). This can lead to hot spots
22 of radioactivity in unexpected locations (Angevine et al. 2004). Beyea, p.11. Therefore
23 dismissing radiation blowing out to sea is inappropriate. Reduction of turbulence on transport
24 from Pilgrim across the water to Boston should also be studied, according to Beyea’s analysis.
25 The program CALPUFF (Scire et al. 2000) has the capability to account for reduced turbulence
26 over ocean water and could be used in sensitivity studies to see how important the
27 phenomenon is at Pilgrim...

28
29 It is assumed that an area exists around the "main portion" of plume, where potential property
30 buyers would be concerned about residual risk. (The main portion of the plume is defined as
31 the area where remediation or demolition takes place.) Outside the main plume, contamination
32 would still be measurable. Lack of trust in statements by government would translate into loss
33 in property values. All things being equal, persons would wish to live as far away from
34 contaminated areas as possible.

35
36 A spent fuel accident is conservatively estimated to cost from \$105 to \$488 billion dollars and
37 result in 8,000 – 24,000 latent cancers from exposure to Cesium-137. Exposure to other
38 radionuclides and other resultant diseases, reproductive disorders and birth defects will up the
39 toll.

Appendix A

1 Currently casks cost about 1 to 2 million dollars per cask. Pilgrim has approximately 440 tons
2 of fuel on-site which would cost about \$71 million dollars to place into dry cask storage. In
3 addition, the licensee will incur the costs of moving the fuel out of the pool as it fills anyway, and
4 will ultimately need to put the fuel in dry casks for transfer to a long term repository when one
5 becomes available. The probability of a spent fuel fire increases yearly with the increase in
6 spent fuel densely packed in the pool, and with the risk of ever more sophisticated acts of
7 terrorism increasing. A rough cost/benefit look at moving spent fuel into secured dry cask
8 storage shows that this mitigation makes economic sense. Although in its ER, Entergy has
9 made vague statements about transferring spent fuel assemblies to dry cask storage in the
10 future, it has not outlined how and when this will happen. In a statement to Cape Cod Times,
11 Pilgrim spokesman David Tarantino has stated that Entergy plans to move assemblies out of
12 the spent fuel pools to dry casks only on an as-needed basis, to free up space in the pool for
13 newer spent fuel. This, and the application's silence on the issue of future spent fuel storage,
14 make clear that Entergy has no intention of reconfiguring its pool to low density storage in the
15 future. It also makes it unlikely that the plant will take the initiative to store spent fuel in secured
16 dry cask storage as soon as possible. It is up to the NRC assure that the public's interests are
17 protected and the vote of the Town of Duxbury that re-licensing be opposed unless Safer
18 storage of spent radioactive fuel rods is required until all spent rods are moved off site - low
19 density pool storage and hardened dispersed dry cask storage.

20
21 A plant-specific assessment of the vulnerability of the spent fuel pool to fires caused by
22 accident or acts of malice is mandated by the NEPA requirement to consider all of the
23 environmental impacts of the re-licensing and by the 9th Circuit Court's decision. In addition,
24 NRC Regulations (10 CFR 51.53(c) (ii) (L)) call for consideration of severe accident mitigation
25 alternatives on a plant specific basis if the plant has not already done so. The spent fuel pool,
26 although a Category 1 issue for the purposes of normal operations, should have been included
27 in the Category 2 SAMA analysis of severe accidents in the Applicant's Environmental Report.
28 There is also new information since the Generic Environmental Impact Statement was prepared
29 that demonstrates the spent fuel is likely to remain on-site longer than anticipated, and is more
30 vulnerable to fires than had been known.

31
32 Also, it is irrelevant whether the Applicant would have decided on mitigation or not. It is the
33 analysis, or "hard look" that is required by NEPA. "While NEPA does not require agencies to
34 select particular options, it is intended to 'foster both informed decision-making and informed
35 public participation, and thus to ensure the agency does not act upon incomplete information,
36 only to regret its decision after it is too late to correct' (citing Louisiana Energy Services
37 (Claiborne Enrichment Center), CLI-98-3, 47 NRC 77, 88 (1998))." . . . "if 'further analysis' is
38 called for, that in itself is a valid and meaningful remedy under NEPA." Duke Energy Corp.,
39 supra at 13. . . .

1 Given the catastrophic impact to human health and the environment if the spent fuel pool
2 experiences loss of water due to accident or terrorist attack, and the benefit that could be
3 achieved at a relatively reasonable cost to the plant operator, mitigation of the existing
4 vulnerability should at least be considered before the license is renewed. (PNPS-AC)
5

6 **Response:** *Onsite storage of spent nuclear fuel including spent fuel pool accidents is a*
7 *Category 1 issue. The NRC staff's review of the SAMA analyses will be discussed in Chapter 5*
8 *and Appendix G of the SEIS. These comments provide no new and significant information and,*
9 *therefore, will not be evaluated further.*
10

11 **Comment:** First item. We know that realistic plume modeling assumptions and wind weather
12 data are key to forecasting and implementing appropriate and effective emergency response
13 plants and to assess damage afterwards. We hope you will look and compare, for this
14 particular site, whether Class A models or Class B models would be the most appropriate way
15 to detect plume dispersion and whether to compare multiple meteorological towers,
16 appropriately located in sites in the community, would give a more accurate picture, in our
17 coastal environment with a varied terrain, than relying simply on the tower on site. (PNPS-A)
18

19 **Comment:** Multidimensional plume dispersion models, Class B Models; and multiple
20 meteorological towers placed in the seven surrounding towns impacted by the sea breeze effect
21 that were identified by Dr. J.D. Spengler [Carver, Duxbury, Kingston, Pembroke, Plymouth,
22 Plympton] and towers located appropriately on Cape Cod in consideration of the site specific
23 meteorological analysis of Cape Cod performed for the Commonwealth by Dr. Bruce Eagan.
24

25 Realistic modeling assumptions and meteorological data are the key to forecasting and
26 implementing appropriate and effective emergency response plans and assessing damage
27 afterwards.
28

29 Currently, Pilgrim uses Class A plume transport models and relies on weather information from
30 their onsite meteorological tower. Neither provides accurate data.
31

32 The Class A plume models used incorrectly assumes a steady-state, straight-line plume
33 transport; although actual wind and weather conditions are variable and complex affected by
34 sea and lake breezes, terrain, location/clustering of buildings, and variable precipitation.
35

36 Pilgrim should use complex Class B models now and from 2012-2032 if the license is extended.
37

38 The on-site Met Tower only tells us what the wind direction is on site but not what happens to
39 the plume as it travels offsite. Therefore Pilgrim should use data from multiple weather stations
40 now and from 2012-2032, if the license is extended. (PNPS-AC)

Appendix A

1 **Response:** *These comments raise questions regarding the adequacy of various input data and*
2 *assumptions (i.e. meteorological data) used in the MACCS2 offsite consequence analysis. The*
3 *MACCS2 analysis will be addressed in Chapter 5 of the SEIS.*

4
5 **Comment:** Pilgrim is located on the coast and the wind is highly variable due to the Sea
6 Breeze Effect, terrain, buildings, and variation in precipitation/fog patches. Therefore planning
7 must be for the entire radius – not simply for those inside one imaginary “relatively narrow
8 plume.” (PNPS-AC)

9
10 **Comment:** In light of NRC and EPA’s Guidance about the use of refined variable trajectory
11 modeling techniques to provide for more realistic, accurate modeling predictions and site
12 specific meteorological studies demonstrating the complexity of weather at this site. Pilgrim
13 should update to Class B models and multiple weather stations. (PNPS-AC)

14
15 **Comment:** A straight line Gaussian model is not applicable here and the applicant should not
16 rely on weather input data simply from that obtained onsite. By relying on the steady-state,
17 straight –line Gaussian model to construct a “key hole” planners are likely to make the wrong
18 call - send citizens into a plume; tell folks to stay put when should evacuate; or tell them to
19 evacuate when should shelter. Class B models must be required if a license extension is
20 granted for 2012-2032. Computerized combination weather-radiation monitors are readily
21 available and also must be required. (PNPS-AC)

22
23 **Comment:** The meteorological input to the modeling tool used by Entergy to characterize
24 weather conditions, and therefore the radiological consequences from a severe accident at the
25 Pilgrim plant, are inaccurate.

26
27 While Pilgrim's Meteorological Monitoring System currently meets applicable Commission
28 requirements, the ER's straight-line Gaussian plume model to estimate the location and
29 magnitude of predicted radionuclide concentrations and resultant doses received from a
30 postulated plant accident is inappropriate for the Pilgrim station. With the Gaussian plume
31 model, the speed and direction of prospectively lethal clouds are determined by the initial wind
32 speed and the direction at the time of release and do not account for variable atmospheric
33 conditions, whether in time or in space. Further, the model does not consider terrain effects,
34 which can significantly affect wind patterns and dispersion/ Variable wind conditions over time
35 and space, likely in the coastal, hilly terrain are surrounding the Town, makes the resultant
36 predictions of the movement of lethal airborne materials based on just onsite meteorological
37 data, with simplistic straight line air quality dispersion models, severely unreliable for evacuation
38 planning purposes. (PNPS-AE)

39
40 **Response:** *Emergency planning decisions at Pilgrim would be based on the Pilgrim*
41 *Emergency Plan. 10 CFR Part 50.47 requires that the Emergency Plan provide adequate*

1 *methods, systems, and equipment for assessing and monitoring actual or potential offsite*
2 *consequences of a radiological emergency condition. The Pilgrim Emergency Plan, including*
3 *meteorological and dose projection capabilities, has been reviewed by the NRC and found to*
4 *meet all regulatory requirements. The comments provide no new and significant information,*
5 *and are not within the scope of license renewal under 10 CFR Part 51 and Part 54. Therefore,*
6 *they will not be evaluated further.*

7
8 **Comment:** The assumptions in the models used by the applicant and the input data put into
9 those models do not provide credible conclusions regarding emergency response outcomes in
10 a severe accident. Nor is there reasonable assurance that the assumptions used by FEMA in
11 this area have any credibility. The MACCS2 emergency planning model requires the user to
12 input the time when notification is given to emergency response officials to initiate protective
13 actions for the surrounding population; the time at which evacuation begins after notification is
14 received; and the effective evacuation speed. However, the model assumes that the population
15 is out of danger once crossing the 10-mile boundary. This will not be true in a severe accident
16 such as a core melt and/or a spent fuel pool accident that leads to a zirconium fire. Safety and
17 Security of Commercial Spent Nuclear Fuel Storage Public Report, National Academy of
18 Sciences, 3 (April, 2005).

19
20 In addition, the model does not consider those who cannot evacuate and must shelter.
21 Protective actions involve both evacuation and sheltering. Under some circumstances
22 evacuation will not be possible for all or a portion of the affected population. The elderly often
23 require transportation assistance because they are infirm, cannot drive themselves or have only
24 one car per household that may not be available in an emergency.

25
26 The applicant's evacuation time input data is from, Pilgrim Station Evacuation Time Estimates
27 and Traffic Management Plan Update, Revision 5, (November 1998). However later data is
28 available. KLD prepared a later report for Entergy, Pilgrim Nuclear Power Station Development
29 of Evacuation Time Estimates, KLD TR-382, Revision 6, (October 2004). The newer KLD study
30 relies on newer census data and newer roadway geometric data. The most recent data
31 available should be used as source material to get the most accurate estimates.

32
33 Many of the assumptions and study estimates in the applicant's source, Pilgrim Station
34 Evacuation Time Estimates and Traffic Management Plan Update, Revision 5, (November
35 1998) are faulty. For example, voluntary evacuation from within the EPZ was estimated to be
36 50% within a 2-5 mile ring around the reactor, excluding the "key-hole;" and 25% in the annular
37 ring between the 5-mile boundary of the circle and the 10-mile EPZ boundary. Shadow
38 evacuation was not considered. Special Events, such as the July 4th celebration, were not
39 considered. Evacuation time estimates for the EPZ was performed for, "Off-season mid-week,
40 mid-day in good weather; and summer mid-week, mid-day, good weather." Using the above
41 false assumptions, the study describes unrealistically low evacuation time estimates. Clearly

Appendix A

1 there is no guarantee that an accident will not occur on holidays, during the commuter rush
2 hour, on summer week-ends, or in bad weather. Emergency planning and a severe accident
3 analysis should assume the worst case scenario. (PNPS-AC)
4

5 **Response:** *The commenter raises questions regarding the adequacy of various input data and*
6 *assumptions used in the MACCS2 offsite consequence analysis, including: estimated times to*
7 *notify emergency response officials and to initiate and complete evacuation, the portion of the*
8 *population that does not evacuate, the impacts of a “shadow evacuation” in which persons*
9 *outside the evacuation zone voluntarily evacuate, and the impact of transient population. The*
10 *MACCS2 analysis will be addressed in Chapter 5 of the SEIS.*

11
12 *The commenter also states that the severe accident analysis should assume the worst case*
13 *scenario. The staff disagrees. As stated in the Commission’s Policy Statement on Use of*
14 *Probabilistic Risk Assessment Methods in Nuclear Regulatory Activities, PRA evaluations in*
15 *support of regulatory decisions should be as realistic as practicable. Similarly, the Regulatory*
16 *Analysis Guidelines of the NRC call for the use of best estimate values. Reliance on best*
17 *estimate rather than worst case assumptions in the SAMA analysis is consistent with this*
18 *guidance.*

19
20 **Comment:** The sea breeze phenomena are observed at the Pilgrim site. A sea breeze is a
21 localized wind that blows from the sea to the land. It is caused by the temperature difference
22 when the sea surface is colder than the adjacent land. Therefore, it usually occurs on relatively
23 calm, sunny, spring and summer days. Depending on topography, intensity of solar heating
24 and pressure gradients, a sea breeze front can penetrate inland from 1(.5 miles) to 15 km (9
25 miles). It can occur throughout the year but it occurs most frequently during the spring and
26 summer months. On average Pilgrim experiences about 45 sea breeze days during these two
27 seasons.
28

29 Typically onshore component commences about 10:00 AM and can persist to about 4 PM. The
30 wind direction changes during the day veering from the north around through the southeast
31 quadrant by late afternoon. The intensity of the sea breeze can be measured by the wind
32 speed and distance of inland penetration. The intensity of the sea breeze circulation depends
33 upon solar radiation (which is influenced by cloud cover), sea water temperature, and strength
34 of the gradient wind flow. The intensity and effective inland penetration of the sea breeze front
35 in the near environment of the Pilgrim site are not well characterized. (PNPS-AC)
36

37 **Comment:** Coast line orientation and topography strongly influence wind patterns (the
38 frequency, direction, and strength of onshore winds). Predominantly in the summer and spring,
39 a sea breeze onshore component is observed along the Massachusetts coast. The dominant
40 sea breeze components are east and east-southeast for Boston-Logan, easterly for Plymouth,
41 northeast and east-northeast for the Canal site, and east and east-southeast for the Pilgrim

1 plant. This finding suggests that the wind speed and direction at one coastal site would not be
2 used as a surrogate for other coastal sites. (PNPS-AC)

3
4 **Comment:** The meteorological sites available provide limited ability to fully characterize or
5 model the sea breeze circulation in the vicinity of the Pilgrim Nuclear Power Plant.

6
7 Physical modeling of coastal sea breeze circulation patterns is limited by both the number of
8 meteorological sites in the vicinity of the Pilgrim Plant and the number of parameters monitored.

9
10 William T. Land, Meteorological Analysis of Radiation Releases For the Coastal Areas of the
11 State of Massachusetts for June 3rd to June 20th 1982 A listing of probable causes resulting in
12 radiation concentration within the microclimate would include (in order of importance):

13
14 1. ONSHORE WINDS: Winds from the east and north moving radiation back toward the land
15 away from the coast.

16
17 2. WIDESPREAD RAINFALL; Rain which could keep radiation in the lower stratosphere and
18 washout radiation into the ecosystems, food chain and water supplies.

19
20 3. COOL DESCENDING AIR; Air which would prohibit radiation from lifting into high altitude
21 winds which would in turn carry the contaminants at the 18,000 foot level safely out to sea.

22
23 4. AIR POLLUTION: Pollution which would give added nuclei for radiation to adhere to thereby
24 increasing its ability to stay at lower stratospheric levels.

25
26 5. FOG: Fog which would give additional hygroscopic nuclei for both pollution and radiation to
27 coalesce upon.

28
29 6. AIR STAGNATION: Stagnation with little or no wind, haze and temperature inversions which
30 in turn have the ability to trap radiation close to the surface. (PNPS-AC)

31
32 **Comment:** Winds along the coast of Massachusetts, and therefore the Town, are significantly
33 affected by the sea breeze effect, which is critically important in estimating contaminant
34 exposures in coastal areas. During moderate to strong wind conditions, such as those
35 associated with coastal storms, approaching warm fronts, or after the passage of cold fronts,
36 the wind direction throughout the region should be fairly uniform as would be depicted from one
37 of Entergy's meteorological towers. However, abrupt wind direction shifts and wind speed
38 changes can occur during the passage of such large-scale weather systems throughout the
39 region. When wind speed starts to get lighter (e.g., below 5-10 mph), and depending upon the
40 time of day and season, the terrain also will affect regional wind patterns in a more pronounced
41 manner. During the spring and summer months whenever day-to-day large-scale regional

Appendix A

1 weather influences are absent (storms and fronts), strong temperature contrasts between the
2 warmer land and the colder Cape Cod Bay can result in sea breeze conditions on sunny, fair
3 weather days. At times, sea breeze influences can penetrate miles inland. Weaker land
4 breezes also can occur during other times, particularly at night, when the land surface is colder
5 than the water body surface. Shifting wind patterns (including temporary stagnations,
6 recirculation, and wind flow reversals) can occur during these daily sea and land breeze
7 conditions, and can persist for several hours. Any shifting wind patten away from Pilgrim could
8 produce a different plume trajectory (and resultant concentrations and radiological doses at
9 specific locations) than what the application depicts. (PNPS-AE)

10
11 **Response:** *These comments raise questions regarding the adequacy of various input data and*
12 *assumptions (i.e. meteorological data) used in the MACCS2 offsite consequence analysis. The*
13 *MACCS2 analysis will be addressed in Chapter 5 of the SEIS.*

14 15 **A.1.7 Comments Concerning Alternative Energy Sources**

16
17 **Comment:** ...wind power, solar power, fuel, gas, gas fuel, as far as bringing it into Fall River,
18 bringing it into Boston Harbor, all of these things are not something that anybody wants to
19 have...The fact is that we have to have alternative energy and if nuclear is not the safest, then I
20 think we have to find out what's better and, as we have proposed just about everything, we
21 have had situations that have caused us to get more and more limited. I don't think we can
22 protect ourselves from just about anything that we are dealing with. (PNPS-V)

23
24 **Comment:** And I think that when we are talking about fossil fuels, we have to consider that
25 there is a risk in everything, there is a risk in everything in our environment. (PNPS-V)

26
27 **Comment:** We have gone from the point where we were heating our homes with firewood, and
28 we went to coal, we didn't like that, we went to oil. We are now into the nuclear age and, as far
29 as its concerned, I would just like to know and I think perhaps people from some of the, some
30 of the people who are providing studies is what are the alternatives? (PNPS-V)

31
32 **Comment:** Let's have a wind farm out in Nantucket Sound, you are not going to have any
33 problems there. There is no NRC to oversee a wind farm because there is no problem with a
34 wind farm as serious as the problem that exists with the radioactive substances that we are
35 using today in these reactors. (PNPS-Z)

36
37 **Response:** *The comments are related to the environmental impacts of alternatives to license*
38 *renewal at PNPS. The GEIS included a discussion of alternative energy sources.*
39 *Environmental impacts associated with various reasonable alternatives to renewal of the PNPS*
40 *operating license will be evaluated in Chapter 8 of the SEIS.*

A.1.8 Comments Concerning Monitoring Programs

Comment: I hope, in that, you will also be looking at the necessity in the future, and actually now, for better monitoring to assess whether the current environmental monitoring program reports are reliable and accurate, whether, instead, we need to include more sampling to have another look at where control and indicator stations are place and also to consider, in the future, whether it's appropriate to have the licensee get the samples, and have their own labs analyze the samples and to provide the reports, whether a system would better protect health and public safety, for 2012-2032, what would you advise? (PNPS-A)

Comment: High School Monitoring Project - This system consists of radiological and meteorological monitoring systems at each of seven high schools [3 in Plymouth; 1 each in Carver, Kingston, Duxbury and Marshfield]. These on-line monitoring stations are connected by modem to each other and to MDPH.

Deficiencies:

- This program was initiated by the Governor's Council on Radiation Protection solely as a teaching device for the students, not as a monitoring device to protect public health and safety. They recognized that this important job could not be left to a changing collection of teachers, students or janitors, working part-time and not trained technicians.
- It is overly optimistic to assume that the schools are all coincidentally placed in the most favorable locations in regard to population density and meteorological conditions.
- The High School monitors, like the Sage, have poor sensitivity to low energy gamma and beta. To be protective of public health they should measure gamma, beta and alpha radiation, at both the high and low energy levels. For example Iodine-125 is at the 60 KeV and most iodine's are less than 100 KeV.
- Calibration and testing of equipment is not adequately and consistently performed. (PNPS-AC)

Comment: The ER must analyze the accuracy and reliability of Pilgrim's monitoring and reporting in order to accurately assess what impact Pilgrim actually has had on the environment and is likely to have in the future.

We contend that in order to have any reasonable assurance that public health and safety will be protected 2012-2032, the following changes in the monitoring program must occur.

Appendix A

1 Environmental monitoring program must be changed as follows:
2

- 3 • Control stations actually placed outside the area of Pilgrim's influence - outside
4 Emergency Planning Zone [EPZ] communities;
- 5
- 6 • Number and type of samples expanded;
- 7
- 8 • Split samples provided to an independent source;
- 9
- 10 • Analysis and reports performed by an independent laboratory, not one owned by the
11 applicant;
- 12
- 13 • Monitoring wells installed to test for groundwater contamination and migration placed
14 onsite, especially along the edge of Cape Cod Bay. Monitoring air emissions modified
15 to include:
- 16
- 17 • Off-site releases - upgrade equipment by installing combination weather/ radiation
18 detection and measurement devices, fix-mounted to provide real-time measurements,
19 placed in appropriate locations as determined by a site-specific meteorological study;
- 20
- 21 • On-site monitors upgraded.
- 22

23 Multidimensional plume dispersion models, Class B Models; and multiple meteorological towers
24 placed in the seven surrounding towns [Carver, Duxbury, Kingston, Pembroke, Plymouth, and
25 Plympton] and on Cape Cod according to site specific meteorological analysis performed, for
26 example, for the Commonwealth by Dr. J.D. Spengler and Dr. Bruce Eagan. (PNPS-AC)
27

28 **Comment:** Radiation detectors are located at exit points from the plant to measure gaseous
29 radioactive effluents. These detectors monitor the gross gamma radiation of gaseous effluents
30 as they pass by. These readings are monitored and recorded in the control room, and when
31 the radiation level approaches release limits, either the effluents can be diverted to another
32 system for further processing, or the power level of the reactor can be reduced in order to
33 reduce the amounts of radioactivity produced. The radiation detectors are sensitive only to the
34 total amount of radiation impinging on them, they don't differentiate between one isotope and
35 another, since there are substantial assumptions regarding short half-lives of isotopes entering
36 the systems. One fundamental limitation to measuring gamma radiation levels exiting the plant
37 ventilation systems is that a small perturbation in the total amount of radiation detected, since
38 the decay rate is so much lower compared to short half-life isotopes. In this way, a leak of long
39 half-life isotope could go undetected by a radiation detector. The use of chemical and gamma
40 spectrographic analysis is designed to augment the stack radiation monitoring program.
41 (PNPS-AC)

1 **Comment:** Periodic sampling and analysis techniques are employed to determine the relative
2 abundance of various isotopes that are being released. This is very important since the
3 biological action and possible impact is quite different for different isotopes. The way this is
4 carried out is that radioactive effluent is sampled by systems that employ filters and charcoal to
5 draw air through them. After a given period of time, the contents of the filters and charcoal are
6 analyzed by measuring the radioactive decay rate as a function of disintegration energy. Since
7 isotopes decay by emitting radiation of characteristic energies, the amount of a given isotope
8 present in the sample can be estimated by the magnitude of the number of disintegrations at
9 characteristic energies. The uncertainties associated with this method are that in general
10 isotopes emit a spectrum of radiation frequencies, and in a case where there are a large
11 number of unknown isotopes present in the sample, the energy peaks can overlap for different
12 species and it may not be possible to assay many isotopes with any accuracy. Another
13 problem that can occur is that the efficiency of the charcoal absorber is strongly a function of
14 relative humidity, so in cases of high humidity, the amount of a given isotope present in the
15 charcoal may not at all reflect the concentrations in the sampled effluent. Detectors used to
16 perform these measurements have non-uniform responses to different energy peaks, and
17 calibration of these sensitive instruments should be conducted frequently. Finally, the raw
18 measurements from these instruments are entered into equations to estimate actual release
19 rates, so the associated uncertainties may be quite high. (PNPS-AC)
20

21 **Comment:** Off-site monitors to measure airborne emission of radionuclides from Pilgrim
22 include: the Sage System consisting of 14 real-time monitors installed on the edge of Pilgrim's
23 property; thermoluminescent docimeters (TLD's) placed in locations 0 to >15 km from Pilgrim;
24 real-time monitors placed in a few schools for the sole purpose of educating students.
25

26 Sage System [Computerized "Ring" Monitors] – Deficiencies

- 27
- 28 • The Sage System does not provide any significant protection to the citizens of
29 Southeastern Massachusetts. The "NRC Draft Report For Comment On Findings On
30 Issues Of Offsite Emergency preparedness For the Pilgrim Nuclear Power Station
31 [NUREG-1438], issued May 1991, expressly noted that MDPH installed this system,
32 "even though fixed offsite monitors are no longer endorsed by the NRC..." [page 2-159].
33
- 34 • Under the agreement with Boston Edison Company [BECO], the previous licensee, the
35 monitors were installed less than a quarter of a mile from the plant. Yet, the NRC has
36 found that monitors closer than 1000 meters [about 2/3 of a mile] would provably
37 provide inaccurate readings in the event of an accident.
38
- 39 • The agreement included 22 potential monitoring sites, but only 14 have been installed.
40 Again this is contrary to NRC research on real time monitoring, which concluded that

Appendix A

1 using as few as 14 monitors would grossly underestimate the radiation from narrow
2 emission plumes.

3
4 • The monitors are only in a small quadrant behind the plant. Therefore, there is no
5 effective monitoring in the directions of Scituate, Marshfield, Duxbury, Kingston, or much
6 of Plymouth [including the Gurnet, Saquish neck at the end of Duxbury r Beach.

7
8 • There are no monitors on Cape Cod. The Cape is across open water -- nothing to
9 break up a plume.

10
11 • The placement of the Sage monitors effectively ignores the results of wind analysis
12 done by the Harvard School of Public health, under the direction of Dr. J.D. Spengler
13 and Dr. G.J. Keeler, May 12, 1988 that described the variability of coastal winds and that
14 the sea breeze effect brought winds inland > 10 miles. Also a true ring of monitors is
15 feasible. At Seabrook NPS, the Citizens Monitoring Network is installing monitors on
16 buoys at sea.

17
18 • The Sage monitors do not measure high and low let alpha and beta radiation.

19
20 • The placement of the Sage monitors effectively ignores the results of wind analysis
21 done by the Harvard School of Public health, under the direction of Dr. J.D. Spengler
22 and Dr. G.J. Keeler, May 12, 1988 that described the variability of coastal winds and that
23 the sea breeze effect brought winds inland > 10 miles. Also a true ring of monitors is
24 feasible. At Seabrook NPS, the Citizens Monitoring Network is installing monitors on
25 buoys at sea.

26
27 • The Sage System lacks software to make sense out of the computer data arriving at
28 Massachusetts Department of Public Health [MDPH]. The data has not been
29 systematically graphed, charted or reported to the public. (PNPS-AC)

30
31 **Comment:** Plutonium historically have been found in Duxbury Bay sediment samples; Entergy
32 has attributed the Plutonium to either weapons testing, cross-contamination from their lab's
33 glassware or simply lost the sample.

34
35 It seems far more likely that the plutonium is from Pilgrim which is visible from Duxbury - rather
36 than from a Chinese bomb launched thousands of miles away. It would be coincidental if the
37 beaker used to test the sample at Entergy's own lab just happened to be improperly cleaned
38 and just happened to be contaminated with Plutonium. It seems coincidental that the next
39 years' plutonium sample happened to get lost. This is one reason Petitioners believe that the
40 Applicant should not be responsible for its own environmental testing – the samples should be
41 sent to an independent lab. (PNPS-AC)

1 **Comment:** Beginning in July 2002 Pilgrim began to use Entergy's J.A. Fitzpatrick
2 Environmental Laboratory for analysis of environmental samples. Petitioners contend, and are
3 prepared to demonstrate to the ASLB, that results can vary considerably depending on who
4 analyzes the data and reports the findings. A clear conflict of interest is present when the
5 applicant's own company both analyzes the data and reports the results. (PNPS-AC)
6

7 **Comment:** The Radiological Environmental Monitoring Program reports can not be relied upon
8 to produce accurate data. The Applicant collects the samples to determine Pilgrim's
9 radiological impact on the general public. The "control stations" are too close to the reactor; in
10 actuality, they are indicator stations. Fewer sample media and numbers now are taken than
11 before; fewer are required. Since July 2002, the Applicant's own laboratory analyzes the
12 samples for radioactivity. Reports for the NRC and public are prepared by the Applicant,
13 Entergy. Finally high deposition of radiation found is attributed by Entergy to sources other than
14 Pilgrim. (PNPS-AC)
15

16 **Comment:** The environmental sampling media collected in the vicinity of PNPS and at distant
17 locations included air particulate filters, charcoal cartridges, seawater, shellfish, Irish moss,
18 American lobster, fishes, sediment, milk, cranberries, vegetation, and animal forage."
19

20 The sampling locations are divided into two classes, indicator and control. Indicator locations
21 are those that are expected to show effects from Pilgrim operations. The REMP states that
22 while the indicator locations are typically within a few kilometers of the plant, the control stations
23 should be located so as to be outside the influence of Pilgrim Station. However, many control
24 stations are too close to Pilgrim - within sight of the reactor and within the official Emergency
25 Planning Zone Communities, [10 miles or 16 kilometers]. In reality they are indicator stations.
26 If radiation is above expected in a sample collected from a "control station" it is attributed to
27 weapons fallout, not Pilgrim. Also the location of the "control stations" ignores the fact that
28 radioactive particulates released to the air from the stack, will be carried by the wind some
29 distance and deposited some distance from the reactor site –in the control locations. (PNPS-
30 AC)
31

32 **Comment:** Milk, a key indicator, is no longer sampled. Prior to 2000, milk samples were
33 obtained from an indicator station, Plymouth County Farm, and from a control station located in
34 Whitman. Plymouth County Farm stopped milking cows and since that time Entergy has
35 claimed that they could not identify any additional milk animals within 5 kilometers [3.1 miles] of
36 Pilgrim. Petitioners contend that milk samples > 5 kilometers could be indicator stations.
37 Additionally there are farms nearby. Plymouth Plantation is about 3 and ½ miles from Pilgrim
38 and has a farm with lactating cows and goats. The oldest operating dairy farm in the Northeast
39 is located in Duxbury. Entergy's claim that Plymouth Plantation can not provide sufficient milk
40 has not been proven. Exactly how much is required, at minimum, for each test? We request
41 this information to verify with independent laboratories. (PNPS-AC)

Appendix A

1 **Comment:** In regard to terrestrial sampling, routine collection and analysis of soil samples was
2 discontinued; instead they claim that if air sampling showed an early indication of any potential
3 deposition of radioactivity, follow-up soil sampling could be performed on an as-needed basis.
4 However, this assumes that the air monitoring is reliable and accurate.

5
6 In the area of marine sampling, the following changes were made.

- 7
- 8 • A sample of the surface layer of sediment is collected, as opposed to specialized
9 depth-incremental sampling to 30 cm and subdividing cores into 2 cm increments.
- 10
- 11 • Standard LLD levels of about 150 to 180 pCi/kg were established for sediment, as
12 opposed to the specialized LLDs of 50 pCi/kg.
- 13
- 14 • Specialized analysis of sediment for plutonium isotopes was removed.
- 15
- 16 • Sampling of Irish moss, shellfish, and fish was rescheduled to a semiannual period, as
17 opposed to a specialized quarterly sampling interval.
- 18
- 19 • Analysis of only the edible portions of shellfish (mussels and clams), as opposed to
20 specialized additional analysis of the shell portions.
- 21
- 22 • Standard LLD levels of 130 to 260 pCi/kg were established for edible portions of
23 shellfish, as opposed to specialized LLDs of 5 pCi/kg.
- 24

25 Petitioners contend that what was discontinued has resulted in the loss of important data that is
26 required, "to assess the impact of Pilgrim Station on the environment and on the general
27 public." And what was discontinued appears to be connected to elevations of radioisotopes in
28 the environment found in previous years. (PNPS-AC)

29
30 **Comment:** I believe we have very, very little data monitoring radiation in the area. There may
31 be occasional radiation monitors at the plant but, for instance, in Duxbury, we don't have any
32 radiation detectors, so I think I hear people say that even during, if we had any kind of an event,
33 it would be very important for us to know where, if there is a radiation release, where is it going
34 and is it in fact in Duxbury, or is it in Carver or is it in Plymouth? So I think, as one of the
35 mitigation things that I would like to very strongly request, is that radiation monitors be put
36 throughout the area, and many of them. And it would be, I think, in Pilgrim's interest to have
37 that because if, as I think they claim, that radiation is not being disseminated around, that would
38 certainly prove their point. If there is nothing being measured, then that's great for all of us to
39 know. (PNPS-L)

1 **Comment:** And third, in assessing health, you would look at, as BEIR VII said, to
2 bioaccumulation and the cumulative effect of health impact by looking at what is documented in
3 the REMPs of how much radiation has been released, and also pay special attention to what
4 was stated by Mass. Department of Public Health in a public meeting that Senator Kerry held,
5 that there is no reason, I can provide the exact quote later, no reason to trust what the licensee
6 has put into their reports of what has been emitted and "they have emitted far too much than
7 they should have" including, for example, transgeneric elements such as neptunium. (PNPS-A)

8
9 **Comment:** The effects of radiation exposure are cumulative. Some types of nuclear power
10 plant emissions stay radioactive for a long time and, because they can enter biological food
11 chains, those materials can accumulate in the environment and adversely affect public health.
12 "If radioactive emissions persist for years, decades or even centuries within the environment,
13 then even modest reductions in annual discharges may not be sufficient to prevent an
14 environmental build up of those materials over time." Estimates of Environmental
15 Accumulations of radioactivity Resulting from Routine Operation of New England Nuclear
16 Power Plants (1973-84), Dr. Richard W. England, Mr. Eric Mitchell, p.4, A Report of the Nuclear
17 Emission Research Project, Whittemore School of Business and Economics, University of New
18 Hampshire, Durham, N.H., August 1987.

19
20 It is known for example that the following radionuclides have been released from Pilgrim into
21 neighboring communities: plutonium 239 (half life 24,400 years); neptunium 236 or 237 (half life
22 ranging from 120,000 years -2.1 million years); cesium 137 (half life 30.2 years); strontium 90
23 (half life 28.5 years); tritium (half life 12.3 years), and xenon (half life 9.17 hours). Xenon
24 transforms after its emission into cesium 135, which persists almost indefinitely in the
25 environment. Examples of previous releases have been reported in the Annual Radiological
26 Environmental Monitoring Program Reports [REMP]. These releases include substances that
27 will remain active in the local environment for the foreseeable future and should be taken into
28 account when actual on-going doses to the public are evaluated. (PNPS-AC)

29
30 **Comment:** We would like to submit that if Applicant, NRC or current MDPH spokespersons
31 dispute a causal link between the radiation released by Pilgrim and the cancers seen in its
32 neighboring towns, the current systems in place to monitor releases are inadequate and must
33 be improved if re-licensing is to be considered. The Comments to the Southeastern
34 Massachusetts Leukemia Study made by Dr. Richard Clapp illustrate this point: I would like to
35 reiterate a point that Drs. Knorr and Morris [Massachusetts Department of Public Health
36 epidemiologists, authors of the Southeastern Massachusetts Health Study] made to you in one
37 of their memoranda, e.g., that the emissions data provided by the utility are not reliable. I have
38 had numerous discussions with individuals in the Department of Public health as well as
39 colleagues who previously worked in a job monitoring worker exposure to Pilgrim contractors in
40 the mid-1970's. From these discussions, I am convinced that the actual emissions were
41 considerably worse than what has appeared in public documents and has been available to

Appendix A

1 researchers to date. In particular, there were transuranic isotopes released that should never
2 have been emitted to the general environment.” Richard C. Clapp, MPH,Sc,D., Statement
3 before the Southeastern Massachusetts health Study Review Committee, (June 26, 1992). In
4 the years since that statement was made, the quality of the environmental monitoring by Pilgrim
5 has, if anything, decreased. (PNPS-AC)
6

7 **Comment:** The public can not be required to prove a causal link between the radiation
8 released and the statistically significant increase in cancers if there is no effective monitoring
9 system in place to measure those releases nor can the Applicant claim that a causal link does
10 not exist.
11

12 As stated previously, the system in place to monitor off-site radiological releases at Pilgrim is
13 inadequate. Although there are documented increases in radiation-linked cancers in the
14 communities around the plant, this aging plant does not use monitors which would allow state
15 or federal authorities to confidently measure radiation releases. Some of the deficiencies of the
16 monitoring system currently used by Pilgrim are described in the following section, as well as
17 needed improvements that need to be made to the Pilgrim environmental monitoring program.
18 (PNPS-AC)
19

20 **Comment:** Pilgrim began operations in 1972 with defective fuel. The Massachusetts
21 Department of Public Health’s Southeastern Massachusetts Health Study 1978-1986 stated,
22 “Pilgrim, which began operations in 1972, had a history of emissions during the 1970s that were
23 above currently acceptable EPA guidelines as a result of a fuel rod problem.” Southeastern
24 Massachusetts Health Study 1978-1986, Morris M.S., Knorr R.S., Executive Summary,
25 Massachusetts Department of Health (October, 1990).
26

27 In the March 2005 and April 2006 Pilgrim SALP (Systematic Assessment of License
28 Performance, performed by the NRC) Reports, NRC Resident Inspector, William Raymond,
29 stated that Pilgrim operated in 2004 and 2005 with defective radioactive fuel – that is, fuel with
30 perforated cladding. We do not have information one way or another whether defective fuel
31 was used in other previous years. Fuel cladding provides the first barrier to prevent radiation
32 from getting out and harming workers and the public. Degraded fuel is an on going issue for
33 the industry. NRC Commissioner Merrifield has admitted nearly 1/3 reactors now have failed
34 fuel, and the trend is increasing, not decreasing. Briefing on Nuclear Fuel Performance,
35 Transcript, p.4, (February 24, 2005), <http://www.nrc.gov>.
36

37 Use of degraded fuel will increase exposure to both the public and workers. For example,
38 according to the NRC, “a plant operating with 0.125 percent pin-hole fuel cladding defects
39 showed a general five-fold increase in whole-body radiation exposure rates in some areas of
40 the plant when compared to a sister plant with high-integrity fuel (<0.01 percent leaks). Around
41 certain plant systems the degraded fuel may elevate radiation exposure rates even more.”

1 United States Nuclear Regulatory Commission, Information Notice No. 87-39, Control Of Hot
2 Particle Contamination At Nuclear plants, (August 21, 1987). (PNPS-AC)

3
4 **Comment:** If radioactivity is discovered that could be attributed to Pilgrim, the response is to
5 attribute the contamination to other sources and/or request NRC to change the monitoring
6 requirements.

7
8 Example, Milk: Milk historically showed elevated levels of contamination. However as
9 mentioned above milk is no longer tested, although lactating animals are available in the area at
10 Plymouth Plantation approximately less than 5 miles away and at a dairy farm in Duxbury,
11 within the Emergency Planning Zone.

12
13 Previously milk was tested in farms near Pilgrim and at a control station in Whitman, 22 miles
14 away. The Radiological Environmental Monitoring Program Report (REMP) for 1980 noted that,
15 at the farms around Pilgrim, "the measured average concentration of both Cesium-137 and Sr-
16 90 were respectively 10,000 and 1,000,000 times in excess of the concentrations expected to
17 be present..." and went on to say that this "is unquestionably due to atmosphere testing." The
18 effort to blame the increase on "atmosphere fallout" ignores a critical fact – no similar increase
19 was experienced at the control station in Whitman.

20
21 The 1982 REMP report stated that the highest mean value occurred at the Kings Residence,
22 located < 5 miles from Pilgrim, in late June 1982. There were concentrations greater than
23 1,000,000 times in excess of the concentration expected. The report, written by Tom Sowden
24 [who continues to work in this area at PNPS] stated,

25
26 It is not uncommon to find marked increase of Cs-137 associated with the cow's pregnancy,
27 and this was most likely the cause.

28
29 However the large animal expert at Tufts Veterinarian School was of a different opinion. He
30 stated that,

31
32 Cows normally do not lactate during pregnancy. And, an animal can not produce Cs-137 on
33 their own. It (Cs-137) must be introduced into the cows system from an environmental source.
34 The cow would have to ingest it in some way." (PNPS-AC)

35
36 **Comment:** TLD's - Thermoluminescent dosimeters placed in offsite locations ranging from 1
37 km (.6 miles) to > 15 km (9.3 miles) to measure gamma radiation levels. These devices are
38 passive in as much as they must be in place for a period of time [3 months] and then brought
39 back to the laboratory to determine the amount of radiation the device received at that location
40 for that period of time.

Appendix A

1 Deficiencies TLD's

- 2
- 3 • TLD's provide only an average figure, and increases of potential significance can be
- 4 masked by lower than average readings during other parts of the month. Biological
- 5 impact occurs on a daily basis.
- 6
- 7 • TLD's can only read to a maximum threshold, that is, like a film badge they can only
- 8 read so high.
- 9
- 10 • TLD's do not read high or low let alpha and beta.
- 11
- 12 • Dr. Hoffman, at Penn State, did an analysis of TLD's and concluded they provided
- 13 poor sensitivity to Zenon 133. He said it took about 85 hours at maximum concentration
- 14 before anything showed up and that even then the amount was underestimated by a
- 15 factor of around 20. (PNPS-AC)
- 16

17 **Comment:** Entergy states that "[v]ery low levels of radioactivity may be released in plant
18 effluents if they meet the limits specified by NRC's regulations. These releases are closely
19 monitored and evaluated for compliance with the NRC restrictions in accordance with the PNPS
20 Offsite Dose Calculation Model." This implies that there will be no danger to public health from
21 routine releases since they will be monitored and will not exceed federal limits. However, the
22 system in place to monitor radiological releases at Pilgrim is inadequate and could result in a
23 health hazards to residents in the Town and neighboring areas. (PNPS-AE)

24

25 **Comment:** These communities are also downwind from the Camel Electric Plant and there has
26 been significant pesticide use in the agriculture. So, we have been exposed and will continue to
27 be exposed to a multiplicity of toxins that will work together. Also, no one denied the fact that
28 1982, when Pilgrim had a severe accident of blowing its filters, that that damaging effect is still
29 here. Many of what never should be released radionuclides, with long half lives, are still in
30 our environment. (PNPS-N)

31

32 **Response:** *The comments relate to monitoring of radiological effluents at Pilgrim. As required*
33 *by NRC regulations, the amounts of radioactive isotopes released from Pilgrim in liquid and*
34 *gaseous effluents are constantly monitored and recorded by Entergy. The meteorological*
35 *conditions at the site also are constantly monitored and recorded. Health physics experts from*
36 *NRC's Region I office routinely inspect these monitoring programs to ensure that they are being*
37 *properly implemented. All of this information is fed into calculational models that estimate the*
38 *amount of radiation dose a member of the public might receive. The calculational models are in*
39 *the ODCM and have been reviewed and approved by the NRC. These models include*
40 *estimates of dose from internally deposited radioactive isotopes as well as direct radiation*
41 *exposure. In addition, Entergy conducts an environmental radiological monitoring program in*

1 *the area around Pilgrim. This program has also been reviewed and approved by the NRC and*
2 *is inspected by the health physics experts from NRC's Region I office. In addition, changes to*
3 *the program, such as the decision to suspend milk sampling because a large enough sample*
4 *size is not available, are also reviewed by the NRC as part of the inspection program. The*
5 *environmental radiological monitoring program samples and measures the amount of*
6 *radioactive isotopes in the air, water, soil, agricultural products, shoreline sediments, and*
7 *aquatic biota and measures direct radiation from the plant using thermoluminescent dosimeters*
8 *(TLDs). The NRC finds the use of TLDs for the purpose of routine monitoring around nuclear*
9 *power plants to be acceptable. This program confirms that the levels of radioactive isotopes in*
10 *the environment that are predicted by the computer dose models. This program will also*
11 *identify any radionuclides that may be accumulating in the environment around Pilgrim.*

12
13 *Licensees also must participate in an interlaboratory comparison program, which provides an*
14 *independent check of the accuracy and precision of environmental measurements. The*
15 *quality assurance laboratories for J.A. Fitzpatrick Laboratory are Analytics, Incorporated in*
16 *Atlanta, Georgia, and the U.S. Department of Commerce's National Institute of Standards and*
17 *Technology in Gaithersburg, Maryland. Also, the Massachusetts Department of Public Health*
18 *conducts an environmental radiological monitoring program around Pilgrim.*

19
20 *As part of the review of the license renewal application for Pilgrim, the NRC will review the*
21 *annual radiological effluent reports and the annual environmental radiological monitoring reports*
22 *for the last several years at Pilgrim. All of these reports are available to the public on the NRC's*
23 *ADAMS document retrieval system. The NRC will also review information from the*
24 *Commonwealth's monitoring program.*

25
26 *While Pilgrim may have experienced significant fuel defects and released transuranic*
27 *radioisotopes earlier in plant operation, NRC believes that the recent effluent reports are the*
28 *best source of information to help estimate the amount of each type and total amount of*
29 *radioactive materials that will be released from the plant during the license renewal period.*
30 *Chapters 2 and 4 of the SEIS will address NRC's assessment of the radiological effluents and*
31 *impacts that are expected during the license renewal period.*

32
33 **Comment:** The EIS should also catalogue other (i.e., non-thermal) pollutant discharges by
34 Pilgrim Station and assess their environmental effects. These other pollutants may include
35 chlorine or other biocides, copper, radionuclide, metals, or other contaminants. Again, EPA has
36 information on some of these pollutants in its NPDES permit files, but the NRC could update
37 this information as needed and likely has more information regarding radionuclides or better
38 access to such information than EPA does. (PNPS-AG)

39
40 **Response:** *The National Pollutant Discharge Elimination System (NPDES) permit, which is*
41 *issued by EPA, designates the chemicals, such as biocides and metals, and the amounts of*

Appendix A

1 *those chemicals that are allowed to be released by Pilgrim. NRC will review the NPDES permit*
2 *as part of its evaluation of the potential environmental impacts of license renewal for the*
3 *purposes of NEPA. These impacts will be discussed in Chapters 2 and 4 of the SEIS. In*
4 *addition, Chapters 2 and 4 of the SEIS will include NRC's assessment of radiological effluents*
5 *and impacts that are expected during the license renewal period.*

Appendix B

Contributors to the Supplement

Appendix B

Contributors to the Supplement

1 The overall responsibility for the preparation of this supplement was assigned to the Office of
2 Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission (NRC). The statement was
3 prepared by members of the Office of Nuclear Reactor Regulation with assistance from other
4 NRC organizations, Earth Tech, Inc. and Information Systems Laboratories, Inc.

Name	Affiliation	Function or Expertise
Nuclear Regulatory Commission		
Alicia Williamson	Nuclear Reactor Regulation	Environmental Project Manager
Robert Schaaf	Nuclear Reactor Regulation	Technical Monitor
Rani Franovich	Nuclear Reactor Regulation	Branch Chief
Christian Jacobs	Nuclear Reactor Regulation	Project Management Support
Alicia Mullins	Nuclear Reactor Regulation	Project Management Support
Jason Flemming	Nuclear Reactor Regulation	Hydrology
Harriet Nash	Nuclear Reactor Regulation	Ecology
Jennifer Davis	Nuclear Reactor Regulation	Cultural Resources
Jeffrey Rikhoff	Nuclear Reactor Regulation	Socioeconomics
Richard Emch	Nuclear Reactor Regulation	Radiation Protection
Andrew Luu	Nuclear Reactor Regulation	Radiation Protection
Robert Palla	Nuclear Reactor Regulation	Severe Accident Mitigation Alternatives
Earth Tech		
Roberta Hurley		Project Manager
John Szeligowski		Technical Team Leader, Alternatives
Stephen Duda		Lead Biologist
Stephen Dillard		Terrestrial Ecology
Charles Flynn		Radiation Protection
Andrew Parker		Socioeconomics
Susan Provenzano		Land Use
Michael Pappalardo		Cultural Resources
Michael Spera		Water Quality
Nathan Craig		Project Coordinator
Robert Dover		Environmental Scientist
Kathleen Garvin		Technical Editor
Nicole Spangler		Project Management Support
Bonnie Freeman		Administrative Support

Appendix B

Name	Affiliation	Function or Expertise
1	Information Systems Laboratories	
2	Robert Schimdt	Severe Accident Mitigation Alternatives
3	Kim Green	Severe Accident Mitigation Alternatives
4	Laurie Fleisher	Severe Accident Mitigation Alternatives
5		
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Appendix C

Chronology of NRC Staff Environmental Review Correspondence Related to Entergy Nuclear Operations, Inc.'s Application for License Renewal of Pilgrim Nuclear Power Station

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Appendix C

Chronology of NRC Staff Environmental Review Correspondence Related to Entergy Nuclear Operations, Inc.'s Application for License Renewal of Pilgrim Nuclear Power Station

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This appendix contains a chronological listing of correspondence between the U.S. Nuclear Regulatory Commission (NRC) and Entergy Nuclear Operations, Inc. (Entergy) and other correspondence related to the NRC staff's environmental review, under 10 CFR Part 51, of Entergy's application for renewal of the Pilgrim Nuclear Power Station (PNPS), operating license. All documents, with the exception of those containing proprietary information, have been placed in the Commission's Public Document Room, at One White Flint North, 11555 Rockville Pike (first floor), Rockville, MD, and are available electronically from the 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 in the publicly available records component of ADAMS. The ADAMS accession number for each document is included below.

- | | | |
|----|------------------|---|
| 23 | January 25, 2006 | Letter from Mr. Michael A. Balduzzi, Entergy, to NRC submitting the application for the renewal of the operating license for PNPS. (Accession No. ML060300026). |
| 24 | | |
| 25 | | |
| 26 | | |
| 27 | January 31, 2006 | Letter from NRC to Mr. Michael R. Kansler, Entergy, regarding receipt and availability of the License Renewal Application for PNPS. (Accession No. ML060310593). |
| 28 | | |
| 29 | | |
| 30 | | |
| 31 | January 31, 2006 | NRC press release announcing the availability of the license renewal application for PNPS. (Accession No. ML060310043). |
| 32 | | |
| 33 | | |
| 34 | February 6, 2006 | Federal Register Notice of receipt of application for renewal of Facility Operating License No. DPR-35 for an additional 20-year period (71 FR 6101). |
| 35 | | |
| 36 | | |
| 37 | | |
| 38 | March 21, 2006 | Letter from NRC to Mr. Michael Kansler, Entergy, regarding Determination of Acceptability and Sufficiency for Docketing, Proposed Review Schedule, and Opportunity for a Hearing regarding the Application from Entergy for Renewal of the Operating License for PNPS. (Accession No. ML060800745). |
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Appendix C

1	March 27, 2006	Federal Register Notice of acceptance for docketing of the application
2		and notice of opportunity for a hearing regarding the application for
3		license renewal of PNPS (71 FR 15220).
4		
5	April 7, 2006	Letter from NRC to Mr. Michael R. Kansler, Entergy, regarding Notice Of
6		Intent to prepare an Environmental Impact Statement and conduct
7		Scoping Process for License Renewal for the PNPS (TAC NO. MC9676).
8		(Accession No. ML061000261).
9		
10	April 14, 2006	Federal Register Notice of Intent to Prepare an Environmental Impact
11		Statement and Conduct Scoping Process regarding the application for
12		license renewal of PNPS (71 FR 19554).
13		
14	April 21, 2006	Letter from NRC to Mr. Michael Bowland, Mashantucket Tribal Council
15		Office regarding request for comments on the PNPS License Renewal
16		Application Review. (Accession No. ML061170222).
17		
18	April 21, 2006	Letter from NRC to Ms. Cheryl Andrews-Maltais, Wampanoag Tribe of
19		Gay Head-Aquinnah, regarding request for comments on the PNPS
20		License Renewal Application Review. (Accession No. ML061170152).
21		
22	April 21, 2006	Letter from NRC to Mr. Sachem M. Thomas, Chief, Narragansett Indian
23		Tribe, regarding request for comments on the PNPS License Renewal
24		Application Review. (Accession No. ML061170085).
25		
26	April 21, 2006	Letter from NRC to Ms. Jean McGinnis, Tribe Council, Mohegan Tribe,
27		regarding request for comments on the PNPS License Renewal
28		Application Review. (Accession No. ML061160613).
29		
30	April 25, 2006	Letter from NRC to Mr. Peter Colosi, National Marine Fisheries Service,
31		regarding request for a list of protected species and essential fish habitat
32		within the area under evaluation for the PNPS License Renewal
33		Application Review. (Accession No. ML061160283).
34		
35	April 25, 2006	Letter from NRC to Mr. Michael Bartlett, U.S. Fish and Wildlife Service,
36		regarding request for a list of the protected species within the area under
37		evaluation for the PNPS License Renewal Application Review.
38		(Accession No. ML061160303).
39		
40	May 2, 2006	Letter from NRC to Mr. Don L. Klima, Advisory Council on Historic
41		Preservation, regarding PNPS License Renewal Application Review.
42		(Accession No. ML061240335).
43		
44	May 11, 2006	Letter from NRC to Ms. Brona Simon, Massachusetts Historical
45		Commission, regarding the PNPS License Renewal Application Review
46		(SHPO No. RC36661). (Accession No. ML061310234).

1
2 May 22, 2006 Letter from NRC to Mr. Michael Kansler, Entergy, regarding Request for
3 Additional Information (RAI) pertaining to Severe Accident Mitigation
4 Alternatives (SAMA) for PNPS (TAC No. MC9676).
5 (Accession No. ML061440026).
6
7 May 23, 2006 Letter from U.S. Fish and Wildlife Service, providing a response to the
8 April 25, 2006 NRC staff letter requesting a list of protected species
9 within the area under evaluation for license renewal of PNPS.
10 (Accession No. ML061650016).
11
12 May 24, 2006 Letter from Advisory Council of Historic Preservation, Ms. Laura Henley
13 Dean, providing a response to NRC notice of the PNPS license renewal
14 application. (Accession No. ML061710601).
15
16 June 8, 2006 Letter from NOAA Fisheries, Mr. Peter Colosi, providing a response to
17 the April 25, 2006 NRC staff letter requesting information regarding
18 protected species and essential fish habitat within the area under
19 evaluation for license renewal of PNPS. (Accession No. ML061710600).
20
21 July 5, 2006 Letter from Stephen J. Bethay, Entergy to NRC Document Control Desk.
22 Subject: License Renewal Application Amendment 4: Response to
23 Request for Additional Information Regarding Severe Accident Mitigation
24 Alternatives for Pilgrim Nuclear Power Station (TAC No. MC9676).
25 (Accession No. ML061930418).
26
27 July 11, 2006 Letter from CZM, Ms. Susan Snow-Cotter, CZM Federal-Consistency
28 Review of the Pilgrim Nuclear Power Station Operating
29 License Renewal; Plymouth. (Accession No. ML062090362).
30
31 July 13, 2006 Summary of Public Scoping Meetings Conducted Related to the Review
32 of the PNPS, License Renewal Application (TAC No. MC9676).
33 (Accession No. ML061700055).
34
35 July 25, 2006 Letter from NRC to Entergy Regarding Summary of Conference Calls to
36 Discuss the Severe Accident Mitigation Alternatives Requests for
37 Additional Information for Pilgrim (Accession No. ML062070295).
38
39 July 25, 2006 Letter from NRC to Entergy Regarding Summary of Environmental Site
40 Audit Related to the Review of the License Renewal Application for
41 Pilgrim. (Accession No. ML062070305).
42
43 July 25, 2006 Summary of Conferences Calls with Entergy Nuclear Operations, Inc., to
44 Discuss the Severe Accident Mitigation Alternatives Requests for
45 Additional Information for Pilgrim Nuclear Power Station (TAC NO.
46 MC9676). (Accession No. ML062070295).
47

Appendix C

- 1 August 23, 2006 Summary of Follow Up Conference Call with Entergy Nuclear Operations,
2 Inc., to Discuss the Severe Accident Mitigation Alternatives Requests for
3 Additional Information for Pilgrim Nuclear Power Station (TAC No.
4 MC9676). (Accession No. ML062360514).
5
- 6 September 26, 2006 Issuance of Environmental Scoping Summary Report Associated with the
7 Staff's Review of the Application by Entergy Nuclear Operations, Inc., for
8 Renewal of the Operating License for Pilgrim Nuclear Power Station.
9 (Accession No. ML062710517).
10
- 11 October 24, 2006 Summary of Conference Call with Entergy Nuclear Operations, Inc, to
12 Discuss the Severe Accident Mitigation Alternatives Requests for
13 Additional Information for Pilgrim Nuclear Power Station.
14 (Accession No. ML062890001).
15
16

Appendix D

Organizations Contacted

Appendix D

Organizations Contacted

1 During the course of the staff's independent review of environmental impacts from operations
2 during the renewal term, the following Federal, State, regional, local, and Native American tribal
3 agencies were contacted:

4
5 Advisory Council on Historic Preservation, Office of Federal Agency Programs, Washington DC

6
7 Barnstable County, Massachusetts

8
9 Cape Cod Commission

10
11 Duxbury Free Library

12
13 Kingston Public Library

14
15 Mashantucket Tribal Council Office, Connecticut

16
17 Massachusetts Department of Environmental Protection

18
19 Massachusetts Department of Public Health

20
21 Massachusetts Department of Telecommunications and Energy

22
23 Massachusetts Division of Coastal Zone Management

24
25 Massachusetts Division of Energy Resources

26
27 Massachusetts Division of Fisheries and Wildlife

28
29 Massachusetts Division of Marine Fisheries

30
31 Massachusetts Environmental Policy Act Office

32
33 Massachusetts Historical Commission

34
35 Mohegan Tribe, Connecticut

36
37 Narragansett Indian Tribe, Rhode Island

Appendix D

- 1 National Oceanic and Atmospheric Administration, National Marine Fisheries Service - Habitat
- 2 Conservation Division, Northeast Region
- 3
- 4 National Oceanic and Atmospheric Administration, National Marine Fisheries Service -
- 5 Protected Resource Division, Northeast Region
- 6
- 7 Old Colony Planning Council
- 8
- 9 Plymouth County Commissioners
- 10
- 11 Plymouth County, Massachusetts
- 12
- 13 Plymouth Public Library
- 14
- 15 Town of Carver, Massachusetts
- 16
- 17 Town of Duxbury, Massachusetts
- 18
- 19 Town of Kingston, Massachusetts
- 20
- 21 Town of Marshfield, Massachusetts
- 22
- 23 Town of Plymouth, Massachusetts
- 24
- 25 U.S. Fish and Wildlife Service, New Hampshire
- 26
- 27 U.S. Environmental Protection Agency, Region I
- 28
- 29 Wampanoag Tribe of Gay Head-Aquinnah, Massachusetts

Appendix E

Pilgrim Nuclear Power Station Compliance Status and Consultation Correspondence

Appendix E

Pilgrim Nuclear Power Station Compliance Status and Consultation Correspondence

1 Correspondence received during the process of evaluation of the application for renewal of the
2 license for Pilgrim Nuclear Power Station (PNPS) is identified in Table E-1. Copies of the
3 correspondence are included at the end of this appendix.
4

5 The licenses, permits, consultations, and other approvals obtained from Federal, State,
6 regional, and local authorities for PNPS are listed in Table E-2.
7

8 **Table E-1.** Consultation Correspondence
9

10	Source	Recipient	Date of Letter
11	National Marine Fisheries Service	Entergy Nuclear Generation Company	March 4, 2005
12	(M.A. Colligan)	(S. Bethay)	
13	U.S. Fish and Wildlife Service	Entergy Nuclear Generation Company	March 9, 2005
14	(M. J. Amaral)	(S. Bethay)	
15	Massachusetts Historical	Entergy Nuclear Generation Company	March 14, 2005
16	Commission (E.S. Johnson)	(S. Bethay)	
17	Massachusetts Division of Fisheries	Entergy Nuclear Generation Company	April 8, 2005
18	& Wildlife (T.W. French)	(S. Bethay)	
19	U.S. Fish and Wildlife Service	U.S. Nuclear Regulatory Commission	May 23, 2006
20	(M. J. Amaral)	(R. Franovich)	
21	Advisory Council on Historic	U.S. Nuclear Regulatory Commission	May 24, 2006
22	Preservation (L.H. Dean)	(R. Franovich)	
23	National Marine Fisheries Service	U.S. Nuclear Regulatory Commission	June 8, 2006
24	(P.D. Colosi)	(R. Franovich)	
25	Massachusetts Office of Coastal	Entergy Nuclear Generation Company	July 11, 2006
26	Zone Management (S. Snow-	(S. Bethay)	
27	Cotter)		

Table E-2. Federal, State, Local, and Regional Licenses, Permits, Consultations, and Other Approvals for Pilgrim Nuclear Power Station

Agency	Authority	Description	Number	Issue Date	Expiration Date	Remarks
NRC	10 CFR Part 50	Operating license	DPR-35	<u>09/15/72</u>	06/08/12	Authorizes operation
NRC	10 CFR Part 40 and 70	Material license	20-07626-04	02/10/03	02/28/13	Contamination on reactor components
DOT	49 CFR 107, Subpart G	Registration	062601551001J	05/16/05	06/30/06	Radioactive and hazardous materials shipment
EPA	Clean Water Act (33 USC 1251)	NPDES Permit	Federal: MA0003557 Massachusetts: 359	04/29/91	04/29/96	Plant discharges into Cape Cod Bay. Permit remains in effect pending EPA and Commonwealth action on renewal applications.
FWS	Migratory Bird Treaty Act (16 USC 703-712)	Depredation Permit	MB831184-0	07/08/05	06/30/06	Removal of birds, eggs and nests from utility structures and property
FWS and NMFS	Section 7 of the Endangered Species Act (16 USC 1536)	Consultation				Requires a Federal agency to consult with FWS and NMFS regarding whether a proposed action would affect endangered or threatened species
Massachusetts Department of Environmental Protection	Clean Water Act Section 401 (16 USC 470f)	Certification				Requires a Commonwealth certification that discharge would comply with Clean Water Act standards
Massachusetts Historical Commission	National Historic Preservation Act Section 106	Consultation				Requires a Federal agency to consider cultural impacts and consult with the State Historic Preservation Officer

Draft NUREG-1437, Supplement 29

E-2

December 2006

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Table E-2. (contd)

Agency	Authority	Description	Number	Issue Date	Expiration Date	Remarks
Massachusetts Office of Costal Zone Management	Federal Costal Zone Management Act (16 USC 1451)	Certification				Requires an applicant to provide certification to the Federal agency that license renewal would be consistent with the Federally-approved state costal zone management plan.
Massachusetts Department of Public Health	M.G.L. Chapter 111, Section 5N	Material License	07-6262	04/22/03	04/30/08	Containment on reactor components
Massachusetts Department of Public Health	M.G.L. Chapter 111, Section 5N	Material License	49-0078	10/11/02	05/31/06	Containment on reactor components
Massachusetts Department of Public Safety	M.G.L. Chapter 148, Section 13	Registration	Not Applicable			Storing flammable materials in tanks
Massachusetts Department of Environmental Protection	310 CMR 7.02 (11) 310 CMR 7.02 (11)(e)	50% Facility Emission Cap		07/18/05		Emissions from various combustion sources
Massachusetts Department of Environmental Protection	M.G.L. Chapter 21, Sections 26-53	Groundwater Discharge Permit	#2-389	04/20/99	04/20/04	Treated effluent discharges to groundwater from wastewater treatment facility. Permit administratively continued pending review of application
Massachusetts Department of Environmental Protection	M.G.L. Chapter 21C 310 CMR 30	Large Quantity Generator	MAR000014167	10/06/99		Hazardous waste generation

December 2006

E-3

Draft NUREG-1437, Supplement 29

Appendix E

Table E-2. (contd)

Agency	Authority	Description	Number	Issue Date	Expiration Date	Remarks
South Carolina Department of Health and Environmental Control	South Carolina Radioactive Waste Transportation and Disposal Act (SC ST SEC 13-7-110)	Radioactive Waste Transport Permit	0007-20-01	12/17/04	12/31/05	Transportation of radioactive waste to disposal facility in South Carolina
Tennessee Department of Environment and Conservation	TCA 68-202-206	Radioactive Waste License-for-Delivery	T-MA004-L01	12/08/04	12/31/05	Shipment of radioactive waste to disposal/processing facility in Tennessee

- CFR = Code of Federal Regulations
- CMR = Code of Massachusetts Regulations
- DOT = U.S. Department of Transportation
- EPA = U.S. Environmental Protection Agency
- FWS = U.S. Fish and Wildlife Service
- M.G.L. = Massachusetts General Laws
- NMFS = National Marine Fisheries Service
- NRC = U.S. Nuclear Regulatory Commission
- SC ST = South Carolina Statutes
- TCA = Tennessee Code Annotated
- USC = United States Code

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UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
 NATIONAL MARINE FISHERIES SERVICE
 NORTHEAST REGION
 One Blackburn Drive
 Gloucester, MA 01930-2298

Stephen Bethay
 Director, Nuclear Assessment
 Entergy Nuclear Generation Company
 Pilgrim Nuclear Power Station
 600 Rocky Hill Road
 Plymouth, MA 02360

MAR -4 2005

Re: Pilgrim Nuclear Power Station, Protected Species

Dear Mr. Bethay,

This is in response to your letter dated February 3, 2005, requesting information on the presence of any federally threatened or endangered species under the jurisdiction of the National Marine Fisheries Service (NMFS) in the vicinity of the Pilgrim Nuclear Power Station (PNPS), located on the western shore of Cape Cod Bay in Plymouth County, MA. Entergy Nuclear Power Station is currently preparing an application to the U.S. Nuclear Regulatory Commission (NRC) for the renewal of the operating license for PNPS, as the current operating license expires in June 2012, the information requested is to assist with the application process.

As mentioned in your letter, four species of federally threatened or endangered sea turtles and three species of endangered whales may be found in the waters of Cape Cod. The sea turtles in northeastern nearshore waters are typically small juveniles with the most abundant being the federally threatened loggerhead (*Caretta caretta*) followed by the federally endangered Kemp's ridley (*Lepidochelys kempii*). Loggerhead turtles have been found to be relatively abundant off the Northeast coast (from near Nova Scotia, Canada to Cape Hatteras, North Carolina). Loggerheads and Kemp's ridleys have been documented in waters as cold as 11°C, but generally migrate northward when water temperatures exceed 16°C. These species are typically present in Massachusetts waters from June – October. Federally endangered leatherback sea turtles (*Dermochelys coriacea*) are located in Massachusetts waters during the warmer months as well. While leatherbacks are predominantly pelagic, they may occur close to shore, especially when pursuing their preferred jellyfish prey. Green sea turtles (*Chelonia mydas*) may also occur sporadically in Massachusetts waters, but those instances would be rare.

Federally endangered North Atlantic right whales (*Eubalaena glacialis*), humpback whales (*Megaptera novaeangliae*), and fin whales (*Balaenoptera physalus*) may all also be found seasonally in Massachusetts waters. North Atlantic right whales have been documented in the nearshore waters of Massachusetts from December through June. Humpback whales feed during the spring, summer, and fall over a range that encompasses the eastern coast of the United States. Fin whales are common in waters of the United States Exclusive Economic Zone, principally offshore from Cape



Appendix E

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Hatteras northward. While these whale species are not considered residents of the Cape Cod Bay area, it is possible that transients may enter the area during seasonal migrations.

It is the understanding of NMFS that there have been no interactions or impingements of sea turtles at PNPS in the past 30 years of monitoring at PNPS. However, since the entrainment and impingement of sea turtles at several nuclear power plants on the East Coast has been documented, and as sea turtles may be seasonally present in the vicinity of the intakes associated with the PNPS, NMFS recommends that this impact be fully addressed in the application being prepared.

Section 7(a)(2) of the Endangered Species Act (ESA) of 1973, as amended, states that each Federal agency shall, in consultation with the Secretary, insure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of a listed species or result in the destruction or adverse modification of designated critical habitat. Any discretionary federal action that may affect a listed species must undergo Section 7 consultation. As listed species may be present in the project area, the federal action agency, in this case the NRC, is responsible for determining whether the proposed action is likely to affect any listed species. The NRC should then submit their determination along with a request for concurrence, to the attention of the Endangered Species Coordinator, NOAA Fisheries, Northeast Regional Office, Protected Resources Division, One Blackburn Drive, Gloucester, MA 01930. After reviewing this information, NOAA Fisheries would then be able to conduct a consultation under section 7 of the ESA.

Should you have any questions about these comments or about the section 7 consultation process in general, please contact Sara McNulty at (978) 281-9328 ext. 6520.

Sincerely,



Mary A. Colligan
Assistant Regional Administrator
for Protected Resources

Cc: Boelke, F/NER4

File Code: Sec 7, Pilgrim Nuclear Power Station, Spp. Pres.

F. H. [unclear]



United States Department of the Interior



FISH AND WILDLIFE SERVICE
New England Field Office
70 Commercial Street, Suite 300
Concord, New Hampshire 03301-5087

March 9, 2005

Stephen Bethay
Entergy Nuclear Generation Company
600 Rocky Hill Road
Plymouth, MA 02360

Dear Mr. Bethay:

We are in receipt of your February 3, 2005 letter regarding the license renewal process for the Pilgrim Nuclear Power Station (PNPS), Plymouth, Massachusetts. 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 Plymouth Beach, just north of the PNPS. Occasional wintering bald eagles (*Haliaeetus leucocephalus*) are also sometimes present in the area. According to our records, none of the above-listed species are known to frequent the immediate vicinity of PNPS and, therefore, the presence of these species near the power station is probably transient in nature.

As stated in your letter, the PNPS-to-Snake Hill Road transmission corridor crosses critical habitat for the endangered red-bellied cooter (*Pseudemys rubriventris*). We concur with your determination that the area crossed by the transmission line does not provide the specific biological habitat needs for the red-bellied cooter. However, turtles may traverse the transmission line corridor and the area is considered critical based on its value to buffer against activities that may degrade water quantity and quality in ponds occupied by the species.

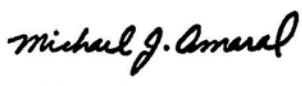
Information was provided regarding several marine mammals and turtles. Jurisdiction for those species resides with the National Marine Fisheries Service. We suggest you contact them at their Gloucester, Massachusetts office at 978-281-9300 with regard to the relicensing of the PNPS.

Appendix E

Since no expansion of existing facilities is planned and no additional land disturbance is anticipated, we concur with your determination that license renewal for PNPS 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 us at 603-223-2541 if we can be of further assistance.

Sincerely yours,



Michael J. Amaral
Endangered Species Specialist
New England Field Office

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

March 14, 2005

Stephen Bethay
Director, Nuclear Assessment
Pilgrim Nuclear Power Station
Entergy Nuclear Generation Company

RE: Pilgrim Nuclear Power Station License Renewal, Plymouth, MHC #RC.36661

Dear Mr. Bethay:

Thank you for submitting information to the Massachusetts Historical Commission regarding the proposed project referenced above. Staff of the MHC have reviewed the information you submitted and have the following comments.

MHC understands from your letter that Entergy has no plans to alter current operations at the power station, to expand existing facilities, or to undertake ground-disturbing activities over the license renewal period.

In addition to the five archaeological sites mentioned in your letter, review of MHC's Inventory of the Historic and Archaeological Assets of the Commonwealth indicates that there is one additional recorded archaeological site within the project area, which consists of the existing power station and transmission line corridor. This site (MHC site #19-68), located within the transmission line corridor north of Rocky Hill Road, is associated with the Native American settlement of the Plymouth area. After review of MHC's files and the information you submitted, MHC staff have determined that the proposed license renewal as currently described is unlikely to affect significant historic or archaeological resources.

Should plans change and if activities involving ground disturbance are contemplated, MHC requests the opportunity to review project plans in order to assess potential effects to historic and archaeological resources and to determine whether an archaeological survey is warranted for project impact areas.

These comments are offered in compliance with Section 106 of the National Historic Preservation Act of 1966, as amended (36 CFR 800) and Massachusetts General Laws, Chapter 9, Sections 26-27C (950 CMR 71). If you have any questions concerning this review, please feel free to contact me at this office.

Sincerely,

A handwritten signature in cursive script, appearing to read "Eric S. Johnson".

Eric S. Johnson
Archaeologist/Preservation Planner
Massachusetts Historical Commission

xc: Plymouth Historical Commission
Cheryl Andrews-Maltais, THPO, WTGHA

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www.state.ma.us/sec/mhc

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Commonwealth of Massachusetts

Division of Fisheries & Wildlife

Wayne F. MacCallum, *Director*

April 8, 2005

Entergy Nuclear Generation Company
Pilgrim Nuclear Power Station
Attn: Stephen Bethay
600 Rocky Hill Road
Plymouth, MA 02360

RE: Pilgrim Nuclear Power Plant
Plymouth, MA
Renewal of Operating License
NHESP File No. 04-16063

Dear Mr. Bethay,

Thank you for contacting the Natural Heritage and Endangered Species Program (NHESP) of the MA Division of Fisheries and Wildlife for information regarding state-listed rare species at the above referenced site.

As you are aware from our previous letters, there are state-protected rare species that occur within proximity to the above site. According to the 11th edition of the Massachusetts Natural Heritage Atlas, a majority of *Priority Habitat 1320* (PH 1320) and *Estimated Habitat 148* (WH 148) falls within a half mile radius to the subject project location. The Spotted Turtle (*Clemmys guttata*), a state-listed species of Special Concern is located in this Estimated Habitat polygon.

This species is protected under the Massachusetts Endangered Species Act (MESA) (M.G.L. c. 131A) and its implementing regulations (321 CMR 10.00). State-listed wildlife are also protected under the state's Wetlands Protection Act (WPA) (M.G.L. c. 131, s. 40) and its implementing regulations (310 CMR 10.37 and 10.59). Fact sheets for this species can be found on our website <http://www.nhesp.org>

With regard to determining the potential impacts this project would have on this and other state-listed species, it is not something that can be assessed without more specific information regarding the details associated with the operation of the power plant. If there are no plans to expand the footprint or to alter current operations over the license period, then it would not seem likely that there would be an adverse affect on state-protected wildlife species. However, the NHESP can not at this time officially make this determination unless we were to receive more detailed information in order to conduct a full environmental review. If you have any further questions, please contact Jenna Garvey, Environmental Review Assistant at: (508) 792-7270, extension 303.

Sincerely,

Thomas W. French, Ph.D.
Assistant Director

cc: Plymouth Conservation Commission

www.masswildlife.org

Division of Fisheries and Wildlife
Field Headquarters, One Rabbit Hill Road, Westborough, MA 01581 (508) 792-7270 Fax (508) 792-7275
An Agency of the Department of Fisheries, Wildlife & Environmental Law Enforcement



United States Department of the Interior



FISH AND WILDLIFE SERVICE
New England Field Office
70 Commercial Street, Suite 300
Concord, New Hampshire 03301-5087

May 23, 2006

Rani Franovich
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Dear Ms. Franovich:

We are in receipt of your April 25, 2006 letter regarding the license renewal process for the Pilgrim Nuclear Power Station, Plymouth, Massachusetts. This office received and responded to a letter dated February 3, 2005 that requested an informal consultation with regard to federally-threatened and endangered species from the applicant, Entergy Nuclear Generation Company. Enclosed is a copy of our response, dated March 9, 2005. In addition, we have no comments with regard to the Fish and Wildlife Coordination Act.

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

Sincerely yours,

Michael J. Amaral
Endangered Species Specialist
New England Field Office

Enclosure

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Preserving America's Heritage

May 24, 2006

Rani Franovich
Division of License Renewal
Office of Nuclear Reactor Regulation
Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Re: License Renewal Application - Pilgrim Nuclear Power Station
Town of Plymouth, Massachusetts

Dear Ms. Franovich:

On May 8, 2006, we received your notice that, in accordance with 10 CFR Part 54, an application for renewal of the Pilgrim Nuclear Power Station operating license has been filed with the Nuclear Regulatory Commission (NRC). In this notice, you refer to 36 CFR §800.8 of the regulation (36 CFR Part 800) implementing Section 106 of the National Historic Preservation Act. This section of the ACHP's regulation contains two parts that serve two different purposes. The first part, 36 CFR §800.8(a), establishes general principles for improving the coordination between the ACHP's regulation and the requirements of the National Environmental Policy Act (NEPA). The second part of this section, 36 CFR §800.8(c), establishes the standards that must be met when a Federal agency decides to use the documentation and requirements of NEPA to comply with Section 106.

It is unclear whether your reference to 36 CFR §800.8 means that NRC intends to adhere to the general principles for better coordination between Section 106 and NEPA, or to substitute the requirements of NEPA for §§ 800.3 through 800.6 of the ACHP's regulation. In accordance with 36 CFR §800.8(c), if NRC intends to use the substitution provision, then you must notify not only the ACHP, but also the State Historic Preservation Officer (SHPO) and/or Tribal Historic Preservation Officer (THPO) that you intend to do so. We note that the SHPO/THPO does not appear to have been included among the recipients of this notice.

We request that NRC clarify this matter and provide us with a copy of any notice that you may send to the SHPO/THPO pursuant to 36 CFR §800.8(c). It is particularly important that you do so because of the advisory role of the ACHP under in resolving consulting parties' objections submitted pursuant to 36 CFR §800.8(c)(2) and (3).

ADVISORY COUNCIL ON HISTORIC PRESERVATION

1100 Pennsylvania Avenue NW, Suite 809 • Washington, DC 20004
Phone: 202-606-8503 • Fax: 202-606-8647 • achp@achp.gov • www.achp.gov

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Should you have any questions, please contact us at 202-606-8503.

Sincerely,



Laura Henley Dean, PhD
Program Analyst
Office of Federal Agency Programs



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UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
NORTHEAST REGION
One Blackburn Drive
Gloucester, MA 01930-2298

JUN - 8 2006

Ms. Rani Franovich
Branch Chief, Environmental Branch B
Division of License Renewal
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulator Commission
Washington, DC 20555-0001

Dear Ms. Franovich:

This letter is in response to your request for information regarding Essential Fish Habitat (EFH) and protected species within the area under evaluation for the Pilgrim Nuclear Power Station License Renewal Application. Pilgrim Nuclear Power Station is located within Plymouth Bay and Cape Cod Bay, in Plymouth, MA. The proposed action is to renew the existing license for an additional 20 years beyond the expiration of the current operating license. The National Marine Fisheries Service (NMFS) is providing the following comments to identify and address potential adverse impacts on EFH, protected species, as well as other public trust resources.

The EFH provisions of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) require federal agencies to consult with NMFS on projects such as this that may adversely affect EFH. 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.

Essential Fish Habitat

Plymouth Bay and Cape Cod Bay have been designated as EFH for a number of federally managed species including, but not limited to, winter flounder, Atlantic cod, windowpane flounder, red hake, and white hake. A complete list of species and life stages that have been designated for the proposed project location can be found on the NMFS Habitat Conservation Division website at <http://www.nero.noaa.gov/ro/doc/webintro.html>

EFH Assessment

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



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5 an analysis of alternatives to the action that could avoid or minimize the adverse effects
6 on EFH. The EFH assessment should be contained in the Draft Environmental Impact
7 Statement (DEIS) and clearly labeled as such within the document. NMFS will
8 commence the EFH consultation upon receipt of the completed assessment.

9 **Fishery Resources under the Fish and Wildlife Coordination Act**

10 In addition to the EFH provisions of the MSA, the Fish and Wildlife Coordination Act
11 (FWCA) requires federal agencies to consult with federal and state natural resource
12 agencies regarding activities or licensing that impact fish and wildlife resources. In that
13 regard, several finfish and shellfish resources, considered to be NMFS trust resources, are
14 expected to be present in the vicinity of the proposed project. These include, but are not
15 limited to, American lobster, alewife, blueback herring, rainbow smelt, and Atlantic
16 menhaden. It is important to note that all fishery resources within the project area are
17 NMFS trust resources. Accordingly, NMFS will seek to avoid and minimize adverse
18 effects to these resources, pursuant to the FWCA.

19 **Impingement and Entrainment**

20 As currently operated, the Pilgrim Nuclear Power Station adversely affects a variety of
21 fish and shellfish resources through impingement on cooling water intake screens and
22 through entrainment into the plant's cooling system. Pilgrim Station has been monitoring
23 entrainment of eggs and larvae for over 25 years, and such site-specific information
24 should be utilized in the evaluation of impacts from the proposed action. Based on this
25 analysis, alternatives which avoid and minimize adverse effect to fishery resources
26 should be considered and analyzed in the DEIS.

27 As described within the 2001 draft EFH assessment, the NRC utilizes the "adult
28 equivalent" analysis in order to determine relative impact of the facility on fishery
29 resources. However, this method focuses solely on finfish survival to maturity and does
30 not account for ecosystem and food web benefits resulting from egg and larval predation.
31 In order to fully account for adverse impacts resulting from the facility, the proposed
32 assessment should include an analysis of ecosystem and food web benefits foregone as a
33 result of operational impacts on eggs and larvae.

34 **Thermal discharges**

35 The Pilgrim Nuclear Power Station is currently authorized to discharge heated effluent
36 into Plymouth Bay. As stated within the 2001 draft EFH assessment, discharge
37 temperature differentials ranging from 33.8 - 48 degrees Fahrenheit have been found to
38 occur in an area of up to 1.17 acres. Adverse impacts on fishery resources and EFH
39 resulting from the thermal plume within this "mixing zone" should be detailed within the
40 EFH assessment.

41 **Compensatory Mitigation**

Currently, Pilgrim Station attempts to offset adverse impacts on living marine resources
through a winter flounder hatchery/stocking program. Pilgrim Station, through Llenoco,
Inc., currently stocks approximately 25,000 winter flounder young-of-year (YOY)
juveniles/larvae per year into Plymouth Bay. The NRC should analyze the success of the

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5 current mitigation program within the proposed environmental review, as well as
6 potential modifications to the program, as compared to the loss of ecosystem and food
7 web benefits forgone as a result of operational impacts on eggs and larvae of all species.

8 **Protected Resources**

9 Several listed species of whales and sea turtles are known to occur seasonally in the
10 waters off of Massachusetts. Federally endangered Northern right whales (*Eubalaena*
11 *glacialis*) have been documented in the nearshore waters of Massachusetts from
12 December through June and are likely to be present in Cape Cod Bay from December 15
13 – April 15 and Great South Channel from March 1 – June 30. Endangered humpback
14 whales (*Megaptera novaeangliae*) feed during the spring, summer, and fall over a range
15 that encompasses the eastern coast of the United States. Humpback whales are found off
16 the coast of Massachusetts from March 15 – November 30. Fin (*Balaenoptera physalus*),
17 sei (*Balaenoptera borealis*), and sperm (*Physeter macrocephalus*) whales are also
18 seasonally present in New England waters but are typically found in deeper offshore
19 waters.

20 Certain New England waters have also been designated as critical habitat for the
21 Northern right whale (final rule at 59 FR 28793). The Great South Channel critical
22 habitat is the area bounded by 41°40' N/69°45' W; 41°00' N/69°05' W; 41°38' W; and
23 42°10' N/68°31' W. The Cape Cod Bay critical habitat is the area bounded by 42°02.8'
24 N/70°10' W; 42°12' N/70°15' W; 42°12' N/70°30' W; 41°46.8' N/70°30' W, and on the
25 south and east by the interior shore line of Cape Cod, Massachusetts.

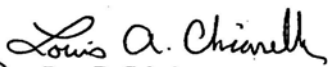
26 The occurrence of sea turtles in northeastern nearshore waters are typically small
27 juveniles with the most abundant being the federally threatened loggerhead (*Caretta*
28 *caretta*), followed by the federally endangered Kemp's ridley (*Lepidochelys kemp*).
29 Loggerhead turtles have been found to be relatively abundant off the Northeast coast
30 (from near Nova Scotia, Canada to Cape Hatteras, North Carolina). Loggerheads and
31 Kemp's ridleys have been documented in waters as cold as 11 degrees Centigrade (C), but
32 generally migrate north towards New England when water temperatures exceed 16
33 degrees C. These species are typically present in New England waters from June 1 –
34 November 30. Federally endangered leatherback sea turtles (*Dermochelys coriacea*) are
35 located in New England waters during the warmer months as well. While leatherbacks
36 are predominantly pelagic, they may occur close to shore, especially when pursuing their
37 preferred jellyfish prey. Green sea turtles (*Chelonia mydas*) may also occur sporadically
38 in New England waters, but those instances would be rare.

Section 7(a)(2) of the Endangered Species Act (ESA) of 1973, as amended, states that
each federal agency shall, in consultation with the Secretary, insure that any action they
authorize, fund, or carry out is not likely to jeopardize the continued existence of a listed
species, or result in the destruction or adverse modification of designated critical habitat.
Any discretionary federal action that may affect a listed species must undergo Section 7
consultation. The NRC is responsible for determining if the proposed project is likely to
affect listed species, and for obtaining the concurrence of NMFS with their
determination. If the NRC determines that the project is "not likely to adversely affect"

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5 any listed species (i.e., when direct or indirect effects of the proposed project or its
6 interdependent and/or interrelated actions on listed species are expected to be
7 discountable, insignificant, or completely beneficial) and NMFS concurs with this
8 determination, NMFS will reply to NRC in a letter that will convey the concurrence, thus
9 completing Section 7 consultation. If the ACOE determines that the project is "likely to
10 adversely affect" any listed species (i.e., if any adverse effect to listed species may occur
11 as a direct or indirect result of the proposed action or its interrelated or interdependent
12 actions, and the effects are not: discountable, insignificant, or beneficial) or NMFS does
13 not concur with the NRC's "not likely to adversely affect" determination, formal Section
14 7 consultation, resulting in the issuance of a Biological Opinion, may be required. Any
15 effects that amount to the take of a listed species (defined by the ESA as "to harass, harm,
16 pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any
17 such conduct") are not discountable, insignificant, or entirely beneficial. Therefore, if
18 any take is anticipated, formal consultation is required.

19
20 Thank you for your coordination with NMFS regarding this issue. If you have further
21 questions regarding this project, please contact Christopher Boelke at 978-281-9131.
22 For more information on the Section 7 process or listed species that are likely to be
23 present in Cape Cod Bay, please contact Julie Crocker in NMFS Protected Resources
24 Division at (978)281-9300 x6530.

25
26 Sincerely,

27
28 
29 for Peter D. Colosi
30 Assistant Regional Administrator
31 for Habitat Conservation

32
33 cc: Alicia Williamson, Project Manager (NRC)
34 David Webster, John Nagle (USEPA)
35 Michael Bartlett (USFWS)
36 Paul Diodati, Jack Schwartz (MADMF)
37 Susan Snow-Cotter, Todd Callaghan (MACZM)
38 Mary Colligan, Julie Crocker (PRD)
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THE COMMONWEALTH OF MASSACHUSETTS
EXECUTIVE OFFICE OF ENVIRONMENTAL AFFAIRS
OFFICE OF COASTAL ZONE MANAGEMENT
251 Causeway Street, Suite 800, Boston, MA 02114-2136
(617) 626-1200 FAX: (617) 626-1240

July 11, 2006

Stephen Bethay
Energy Nuclear Generation Company
Pilgrim Nuclear Power Station
600 Rocky Hill Road
Plymouth, MA 02360

RE: CZM Federal Consistency Review of the Pilgrim Nuclear Power Station Operating License Renewal; Plymouth

Dear Mr. Bethay:

The Massachusetts Office of Coastal Zone Management (CZM) has completed its review of the operating license renewal for the Pilgrim Nuclear Power Station, in Plymouth.

We concur with your certification and find that the activity as proposed is consistent with the CZM enforceable program policies.

If the above-referenced proposal, which has received this concurrence from CZM, is modified in any manner or is noted to be having effects on the coastal zone or its uses that are substantially different than originally proposed, please submit an explanation of the nature of the change to this Office pursuant to 301 CMR 21.17 and 15 CFR 930.66.

Thank you for your cooperation with CZM.

Sincerely,

Susan Snow-Cotter
Director

SSC/JB

Cc: Rani Franovich, Branch Chief
Branch B, Division of License Renewal
U.S. Nuclear Regulatory Commission, Washington D.C. 20555-0001
Jason Burtner, CZM South Shore Regional Coordinator



Appendix E

Biological Assessment for Pilgrim Nuclear Power Station

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Biological Assessment

**Pilgrim Nuclear Power Station
License Renewal**

December 2006

**Docket Number
50-293**

**U.S. Nuclear Regulatory Commission
Rockville, Maryland**

Biological Assessment of the Potential Effects on Endangered or Threatened Species from the Proposed License Renewal for the Pilgrim Nuclear Power Station

1.0 Introduction

The U.S. Nuclear Regulatory Commission (NRC) issues operating licenses (OLs) for domestic nuclear power plants in accordance with the provisions of the Atomic Energy Act of 1954, as amended, and NRC implementing regulations. The purpose and need for this proposed action (renewal of the OL for Pilgrim Nuclear Power Station [PNPS]) is to provide an option that permits electric power generation to continue beyond the term of the current nuclear power plant OL. This would allow future electric generating needs to be met, if the operator and State regulatory agencies pursue that option.

The NRC is reviewing an application submitted by Entergy Nuclear Operations, Inc. (Entergy) for the renewal of OL DPR-35 for PNPS for 20 years beyond the current OL expiration date. Entergy has prepared an Environmental Report (ER) as part of its application for the renewal of the PNPS OL. The ER (Entergy 2006) addressed the requirements of the following NRC regulations:

- Title 10, *Energy*, Code of Federal Regulations (CFR) Part 54, "Requirements for Renewal of Operating Licenses for Nuclear Power Plants," Section 54.23, Contents of application – environmental information (10 CFR 54.23).
- Title 10, *Energy*, CFR Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions," Section 51.53, Postconstruction environmental reports, Subsection 51.53(C), OL renewal stage [10 CFR 51.53(C)].
- Title 10, *Energy*, CFR Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions," Section 51.45, Environmental reports – general requirements (10 CFR 51.45).

In addition, the ER addressed the underlying intent of the National Environmental Policy Act of 1969, as amended (NEPA), 42 USC 4321 *et seq.*, and followed the guidance of Supplement 1 to Regulatory Guide 4.2 – Preparation of Supplemental Environmental Reports for Applications to Renew Nuclear Power Plant Operating Licenses. In the ER, Entergy analyzed the environmental impacts associated with the proposed license renewal action, considered alternatives to the proposed action, and evaluated mitigation measures for reducing adverse environmental effects. The NRC is using the ER and other information as the basis for a

Appendix E

1 Supplemental Environmental Impact Statement, a plant-specific supplement to the *Generic*
2 *Environmental Impact Statement for License Renewal of Nuclear Power Plants, NUREG-1437.*
3

4 This biological assessment examines the potential effects of the continued operation of PNPS
5 on ten Federally listed species that could occur within the PNPS site or near the site. This
6 consultation is pursuant to Section 7(e)(2) of the Endangered Species Act of 1973, as amended
7 (ESA).
8

9 In a letter dated April 25, 2006, the NRC staff requested that the National Marine Fisheries
10 Service (NMFS) provide lists of Federally listed endangered or threatened species and
11 information on protected, proposed, and candidate species, as well as any designated critical
12 habitat, that may be in the vicinity of PNPS (NRC 2006). The project area is defined as the
13 PNPS site, adjacent areas of Cape Cod Bay, and approximately 7.2 miles (mi) of transmission
14 line right-of-way (ROW). Cape Cod Bay serves as the source of cooling water for the power
15 station. In a letter from the NMFS (NMFS 2006a), the NRC was provided with a list of Federally
16 protected species in the project area. A total of ten aquatic species under NMFS jurisdiction
17 that are afforded protection under the ESA, were identified as having the potential to inhabit the
18 project area.
19

20 **2.0 The Proposed Federal Action**

21

22 The proposed action is the renewal of the OL for PNPS. PNPS is located in the Town of
23 Plymouth, Plymouth County, Massachusetts, on the western shore of Cape Cod Bay. The
24 location of the facility, and the areas within 50-mi and 6-mi radii, are shown in Figures 2-1 and
25 2-2, respectively. The current OL expires on June 8, 2012. Entergy has submitted an
26 application to the NRC to renew this license for an additional 20 years of operation, until June 8,
27 2032.
28

29 There would be no major construction, refurbishment, or replacement activities associated with
30 the license renewal. If the NRC approves the license renewal application, the reactor and
31 support facilities, including the cooling system, would be expected to continue to be operated
32 and maintained until the renewed license expires in 2032. Maintenance activities would also
33 continue to be performed on the transmission lines that connect PNPS to the electric grid,
34 including inspection, surveillance, and vegetation management within the ROW.

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Figure 2-1. Location of PNPS, 50-mile radius

Appendix E

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Figure 2-2. PNPS, 6-mile radius

3.0 The Plant and Associated Transmission Line System

3.1 Reactor Systems

The principal facilities present at the PNPS site include the reactor and turbine buildings, an offgas retention building, a radwaste building, a diesel generator building, an administration building, the cooling water intake structure, and the main stack. The facility operates a single reactor unit with a boiling water reactor design and turbine generator manufactured by General Electric. The facility has a licensed output of 1998 megawatts-thermal and a current electrical rating of 715 megawatts-electric. The fuel used by the facility is low-enriched uranium dioxide with maximum enrichment of 4.6 percent by weight uranium-235 (Entergy 2006).

The primary containment for the reactor is a pressure suppression system that contains a drywell, a pressure suppression chamber, a vent system, isolation valves, and a containment cooling system connected to the water intake system. This system is enclosed within a secondary containment structure (Entergy 2006).

3.2 Cooling and Auxiliary Water Systems

The cooling and service water systems at PNPS operate as a once-through cooling system, with Cape Cod Bay being the water source. Seawater is withdrawn from the bay through an intake embayment formed by two breakwaters (Figure 3-1). The intake structure consists of wing walls, a skimmer wall that functions as a submerged baffle, slanted vertical trash racks that capture large debris, vertical traveling screens to reduce entrainment, fish return sluiceways, condenser cooling water pumps, and service water pumps (Figure 3-2). The two wing walls are constructed of concrete, and guide flow into four separate intake bays. Each wing wall extends from the face of the intake structure at a 45 degree angle, one at a distance of 130 feet (ft) to the northwest and the other 63 ft to the northeast. The entrance of the intake measures 62 ft wide at the stop log guide, and extends to the floor of the intake structure at 24 ft below mean sea level (MSL). The skimmer wall at the front of the intake removes floating debris, with the bottom of the wall extending to 12 ft below MSL. Fish are able to escape the system by way of approximately 6 to 12 10-inch (in.) circular openings that are located in the skimmer walls and at each end of the intake structure. Divers have visually verified that the escape openings are effective. Bar racks behind the skimmer wall intercept large debris. The racks are constructed of 3 in. by 3/8 in. rectangular bars, with a 3 in. opening between each bar. Debris and large, impinged organisms are removed from the bar racks using a mechanical rake.

Located in the seawater pump wells of the intake structure, two vertical, mixed-flow, wet-type pumps provide a continuous supply of condenser cooling water. Each 1450 horsepower (hp) pump has a capacity of 155,500 gallons per minute (gpm) (346.5 cubic ft per second [cfs]).

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Figure 3-1. Intake System Map

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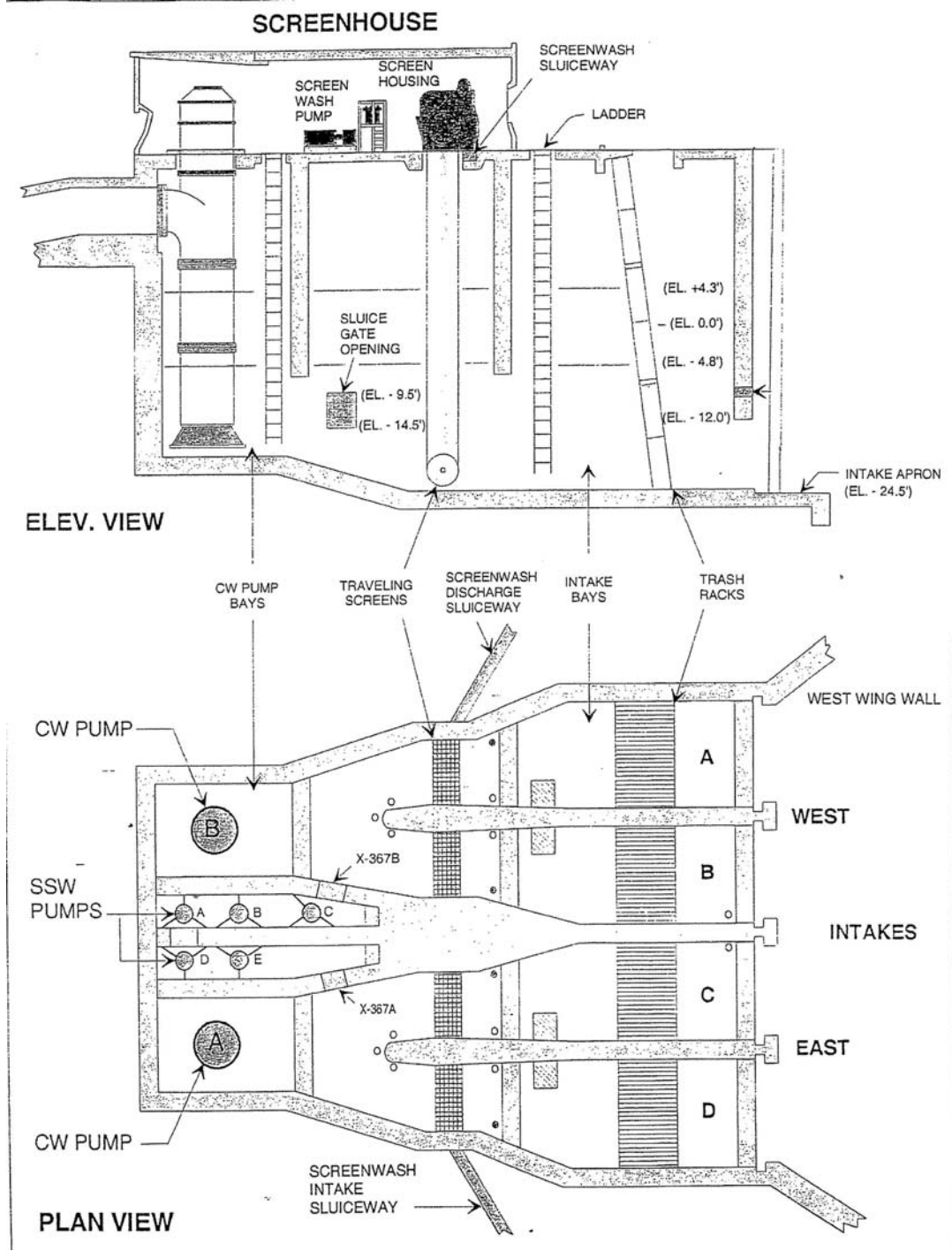


Figure 3-2. PNPS Intake Structure (Source: ENSR 2000)

Appendix E

1 The water is pumped from the intake structure to the condensers via two buried concrete pipes
2 measuring 7.5 ft in diameter. Measurements taken at the breakwaters during mid-tide level with
3 both pumps running indicate that the average intake velocity is 0.05 ft per second (fps). At the
4 intake, before the screens, the velocity is about 1 fps during all tidal conditions. Through the
5 traveling screens, the velocity is about 2 fps. The velocity is approximately 0.15 fps near the
6 end of the east fish-return sluiceway, which is located in the intake embayment just east of the
7 intake structure.

8
9 Located in the central wet well of the intake structure are five service water pumps that supply
10 the service water system. Generally, four pumps run while one is kept on standby. Each pump
11 has a capacity of 2500 gpm, providing a combined capacity at normal operation of
12 approximately 10,000 gpm. The service water system is continuously chlorinated in order to
13 control nuisance biological organisms in the service water discharge. Diffusers located
14 downstream of the trash or bar racks deliver a 12 percent sodium hypochlorite and seawater
15 mixture to each intake bay. The mixture is used to ensure the total residual chlorine discharge
16 concentration does not exceed a maximum daily concentration of 0.10 parts per million (ppm)
17 and an average monthly concentration of 0.5 ppm in the service water discharge.

18
19 Chlorination of the main cooling water system also takes place, but not on a continuous basis.
20 Hypochlorination events occur during spring, summer, and fall, when the circulating water
21 system is chlorinated for up to two hours per day (one hour for each pump). A chlorine solution
22 is added inboard of the trash rack to control fouling.

23
24 From intake to discharge, the travel time for water to move through the system varies from 5 to
25 10 minutes, depending upon whether one or two intake pumps are in service. The tidal stage
26 affects pump output, also causing changes in the transit time. In addition to dye dilution studies
27 conducted in the 1980s, the transit time has been estimated during chlorination events. During
28 these chlorination events, chlorine is added outboard of the intake screens and monitored
29 readings are taken in the discharge canal. Residual chlorine is typically detected approximately
30 5 minutes into the cycle. Since the chlorination events are usually conducted only when both
31 pumps are running, it has been estimated that the transit time would be twice as fast when
32 operating only one pump.

33
34 Prior to water flowing through either the cooling water pumps or the service water pumps, water
35 passes through one of four 10-ft-wide traveling screens. The screens work to prevent small
36 debris and small aquatic organisms from being entrained into the cooling water or service water
37 systems. Each screen is constructed of 53 segments with $\frac{1}{4}$ in. by $\frac{1}{2}$ in. stainless steel wire
38 mesh. Each segment has a stainless steel lip that is used to lift debris and organisms and direct
39 them into the fish return sluiceway.

1 The traveling screens are not operated continuously but are operated during any of the
2 following scenarios:

- 3
- 4 • When the difference in water level on each side of the screen reaches a specified
5 threshold at an alarm set point. The threshold is typically set at 6 in. This level difference
6 signifies that too much debris has collected on the screen. Level differences are rare,
7 and usually the result of a storm event.
8
- 9 • When there is an indication that fish are being impinged at a rate exceeding 20 fish per
10 hour, at which time the traveling screens are turned continuously until the impingement
11 rate drops below 20 fish per hour for two consecutive sampling events. Each
12 impingement sampling event is conducted for a minimum of 30 minutes, 3 times per
13 week.
14
- 15 • During marine life monitoring. The screen wash which occurs during screen rotations, is
16 scheduled for eight hours prior to each of the three weekly sampling events.
17
- 18 • During hypo-chlorination, which occurs each day for two hours when the main cooling
19 water system is chlorinated inboard of the trash rack to control fouling.
20
- 21 • Whenever water temperatures are less than 30°Fahrenheit (F).
22
- 23 • At a minimum, once per each 12-hour shift. This usually occurs at the beginning and end
24 of each shift, and will usually last for a few hours.
25

26 On average, the traveling screens rotate 3 to 4 times each day. The screens normally operate
27 at 5 fps, but can be accelerated to 20 fps during storm events that are causing extreme debris
28 loading.
29

30 The screens are washed when they are in operation, using a dual-level spray wash. Service
31 water is used as the source for the spray wash. Sodium thiosulfate is added to the wash water
32 to remove chlorine and protect organisms returned to the intake embayment. The screens are
33 washed from the side that faces the approaching flow at the splash housing, which is located
34 about 46 ft above the bottom of the intake structure. Low pressure spray, about 20 pounds per
35 square inch (psi), removes light fouling and organisms from the screen. Subsequently, a high
36 pressure wash, about 100 psi, is applied to remove heavy fouling. The low and high pressure
37 washes are about 18 to 24 inches apart. The screen rotation rate is kept slow during high
38 impingement events.
39

40 Impinged fish are washed into a seamless concrete fish-return sluiceway and usually returned
41 to the intake embayment approximately 300 ft east of the intake structure. The original west

Appendix E

1 sluiceway was installed in 1972 and was connected to the discharge canal. In 1979, the east
2 sluiceway was installed and connected to the intake embayment. During storms, the wash is
3 discharged via the original sluiceway to the discharge canal. An interchangeable baffle plate is
4 utilized to divert the flow to one sluiceway or the other from the screenhouse. The baffle plate
5 will direct organisms and debris; however, some water will flow over this structure and into the
6 alternate sluiceway. The new sluiceway was designed to maintain a minimum 6-in. depth and a
7 water velocity of less than 8 fps and is covered with galvanized wire screen. Though there are
8 several turns in the sluiceway, none appear to be greater than 23 degrees. The discharge point
9 of the east sluiceway is at the mean low water (MLW) level. On occasion, the end of the east
10 sluiceway has been seen above the water level, causing an actual "free fall" scenario. The west
11 sluiceway discharge is above the MLW level in the discharge canal.
12

13 Under normal operation, seawater is heated in the condensers to approximately 27 to 30°F
14 above the intake temperature. This is within the plant's NPDES permit, which allows for as
15 much as a 32°F temperature change. With the cooling water flow being relatively constant at
16 311,040 gpm (693 cfs) throughout the year, the discharge temperature is almost entirely a
17 function of the intake water temperature. The permitted change in temperature across the
18 service water is 5 to 10°F. From the condensers, water flows through a buried concrete
19 conveyance to the discharge canal. The conveyance consists of 235 ft of 13 ft by 17 ft
20 reinforced concrete box culvert, followed by 250 ft of a concrete pipe that is 10.5 ft in diameter.
21

22 Three to five times each year, the plant is reduced to 50 percent power, and a thermal
23 backwash is conducted to control biological fouling. During the backwash, water is heated to
24 about 105°F, and two of the four traveling screens are rotated in reverse, allowing heated, non-
25 chlorinated seawater from the condensers to flow back over the screens and to the intake
26 embayment. The treatment is maintained for about 35 minutes. Scheduling of the thermal
27 backwash treatments is coordinated with the highest tide to achieve maximum coverage,
28 preventing mussels from growing in the upper elevations of the intake structure.
29

30 Upon exiting the concrete pipe, discharged water enters a 900-foot-long trapezoidal discharge
31 canal separated from the intake embayment by a breakwater. The discharge canal is created by
32 two breakwaters that are oriented perpendicular to the shoreline, one of which is shared with
33 the intake embayment. The channel sides are sloped at a 2:1 horizontal to vertical ratio. The
34 bottom is 30 ft wide at an elevation of 0 ft MLW, or 4.8 ft below MSL. The channel bottom
35 remains at this elevation until it converges with the shore, which has a slope of approximately
36 40:1 at the channel mouth. At low tide, the water in the discharge canal is several feet higher
37 than sea level, and the discharge is rapid and turbulent (estimated at 8.1 fps). At high tide, the
38 velocity is much lower (estimated at 1.4 fps) because the cross sectional area of flow in the
39 channel is greater. Discharge of the heated water creates a thermal plume in the nearshore
40 area of PNPS.
41

1 Dredging of the discharge canal has never been conducted. The intake embayment has been
2 dredged twice, once in 1982 and again in the late 1990s. The purpose of dredging in the
3 1990s, though unsuccessful, was to bring colder water into the cooling water system. Each
4 dredging event was individually permitted through the U.S. Army Corps of Engineers (USACE).
5 The potential dredge material was tested as part of the permit, undergoing chemical, biological,
6 and radiological analyses (see Section 2.2.5.2). The sediments were described as having
7 relatively low concentrations of the chemical parameters tested [polychlorinated biphenyls
8 (PCBs), polycyclic aromatic hydrocarbons (PAHs), pesticides, petroleum hydrocarbons, heavy
9 metals], and thus considered to be Category One material under the Massachusetts
10 Department of Environmental Protection (MDEP) dredged material classification guidelines and
11 being suitable for disposal (BSC Group 1996). Of the three potential categories of dredged
12 material, a Category One classification has the lowest amount of contaminants. The dredged
13 material was disposed of in open water, at the Massachusetts Bay Disposal Site, north of
14 Boston.

16 3.3 Power Transmission System

17
18 The facility is connected to the electric power grid by two transmission lines, referred to as the
19 342 line and the 355 line (Figure 3-3). The two lines share a single 300-ft-wide transmission
20 line ROW that extends from the PNPS switchyard approximately 5.0 mi to the Jordan Road Tap,
21 and then the ROW extends an additional 2.2 mi to the Snake Hill Road substation (Entergy
22 2006a; AEC 1972) (Figure 2-6). Over its 7.2 mi length, the ROW covers approximately 260 ac.
23 The transmission line ROW does not cross any State or Federal parks, wildlife refuges, or
24 wildlife management areas (Entergy 2006a), nor does it cross any major lakes, ponds, or
25 streams. However, the transmission line crosses a small stream near Old Sandwich Road.

26
27 Entergy does not own, operate, or maintain the PNPS-to-Snake Hill Road transmission ROW or
28 transmission lines. The lines are owned and maintained by NSTAR, which provides electricity
29 and natural gas to businesses and residents in eastern Massachusetts (Entergy 2006a; NSTAR
30 2006). NSTAR maintains the transmission ROW in accordance with a Vegetation Management
31 Plan (NSTAR 2006) approved by the Massachusetts Department of Agricultural Resources and
32 the Natural Heritage and Endangered Species Program (NHESP). Under this plan, NSTAR
33 maintains the PNPS ROW from the station to the Snake Hill Road substation, as well as the rest
34 of their system, using an integrated vegetation management program. The ROW is managed
35 by NSTAR to encourage the natural development of low-growing woody shrubs and herbaceous
36 plant communities while controlling tall growing trees and undesirable shrub species that may
37 interfere with the operation of the transmission lines. The program is conducted in a manner to
38 protect wetland areas and sensitive plant communities that are crossed by the ROW, and the
39 timing of maintenance is scheduled with consideration of the life cycles of species located within
40 the ROW (Entergy 2006).

Appendix E

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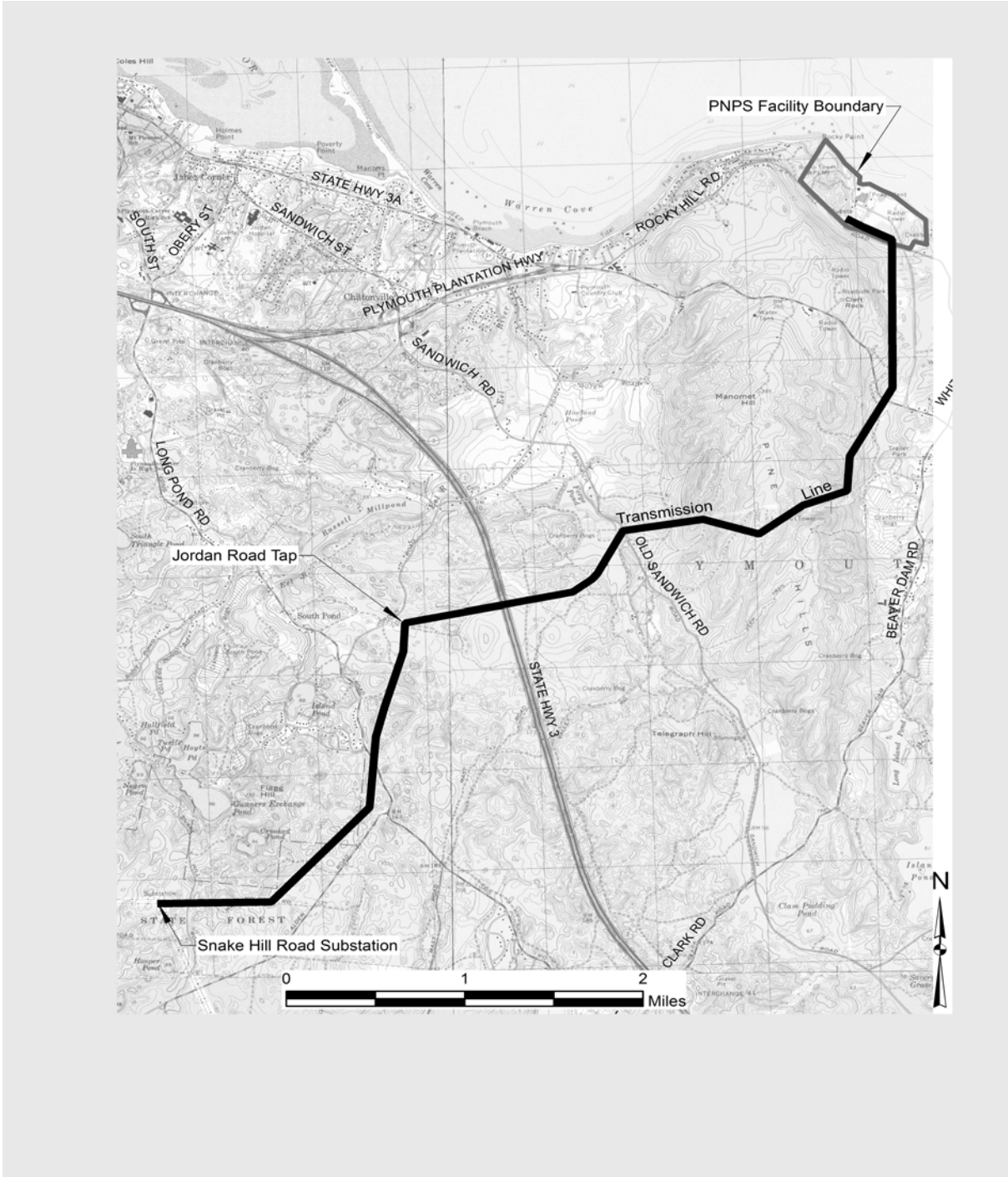


Figure 3-3. Transmission Lines

4.0 Aquatic Resources

Aquatic resources in the vicinity of PNPS are associated with the marine environment within Cape Cod Bay. The seawater of the bay is the source of the cooling water for the once-through reactor cooling system of PNPS, as well as service water for the station. The bay also receives the heated water discharged from the station. There are no other major water bodies on or adjacent to the PNPS property, and there are no major water bodies crossed or paralleled by the transmission line ROW.

Cape Cod Bay is a large embayment in southeastern Massachusetts that covers an area of approximately 365,000 acres (Entergy 2006). The bay is open to the north to the Gulf of Maine, and is enclosed by the mainland to the west and Cape Cod to the south and east. The volume of the bay is approximately 36 million acre-ft (4.5 km³) (Stone and Webster 1975 in ENSR 2000). Circulation patterns within the Gulf of Maine are counter-clockwise, resulting in a generally southward flow of cold ocean currents from the Labrador Current along the Massachusetts coast (Tyrrell 2005).

Water depths in the vicinity of PNPS are typically 10 ft and up to 35 ft several mi offshore of the site. The nearshore depths to the north of PNPS average approximately 12 ft deep. The greatest depth, approximately 180 ft, occurs at the mouth of the bay. The bottom of the bay is primarily mud (Tyrrell 2005), but the sea floor in the vicinity of PNPS is generally sandy, with depths of approximately 21 ft offshore and to the south of PNPS (ENSR 2000).

The movement of water within Cape Cod Bay is controlled mainly by tidal exchange, ocean circulation patterns, and wind (Entergy 2006). Ocean currents in the vicinity of the PNPS are generally toward the south and are part of the large-scale, counterclockwise circulation pattern within Massachusetts Bay. In contrast, tidal currents tend to rotate clockwise, completing one revolution per tide cycle (EG&G 1995 in ENSR 2000). Historical investigations of current velocities in Cape Cod Bay have indicated that net surface velocities range from 1.3 ft/min to as much as 30.4 ft/min (ENSR 2000).

The aquatic habitat within Cape Cod Bay includes numerous species that are commercially, recreationally, or ecologically important. The species present in the western portion of Cape Cod Bay reflects a transition between the aquatic habitats in the Gulf of Maine to the north and the Mid-Atlantic Bight to the south (Lawton *et al.* 1995 in ENSR 2000). Cape Cod is approximately the southern boundary of the ranges of many northern Atlantic fish species and the northern boundary of the ranges of many warmer water species (ENSR 2000). Because PNPS is situated on an open part of the coast, and not within an estuary or embayment, the species in the vicinity of the station are more typical of marine than of estuarine environments (ENSR 2000).

5.0 Evaluation of Federally Listed Endangered and Threatened Species

Ten Federally listed marine species could occur in Cape Cod Bay in the vicinity of PNPS. These include five whale species, four sea turtle species (NMFS 2006a), and one fish species (Table 5-1). Protected marine species are those that are Federally protected under the ESA and listed by the U.S. Fish and Wildlife Service (FWS) and/or the NMFS.

Table 5-1. Marine Aquatic Endangered and Threatened Species

Scientific Name	Common Name	Federal Status
TURTLES		
<i>Caretta caretta</i>	loggerhead turtle	Threatened
<i>Chelonia mydas</i>	green turtle	Threatened (endangered in FL)
<i>Dermochelys coriacea</i>	leatherback turtle	Endangered
<i>Lepidochelys kempii</i>	Kemp's ridley turtle	Endangered
WHALES		
<i>Balaenoptera borealis</i>	sei whale	Endangered
<i>Balaenoptera physalus</i>	fin whale	Endangered
<i>Eubalaena glacialis</i>	North Atlantic right	Endangered
<i>Megaptera novaengliae</i>	humpback whale	Endangered
<i>Physeter catadon</i>	sperm whale	Endangered
FISH		
<i>Acipenser brevirostrum</i>	shortnose sturgeon	Endangered

Source: FWS 2006b

Many sea turtle species migrate north in summer months, and may be found in Cape Cod Bay (Prescott 2000 in Entergy 2006). The loggerhead turtle (*Caretta caretta*) is the most common visitor to Cape Cod Bay, followed by the leatherback (*Dermochelys coriarea*), green (*Chelonia mydas*), and Kemp's ridley (*Lepidochelys kempii*) turtles (Prescott 2000). In late fall and winter, sea turtles still present in the Bay may become cold-stunned, and wash ashore (Entergy 2006). This typically includes fewer than 20 sea turtles in any given year. The largest incident recorded was in the winter of 1999-2000, when a total of 277 sea turtles were found on Cape Cod beaches (Entergy 2006). In 2003, the total number of turtles found stranded was 89 (Mass Audubon 2005 in Entergy 2006). Records have been maintained on turtle strandings in Massachusetts for 25 years, and in that time, only one sea turtle has been stranded in the Plymouth area (Entergy 2006). This incident occurred in November 2003, when a small (approximately 50 pounds) loggerhead sea turtle was stranded on Priscilla Beach approximately 0.63 mi south of PNPS (Prescott 2005 in Entergy 2006). No impingement of sea turtles has

1 been observed at PNPS.

2
3 Six species of great whales, five of which are federally listed, migrate along the Massachusetts
4 coast, with the largest number sighted in the spring on Stellwagen Bank off of the tip of Cape
5 Cod (Entergy 2006). The most common species seen in this area are minke
6 (*Balaenoptera acutorostrata*), fin (*B. physalus*), and humpback (*Megaptera novaengliae*) whales
7 (Entergy 2006). North Atlantic right whales (*Eubalaena glacialis*) may be found in
8 Massachusetts and Cape Cod Bays throughout the year (Brown *et al.* 2002 in Short and
9 Michelin 2006), and Cape Cod Bay has been designated as critical habitat for the species
10 (Entergy 2006). Sei whales (*B. borealis*) are rarely sighted in Massachusetts and Cape Cod
11 Bays (EPA 1993 in Short and Michelin 2006). Sperm whales (*Physeter catadon*) are deep
12 water whale that would not be expected in Cape Cod Bay (Provincetown Center for Coastal
13 Studies 2006).

14
15 The applicant has been monitoring aquatic communities in western Cape Cod Bay since 1969.
16 No Federally endangered or threatened species have ever been observed in Cape Cod Bay
17 near PNPS, or in the facility intake and discharge areas, during the duration of these studies
18 (Entergy 2006).

19
20 Following are detailed discussions of the potential impacts of the proposed action on these ten
21 Federally listed species.

22 23 **Loggerhead Turtle (*Caretta caretta*)**

24
25 The loggerhead turtle is the most abundant species of sea turtle found in U.S. coastal waters
26 (NMFS 2006g). The species is Federally listed as threatened throughout its range, which
27 includes temperate and tropical regions in the Atlantic, Pacific, and Indian Oceans (NMFS
28 2006g). In the Atlantic, loggerhead turtles are found from Newfoundland to Argentina, with the
29 primary nesting sites in the U.S. ranging from North Carolina to southwest Florida (NMFS
30 2006g). The species can live in water temperatures as low as 11° Celsius (C) and can be
31 present in New England waters from June 1 to November 30, when water temperatures exceed
32 16°C (NMFS 2006a).

33
34 Loggerhead turtles hatch on ocean beaches and immediately swim to offshore areas, where
35 they feed on floating items (NMFS 2006g). Once in the ocean, loggerheads live within the top 5
36 meters (m) (15 ft) of the water column and are carried by ocean currents. They live offshore for
37 a period of 7 to 12 years, at which time the juveniles migrate to nearshore coastal areas,
38 including bays, sounds, and estuaries in Massachusetts (NMFS 2006g). The species becomes
39 sexually mature and begins to mate at an age of about 35 years (NMFS 2006g).

Appendix E

1 Population estimates are based on studies of the nesting populations, primarily in southeastern
2 Florida. Based on these studies, the population of loggerheads is thought to be declining
3 (NMFS 2006g). The primary threats to the species are incidental capture in fishing gear, and
4 continuing directed harvesting in some areas (NMFS 2006g). The species is protected by
5 various international agreements. In the U.S., NMFS is the lead agency for the sea turtles in
6 the marine environment, and FWS has jurisdiction over the nesting beaches. The species was
7 placed on the endangered species list in 1978, and in 1991, NMFS and FWS finalized a
8 recovery plan for loggerheads. Critical habitat has not been designated for the loggerhead
9 turtle (FWS 2006d).

10
11 No loggerhead turtle has ever been observed at PNPS. On the basis of this information, and
12 information previously provided for the aquatic resources in the vicinity of the plant, the staff has
13 determined that continued operation of PNPS over the 20-year renewal period would have no
14 effect on the loggerhead turtle.

15 **Kemp's Ridley Turtle (*Lepidochelys kempi*)**

16
17
18 The Kemp's ridley turtle is listed as endangered throughout its range, and is the most critically
19 endangered of the sea turtle species (FWS 2006). The range for the species includes the Gulf
20 of Mexico and the western Atlantic coast from the Gulf of Mexico to Newfoundland (FWS 2006).
21 The primary nesting sites for the species are on the coast of Tamaulipas and Veracruz, Mexico;
22 some minor nesting has been known to occur in Texas, Florida, South Carolina, and North
23 Carolina (FWS 2006). The species can live in water temperatures as low as 11°C, and can be
24 present in New England waters from June 1 to November 30, when water temperatures exceed
25 16°C (NMFS 2006a).

26
27 After hatching, the juvenile turtles are dispersed throughout the Gulf of Mexico and Atlantic
28 Ocean by surficial ocean currents until they reach the age of about two years (FWS 2006b).
29 From the age of two years, the turtles live within coastal shallow water habitats (FWS 2006b).
30 The Kemp's ridley turtle was placed on the endangered species list in 1970; critical habitat has
31 not been designated (FWS 2006b).

32
33 Population estimates for the species are based on inventories of nesting sites. The number of
34 nesting sites declined from over 40,000 in 1947 to a low of 702 in 1985, primarily due to direct
35 harvesting and entanglement in fishing equipment (FWS 2006b). Nest protection and
36 implementation of fishery regulations requiring turtle excluder devices have allowed a rebound
37 of the population, with more than 8,000 nests observed in 2003 (FWS 2006b).

1 No Kemp's ridley turtle has ever been observed at PNPS. On the basis of this information, and
2 information previously provided for the aquatic resources in the vicinity of the plant, the staff has
3 determined that continued operation of PNPS over the 20-year renewal period would have no
4 effect on the Kemp's ridley turtle.

5 6 **Leatherback Turtle (*Dermochelys coriacea*)**

7
8 The leatherback sea turtle is the largest of the sea turtles and can reach a weight of 2,000
9 pounds (NMFS 2006h). The species is listed as endangered throughout its range, which is
10 global (NMFS 2006h). In the U.S., leatherback turtles nest in Puerto Rico, the U.S. Virgin
11 Islands, and southeast Florida, and they have been found along the Atlantic coast as far north
12 as the Gulf of Maine (NMFS 2006h). Leatherback turtles are expected to be present in New
13 England waters in the summer months (NMFS 2006a).

14
15 Leatherback turtles are pelagic, but have been found to forage in coastal environments (NMFS
16 2006a). Nesting occurs on sandy beaches in tropical climates, with the largest nesting area
17 being northern South America and western Africa (NMFS 2006h). The primary prey for the
18 species is jellyfish (NMFS 2006h). The species is highly migratory, with adults known to nest in
19 South America and travel as far north as Nova Scotia (NMFS 2006h).

20
21 Information on populations and trends is sparse because the adult females can nest on several
22 different beaches within one mating season (NMFS 2006h). In the Pacific, available data
23 suggest a decline of up to 80 percent in nesting populations. Nesting trends on U.S. beaches
24 have been increasing, but since these are relatively minor nesting grounds, they may not be a
25 good indicator of overall population trends (NMFS 2006h). The primary threats to the species
26 are directed harvest of eggs, juveniles, and adults during nesting, as well as incidental capture
27 in fishing gear (NMFS 2006h). The species is protected by various international agreements.
28 The species was listed as endangered under the ESA in 1970 (FWS 2006c). Critical habitat is
29 designated for the leatherback turtle in locations within the U.S. Virgin Islands (NMFS 2006h).

30
31 No leatherback turtle has ever been observed at PNPS. On the basis of this information, and
32 information previously provided for the aquatic resources in the vicinity of the plant, the staff has
33 determined that continued operation of PNPS over the 20-year renewal period would have no
34 effect on the leatherback turtle.

35 36 **Green Turtle (*Chelonia mydas*)**

37
38 The green turtle is listed as endangered in breeding populations in Florida, and as threatened in
39 other areas of the U.S. (NMFS 2006i). The species' range is global, including coastal areas in
40 tropical and subtropical climates (NMFS 2006i). In the U.S., the habitat includes inshore and
41 nearshore waters from Texas to Massachusetts (NMFS 2006i). The species becomes sexually

Appendix E

1 mature between the ages of 20 and 50 years, and females nest every 2 to 4 years on the same
2 beaches where they were born (NMFS 2006i). Nesting in the U.S. occurs in the southeastern
3 states and peaks in June and July (NMFS 2006i). Green turtles are expected to be present in
4 New England waters only sporadically (NMFS 2006a).

5
6 After hatching, juveniles swim to offshore areas and are pelagic for several years, feeding on
7 both plants and pelagic animals. As they grow larger, they move to inshore feeding areas, and
8 feed entirely on sea grass and algae (NMFS 2006i).

9
10 Population assessments indicate that there has been a decline of 48 to 65 percent in nesting
11 populations over the past 100 to 150 years (NMFS 2006i). The principal threats to the species
12 include harvesting of eggs and adults in nesting areas, harvesting of adults and juveniles in
13 feeding grounds, and incidental capture in fishing gear (NMFS 2006i). The species is protected
14 by various international agreements. The species was listed under the ESA in 1978 (FWS
15 2006a). Critical habitat is designated for the green turtle in one location in Puerto Rico
16 (NMFS 2006i).

17
18 No green turtle has ever been observed at PNPS. On the basis of this information, and
19 information previously provided for the aquatic resources in the vicinity of the plant, the staff has
20 determined that continued operation of PNPS over the 20-year renewal period would have no
21 effect on the green sea turtle.

22 **North Atlantic Right Whale (*Eubalaena glacialis*)**

23
24
25 The North Atlantic right whale is the rarest of the large whale species, and is Federally listed as
26 endangered throughout its range. The International Whaling Commission has identified four
27 categories of right whale habitats, including feeding, calving, nursery, and breeding areas.
28 Right whales primarily occur in coastal or shelf waters. During winter, calving occurs in low
29 latitudes, including the southeastern U.S. In spring and summer, the whales migrate to higher
30 latitudes, including the New England coast, for feeding and nursing (NMFS 2006b). New
31 England waters are considered to be a primary feeding ground for the right whale, with the
32 primary food source being copepods of the genera *Calanus* and *Pseudocalanus* (NMFS 2005).

33
34 This species was Federally listed as endangered in 1970. In 1994, NMFS designated three
35 areas as critical habitat for the western population of the North Atlantic right whale, with one of
36 the areas being Massachusetts Bay and Cape Cod Bay (NMFS 2006b). Right whales have
37 been documented in the nearshore waters of Massachusetts from December through June, and
38 are likely to be present in Cape Cod Bay from December 15 to April 15 (NMFS 2006a). Since
39 studies began 40 years ago, 72 percent of the catalogued population of right whales has been
40 documented to have visited Cape Cod Bay and Massachusetts Bay (Hamilton and Mayo 1990
41 in Short and Michelin 2006). The critical habitat for the right whale in Cape Cod Bay begins

1 approximately 3 mi east of PNPS and extends south and east to the coastline and north beyond
2 the tip of Cape Cod.

3
4 The right whale population within the western North Atlantic is estimated to number less than
5 300 individuals. A workshop convened by NMFS in 2002 to evaluate data on population trends
6 concluded that the population was decreasing (Clapham 2002), and the NMFS Office of
7 Protected Resources website references a recent model that predicts that the species will be
8 extinct within 200 years (NMFS 2006b). The primary human causes of serious injury and
9 mortality to the western population of the North Atlantic right whale are ship collisions and
10 entanglement in fishing gear. Habitat degradation, contamination, and climate and ecosystem
11 change are also possible threats to the population (NMFS 2005).

12
13 On the basis of this information and that previously provided for the aquatic resources in the
14 vicinity of the plant, the staff has determined that continued operation of PNPS over the 20-year
15 renewal period would have no effect on the North Atlantic right whale.

16 **Humpback Whale (*Megaptera novaengliae*)**

17
18
19 The humpback whale is Federally listed as endangered throughout its range and was placed on
20 the endangered species list in 1970 (FWS 2006f). Critical habitat has not been designated for
21 the humpback whale (FWS 2006f). There are four distinct stocks of humpback whales in U.S.
22 waters, including a Gulf of Maine stock. The Gulf of Maine stock was reclassified as a separate
23 stock from the North Atlantic stock following studies that showed that the population had a very
24 strong fidelity to the Gulf of Maine area, and genetic analyses that showed a substantial
25 separation of this population from other North Atlantic populations (NMFS 2005). This
26 information suggested that depletion of the Gulf of Maine subpopulation would not be mitigated
27 by migration from any of the other areas (NMFS 2005). Humpback whales inhabit shallow
28 water on continental shelves, with summer ranges close to shore, including major coastal
29 embayments (NMFS 2005). The Gulf of Maine stock mates and calves in the West Indies in
30 winter, but there are recent incidents of humpback whale strandings and sightings during this
31 time in the Chesapeake and Delaware Bays, along the Virginia and North Carolina coasts, and
32 in the southeastern U.S. (NMFS 2005).

33
34 Humpback whales may be found off of the coast of Massachusetts during the period from March
35 15 to November 30 (NMFS 2006a). Humpback whales are documented in the Stellwagen Bank
36 area from mid-April to November, with a peak abundance in May and June (CeTap 1982 in
37 Short and Michelin 2006). The population of humpback whales is known to change through
38 time in response to the availability of prey. In the 1970s, the population was seen to shift from
39 its historical location in the Gulf of Maine to more inshore areas, including the Stellwagen Bank.
40 This shift was attributed to the collapse of the herring population due to overfishing in the Gulf of
41 Maine (Anthony and Waring 1980; and Grosslein *et al.* 1980 in Weinrich *et al.* 1997). By the

Appendix E

1 mid 1990s, the population appeared to have shifted back to Jeffrey's Ledge in response to
2 recovery of the herring population in that area (Weinrich *et al.* 1997).

3
4 The number of humpback whales in the North Atlantic population is approximately 11,500
5 (NMFS 2005), with approximately 900 whales within the Gulf of Maine stock (NMFS 2006f).
6 The population data suggest that the Gulf of Maine stock is steadily increasing in size, but there
7 are not enough data to make a judgment regarding trends in the overall North Atlantic
8 population (NMFS 2005). Because they inhabit relatively shallow coastal waters, humpback
9 whales are susceptible to human activities, including subsistence hunting, entanglement in
10 fishing equipment, ship collisions, disturbance by noise, and possible impacts from pollution and
11 waste disposal (NMFS 2006f).

12
13 On the basis of this information, and information previously provided for the aquatic resources in
14 the vicinity of the plant, the staff has determined that continued operation of PNPS over the 20-
15 year renewal period would have no effect on the humpback whale.

16 **Fin Whale (*Balaenoptera physalus*)**

17
18
19 The fin whale is Federally listed as endangered throughout its range (NMFS 2006c) and was
20 placed on the endangered species list in 1970 (FWS 2006f). Critical habitat has not been
21 designated for this species (FWS 2006f). Fin whales are common from Cape Hatteras to Nova
22 Scotia, accounting for 46 percent of all large whale sightings in a study from 1978 to 1982
23 (CETAP 1982). The fin whale is reported to be the dominant species among cetaceans in all
24 seasons, based on having the largest population with the largest food requirements (NMFS
25 2005). Information on the calving, mating, and feeding grounds for fin whales is limited, but
26 New England waters are known to be a major feeding ground for the species (NMFS 2005).
27 Data also suggest that there is substantial site fidelity in Massachusetts Bay and the Gulf of
28 Maine, with repeated sightings of individuals within the same year and throughout multiple years
29 (NMFS 2005). Fin whales are the most frequently sighted endangered whale species found in
30 Massachusetts and Cape Cod Bays (EPA 1993 in Short and Michelin 2006).

31
32 The fin whale population in the western North Atlantic is estimated to number approximately
33 2,814 individuals. There are not enough data upon which to identify population trends at this
34 time (NMFS 2005). The primary human cause of mortality is ship collisions, with an additional
35 component from entanglement in fishing gear NMFS 2005).

36
37 On the basis of this information, and information previously provided for the aquatic resources in
38 the vicinity of the plant, the staff has determined that continued operation of PNPS over the 20-
39 year renewal period would have no effect on the fin whale.

Sei Whale (*Balaenoptera borealis*)

The sei whale is Federally listed as endangered throughout its range (NMFS 2006e) and was placed on the endangered species list in 1970 (FWS 2006f). Critical habitat has not been designated for this species (FWS 2006f). The range of the sei whale covers the area from Cape Hatteras to Nova Scotia, with a concentration of spring, summer, and fall feeding in the Georges Bank area (NMFS 2005). Sei whales typically inhabit deep waters of the outer continental shelf, in areas of water depth of about 2,000 m (6,560 ft) (NMFS 2005). However, there are reports of episodic incursions into inshore waters, including the southern Gulf of Maine (Schilling *et al.* 1993). Sei whales are only rarely sighted in Massachusetts and Cape Cod Bays (EPA 1993 in Short and Michelin 2006).

The size of sei whale population in the U.S. Atlantic Exclusive Economic Zone is unknown. Studies from the 1970s and early 1980s indicated a population of up to 2,248 individuals, but there are no recent data upon which to base current population trends (NMFS 2005). There are very few reports of human-caused mortality or injury, and the few that exist are all related to ship strikes (NMFS 2005).

On the basis of this information, and information previously provided for the aquatic resources in the vicinity of the plant, the staff has determined that continued operation of PNPS over the 20 year renewal period would have no effect on the sei whale.

Sperm Whale (*Physeter macrocephalus*)

The sperm whale is Federally listed as endangered throughout its range (NMFS 2006d) and was placed on the endangered species list in 1970 (FWS 2006f). Critical habitat has not been designated for this species (FWS 2006f). Five different stocks of sperm whales are recognized in U.S. waters, including a North Atlantic stock. This population is concentrated east and northeast of Cape Hatteras in the winter, shifts northward to east of Delaware and Virginia in the spring, and is located offshore of New England in the summer and fall (NMFS 2005). The sperm whale is primarily found in water greater than 600 m (1970 ft) deep and is rarely found in water less than 300 m (984 ft) deep (NMFS 2006d). The sperm whale may be seasonally present in New England waters, but is typically found in deeper offshore waters (NMFS 2006a).

The sperm whale population in the western North Atlantic is estimated to number approximately 4,700 individuals, and the total worldwide population is between 200,000 and 1,500,000 individuals (NMFS 2006d). The sperm whale was extensively hunted between 1800 and 1987, with an estimate of about 1,000,000 whales taken (NMFS 2006d). Because the sperm whale inhabits deeper waters farther from shore, they are suspected to be less susceptible than coastal whale species to human-caused mortality and injury, including ship strikes, fishing, and pollutants (NMFS 2006d). There are currently not enough data upon which to determine

Appendix E

1 population trends (NMFS 2005).

2
3 On the basis of this information, and information previously provided for the aquatic resources in
4 the vicinity of the plant, the staff has determined that continued operation of PNPS over the 20-
5 year renewal period would have no effect on the sperm whale.

6 7 **Shortnose Sturgeon (*Acipenser brevirostrum*)**

8
9 The shortnose sturgeon is Federally listed as endangered throughout its range (NMFS 2006j)
10 and was placed on the endangered species list in 1967 (FWS 2006c). Critical habitat has not
11 been designated for this species. The shortnose sturgeon is often confused with the Atlantic
12 sturgeon (*Acipenser oxyrinchus*), but the two species can be distinguished by comparing the
13 width of the mouths: the shortnose sturgeon has a much wider mouth than the Atlantic
14 sturgeon. The shortnose sturgeon is amphidromous, which indicates that the fish spawns in
15 freshwater but regularly enters marine habitats during its lifespan. The shortnose sturgeon
16 spawns in fast-flowing, rocky rivers in April and May. There are three known shortnose
17 sturgeon populations in Massachusetts: one in the Merrimack River in northeastern
18 Massachusetts and two in the Connecticut River in the western portion of the state. There are
19 no known occurrences of the shortnose sturgeon in the Town of Plymouth or the surrounding
20 area (NHESP 2006); no shortnose sturgeon has ever been observed at PNPS.

21
22 On the basis of this information, and information previously provided for the aquatic resources in
23 the vicinity of the plant, the staff has determined that continued operation of PNPS over the 20-
24 year renewal period would have no effect on the shortnose sturgeon.

25 26 **6.0 Conclusions**

27
28 The staff has identified ten Federally listed endangered or threatened, species that are under
29 full or partial NMFS jurisdiction, that have a reasonable potential to occur in the vicinity of
30 PNPS, and, therefore, may be affected by continuing operations of PNPS. In addition, Entergy
31 has ongoing ecological studies and monitoring systems in place to evaluate the impact of the
32 facility on aquatic organisms and has not observed any interactions with any Federally
33 endangered or threatened species.

34
35 The NRC staff has evaluated the species that are likely to be present in the vicinity of PNPS,
36 the known distributions and habitat ranges of those species, the ecological impacts of the
37 operation of PNPS on the species, and the studies and mitigation measures that Entergy
38 employs to protect the species. Based on this analysis, the staff has determined that continued
39 operation of PNPS for an additional 20 years would not have any adverse impact on any
40 threatened or endangered marine aquatic species.

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Appendix E

Essential Fish Habitat Assessment Pilgrim Nuclear Power Station

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Essential Fish Habitat Assessment

**Pilgrim Nuclear Power Station
License Renewal**

**Docket Number
50-293**

**U.S. Nuclear Regulatory Commission
Rockville, Maryland**

December 2006

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**Assessment of the Potential Effects on Essential Fish Habitat
from the Proposed License Renewal for the
Pilgrim Nuclear Power Station**

1.0 Introduction

The U.S. Nuclear Regulatory Commission (NRC) issues licenses for domestic nuclear power plants in accordance with the provisions of the Atomic Energy Act of 1954, as amended, and NRC implementing regulations. The NRC is reviewing an application submitted by Entergy Nuclear Generation Company (the applicant) for the renewal of Operating License (OL) DPR-35 for Pilgrim Nuclear Power Station (PNPS) for 20 years beyond the current operating license expiration date. The current OL will expire at midnight on June 8, 2012. Entergy has submitted an application to the NRC to renew this license for an additional 20 years of operation, until June 8, 2032, and the proposed action evaluated in this assessment is the renewal of the OL.

The 1996 amendments to the Magnuson-Stevens Fishery Conservation and Management Act (MSA) identified the importance of habitat protection to healthy fisheries. The amendments known as the Sustainable Fisheries Act, strengthened the governing agencies' authority to protect and conserve the habitat of marine, estuarine, and anadromous animals (NEFMC 1999). Essential Fish Habitat (EFH) is defined as those waters and substrate necessary for spawning, breeding, feeding, or growth to maturity (Magnuson-Stevens Act, 16 USC 1801 et seq). Identifying EFH is an essential component in the development of Fishery Management Plans (FMPs) to evaluate the effects of habitat loss or degradation on fishery stocks and take actions to mitigate such damage. This responsibility was expanded to ensure additional habitat protection (NMFS 1999). The consultation requirements of Section 305(b) of the MSA provide that Federal agencies consult with the Secretary of Commerce on all actions, or proposed actions, authorized, funded, or undertaken by the agency, that may adversely affect EFH.

PNPS is located in the Town of Plymouth, Plymouth County, Massachusetts, on the western shore of Cape Cod Bay. Cape Cod Bay serves as the source of cooling water for PNPS, and discharge water is discharged into the bay. Pursuant to the Endangered Species Act, a biological assessment regarding license renewal of PNPS has been provided to the National Marine Fisheries Service (NMFS).

On May 16, 2006, NRC staff met with NMFS staff to discuss the EFH consultation process. Discussions included a description of the overall re-licensing process and requirements for the EFH assessment. Additionally a letter was received from the NMFS on June 8, 2006 documenting some of the NMFS's requirements regarding the EFH assessment.

2.0 Proposed Federal Action

The proposed action is the renewal of the OL for PNPS. If approved and issued by the NRC, the renewed OL would allow up to 20 additional years of plant operation beyond the current licensed operating term. The renewed OL would be issued well in advance of the current OL's expiration date and would replace the existing OL. Therefore, if issued, the new PNPS OL would expire in 2032. No major refurbishment or replacement of important systems, structures, or components is expected during the 20-year PNPS license renewal term. In addition, no construction activities are expected to be associated with license renewal. If the NRC renews the license, the reactors and support facilities, including the cooling system, would be expected to continue to be operated and maintained until the renewed license expires in 2032.

3.0 Environmental Setting

The location of the facility, the areas within 50-mi and 6-mi radii, are shown in Figures 3-1 and 3-2, respectively. PNPS is located approximately 38 mi southwest of Boston, Massachusetts and 44 mi east of Providence, Rhode Island. The area within a 6-mi radius of the facility includes the town of Plymouth. Most of the area within the 6-mi radius is open water within Cape Cod Bay.

The facility, shown in Figure 3-3, comprises an area of approximately 140 ac. An additional 1500 ac of adjacent property owned by Entergy is in a forest management trust. One tract of privately owned land is contained within the Entergy land holdings, but it is located outside of the NRC-mandated, 1800-foot buffer between the reactor and the nearest residence.

Aquatic resources in the vicinity of PNPS are associated with the marine environment within Cape Cod Bay. The seawater of the bay is the source of the cooling water for the once-through reactor cooling system of PNPS, as well as service water for the station. The bay also receives the heated water discharged from the station. There are no other major water bodies on or adjacent to the PNPS property, and there are no major water bodies crossed or paralleled by the transmission line right-of-way.

Cape Cod Bay is a large embayment in southeastern Massachusetts that covers an area of approximately 365,000 ac (1,477 km²) (Entergy 2006a). The bay is open to the north, and is enclosed by the mainland to the west and Cape Cod to the south and east. The volume of the bay is approximately 36 million acre-feet (4.5 km³) (Stone and Webster 1975 in ENSR 2000).

Water depths in the vicinity of PNPS are typically 10 ft (3 m) and up to 35 ft (10.7 m) several miles offshore of the site. The nearshore depths to the north of PNPS average approximately 12 ft (3.7 m) deep. The greatest depth, approximately 180 ft (54.9 m), occurs at the mouth of the bay.

Appendix E

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Figure 3-1. Location of PNPS, 50-mi Radius

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Figure 3-2. Location of PNPS, 6-mi Radius

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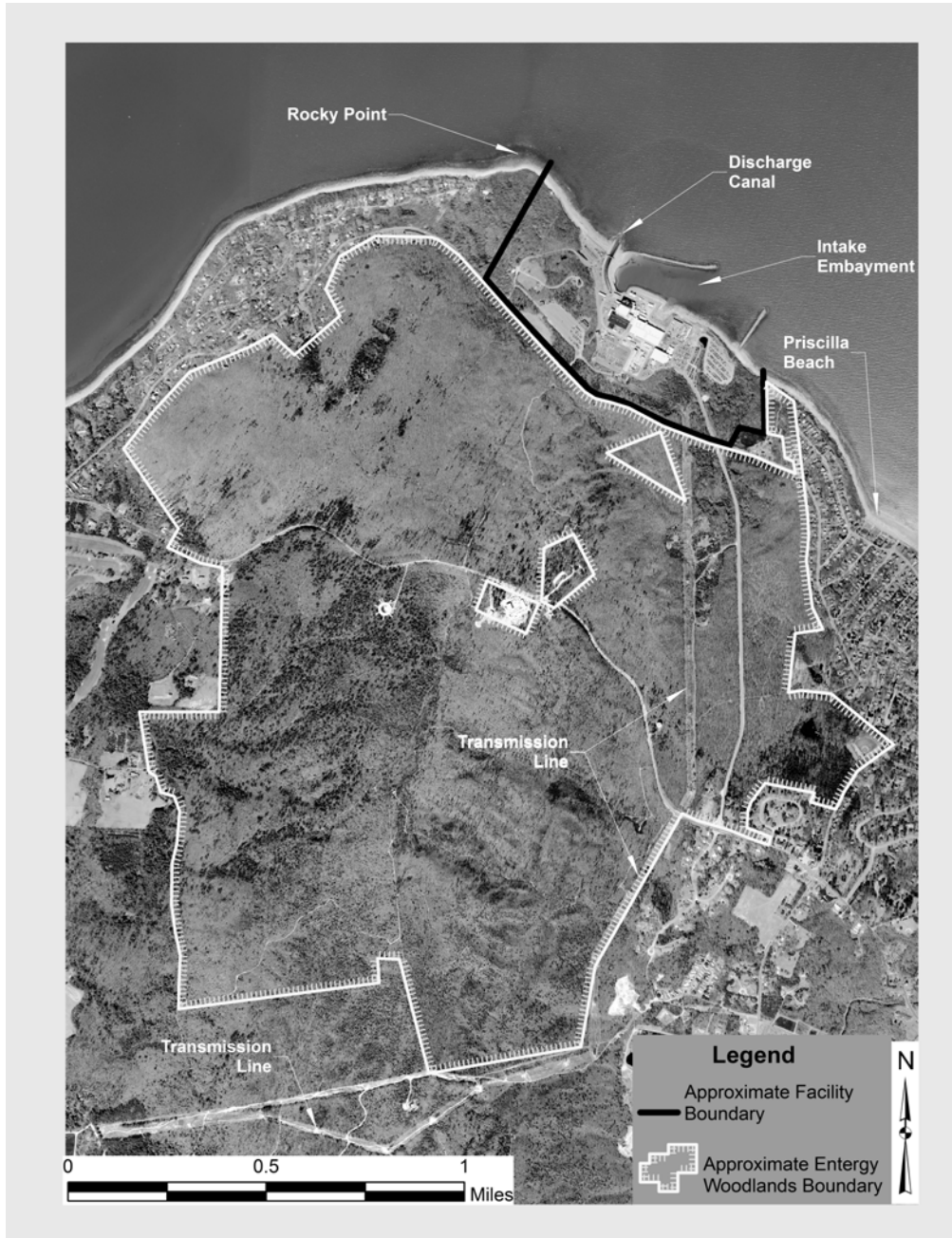


Figure 3-3. Aerial Photograph Showing PNPS Property Boundaries and Environs.

1 The bottom is mainly unconsolidated sediment, finer in deeper waters than near shore (Bridges
2 and Anderson 1984 in ENSR 2000). The sea floor in the vicinity of PNPS is generally sandy,
3 with depths of approximately 21 feet offshore and to the south of PNPS. Two shallow rocky
4 ledges bracket the PNPS area. One ledge extends northward from Rocky Point near the
5 northern tip of the PNPS property. The other ledge also extends northward for several hundred
6 meters from the vicinity of Manomet Point (ENSR 2000, Davis and McGrath 1984).

7
8 The movement of water within Cape Cod Bay is controlled mainly by tidal exchange, ocean
9 circulation patterns, and wind (Entergy 2006a). Ocean currents in the vicinity of PNPS are
10 generally toward the south and are part of the large-scale, counterclockwise circulation pattern
11 within Massachusetts Bay. In contrast, tidal currents tend to rotate clockwise, completing one
12 revolution per tide cycle (EG&G 1995 in ENSR 2000). Historical investigations of current
13 velocities in Cape Cod Bay have indicated that net surface velocities range from 1.3 ft/min (0.7
14 cm/sec) to as much as 30.4 ft/min (15.4 cm/sec) (ENSR 2000).

15
16 Water temperature measurements have been collected by the Massachusetts Water Resources
17 Authority (MWRA) in Boston Harbor, Massachusetts Bay, and Cape Cod Bay from 1989 through
18 2004. Over the 15 year period, temperatures have remained fairly consistent, ranging from
19 approximately 2°Celsius (C) (in mid-winter) to 22°C (in mid-summer) in the near-surface water
20 and approximately 3°C (in mid-winter) to approximately 12°C (in mid-summer) in the near-bottom
21 water (Libby et al. 2006). Large fluctuations during the summer are typical, resulting from
22 upwelling-downwelling fluctuations as well as short-lived wind-mixing events (Libby et al. 2006).

23
24 As reported in ENSR (2000), during 1996 at a mooring in Massachusetts Bay, the salinity at the
25 bottom of the water column remained relatively consistent at 31-32 parts per thousand (ppt)
26 throughout the year, while the salinity of the surface waters varied from approximately 28 ppt
27 from late spring to early fall, to approximately 31 ppt during the remainder of the year. It is
28 expected that salinities in the immediate nearshore vicinity of PNPS would be similar.

29
30 Dissolved oxygen (DO) concentrations in the water column of Cape Cod Bay are highest during
31 the winter and early spring when oxygen is well mixed throughout the water column. DO
32 measurements have been collected throughout the Massachusetts Bay/Cape Cod Bay system
33 since 1992 by the MWRA (Libby et al. 2006). Monitoring results from this program indicate that
34 the DO varies significantly throughout the year, with values in 2004 ranging from approximately
35 11 mg/L in March of 2004 to a low of approximately 7.5 mg/L in Cape Cod Bay during early fall
36 (Libby et al. 2006). In general, the DO at the bottom is less than at the surface by 1 to 2 mg/L
37 throughout the year (Galya et al. 1997 in ENSR 2000).

38
39 Cape Cod Bay provides habitat for numerous commercially, recreationally, or ecologically
40 important species. The species present in western Cape Cod Bay reflect a transition between
41 the aquatic habitats in the Gulf of Maine to the north and the Mid-Atlantic Bight to the south via

Appendix E

1 the Cape Cod canal (Lawton et al. 1995 in ENSR 2000). Cape Cod is approximately the
2 southern boundary of the ranges of many northern Atlantic fish species and the northern
3 boundary of the ranges of many warmer water species (ENSR 2000). Because PNPS is situated
4 on an open part of the coast, and not within an estuary or embayment, the species in the vicinity
5 of the station are more typical of marine than of estuarine environments (ENSR 2000).

6 7 **4.0 The Plant and Cooling Water Systems**

8
9 This section describes the structures and operations of PNPS.

10 11 **4.1 Reactor Systems**

12
13 The principal facilities present at the PNPS site include the reactor and turbine buildings, an
14 offgas retention building, a radwaste building, a diesel generator building, an administration
15 building, the cooling water intake structure, and the main stack. The facility operates a single
16 reactor unit with a boiling water reactor design and turbine generator manufactured by General
17 Electric. The facility has a licensed output of 1,998 megawatts-thermal and a current electrical
18 rating of 715 megawatts-electric. The fuel used by the facility is low-enriched uranium dioxide
19 with maximum enrichment of 4.6 percent by weight uranium-235 (Entergy 2006a).

20 21 **4.2 Cooling and Auxiliary Water Systems**

22
23 The cooling and service water systems at PNPS operate as a once-through cooling system, with
24 Cape Cod Bay being the water source. Seawater is withdrawn from the Bay through an intake
25 embayment formed by two breakwaters (Figure 4-1). The intake structure consists of wing walls,
26 a skimmer wall that functions as a submerged baffle, slanted vertical bar racks that capture large
27 debris, vertical traveling screens to prevent entrainment, fish return sluiceways, condenser
28 cooling water pumps, and service water pumps (Figure 4-2). The two wing walls are constructed
29 of concrete and guide flow into four separate intake bays. Each wing wall extends from the face
30 of the intake structure at a 45 degree angle, one at a distance of 130 ft to the northwest and the
31 other 63 ft to the northeast. The entrance of the intake measures 62 ft wide at the stop log guide,
32 and extends to the floor of the intake structure at 24 ft below mean sea level (MSL). The skimmer
33 wall at the front of the intake removes floating debris, with the bottom of the wall extending to 12
34 feet below MSL. Fish are able to escape the system by way of approximately 6 to 12 10-in
35 circular openings that are located in the skimmer walls and at each end of the intake structure.
36 Divers have visually verified the effectiveness of the escape openings. Bar racks behind the
37 skimmer wall intercept large debris. The racks are constructed of 3 in. by 3/8 in. rectangular bars,
38 with a 3 in. opening between each bar. Debris and large, impinged organisms are removed from
39 the bar racks using a mechanical rake.

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Figure 4-1. Intake System Map

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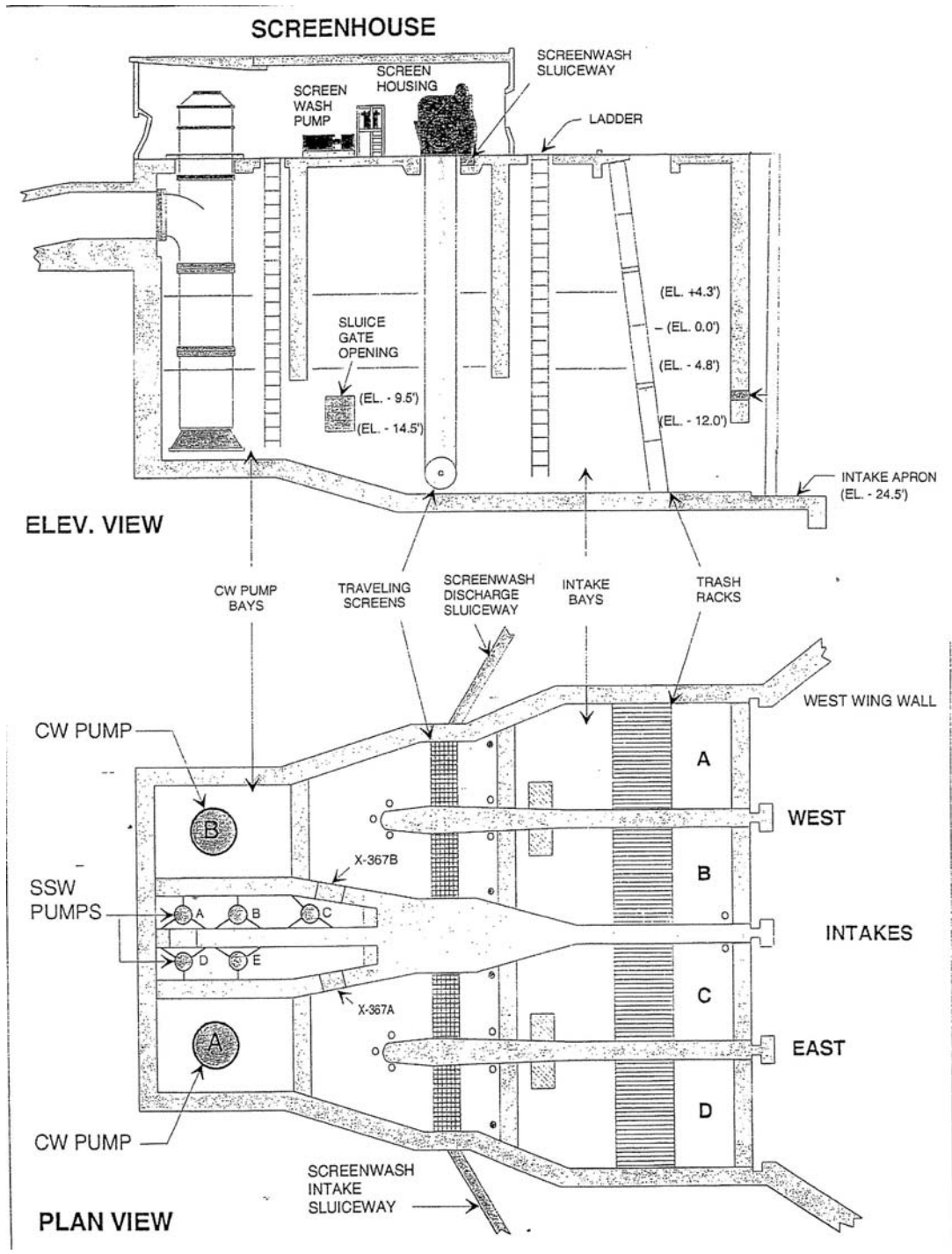


Figure 4-2. PNPS Intake Structure (Source: ENSR 2000)

1 Located in the seawater pump wells of the intake structure, two vertical, mixed-flow, wet-type
2 pumps provide a continuous supply of condenser cooling water. Each 1450 horsepower (hp)
3 pump has a capacity of 155,500 gallons per minute (gpm) (346.5 cubic feet per second [cfs]).
4 The water is pumped from the intake structure to the condensers via two buried concrete pipes
5 measuring 7.5 ft in diameter. Measurements taken at the breakwaters during mid-tide level with
6 both pumps running indicate that the average intake velocity is 0.05 ft per second (fps). At the
7 intake, before the screens, the velocity is about 1 fps during all tidal conditions. Through the
8 traveling screens, the velocity is about 2 fps. The velocity is approximately 0.15 fps near the end
9 of the east fish-return sluiceway, which is located in the intake embayment just east of the intake
10 structure.

11
12 Located in the central wet well of the intake structure are five service water pumps that supply
13 the service water system. Generally, four pumps run while one is kept on standby. Each pump
14 has a capacity of 2500 gpm, providing a combined capacity at normal operation of approximately
15 10,000 gpm. The service water system is continuously chlorinated in order to control nuisance
16 biological organisms in the service water discharge. Diffusers located downstream of the bar
17 racks deliver a 12 percent sodium hypochlorite and seawater mixture to each intake bay. The
18 mixture is used to ensure the total residual chlorine (TRC) discharge concentration does not
19 exceed a maximum daily concentration of 0.10 parts per million (ppm) and an average monthly
20 concentration of 0.5 ppm in the service water discharge.

21
22 Chlorination of the main cooling water system also takes place, but not on a continuous basis.
23 Hypochlorination events occur during spring, summer, and fall, when the circulating water
24 system is chlorinated for up to two hours per day (one hour for each pump). A chlorine solution
25 is added inboard of the trash rack to control fouling.

26
27 From intake to discharge, the travel time for water to move through the system varies from 5 to
28 10 minutes, depending upon whether one or two intake pumps are in service. The tidal stage
29 affects pump output, also causing changes in the transit time. In addition to dye dilution studies
30 conducted in the 1980s, the transit time has been estimated during chlorination events. During
31 these chlorination events, chlorine is added outboard of the intake screens and monitored
32 readings are taken in the discharge canal. Residual chlorine is typically detected approximately
33 five minutes into the cycle. Since the chlorination events are usually conducted only when both
34 pumps are running, it has been estimated that the transit time would be twice as fast when
35 operating only one pump.

36
37 Prior to water flowing through either the cooling water pumps or the service water pumps, water
38 passes through one of four 10-ft-wide traveling screens. The screens work to prevent small
39 debris and small aquatic organisms from being entrained into the cooling water or service water
40 systems. Each screen is constructed of 53 segments with $\frac{1}{4}$ in. by $\frac{1}{2}$ in. stainless steel wire

Appendix E

1 mesh. Each segment has a stainless steel lip that is used to lift debris and organisms and direct
2 them into the fish-return sluiceway.

3
4 The traveling screens are not operated continuously but are operated during any of the following
5 scenarios:

- 6
7 • When the difference in water level on each side of the screen reaches a specified
8 threshold at an alarm set point. The threshold is typically set at 6 in. This level difference
9 signifies that too much debris has collected on the screen. Level differences are rare and
10 usually the result of a storm event.
- 11
12 • When there is an indication that fish are being impinged at a rate exceeding 20 fish per
13 hour, at which time the traveling screens are turned continuously until the impingement
14 rate drops below 20 fish per hour for two consecutive sampling events. Each
15 impingement sampling event is conducted for a minimum of 30 minutes, 3 times per
16 week.
- 17
18 • During marine life monitoring. The screen wash, which occurs during screen rotations, is
19 scheduled for eight hours prior to each of the three weekly sampling events.
- 20
21 • During hypo-chlorination, which occurs each day for two hours when the main cooling
22 water system is chlorinated inboard of the trash rack to control fouling.
- 23
24 • Whenever water temperatures are less than 30°Fahrenheit (F).
- 25
26 • At a minimum, once per each 12-hour shift. This usually occurs at the beginning and end
27 of each shift, and will usually last for a few hours.

28
29 On average, the traveling screens rotate 3 to 4 times each day. The screens normally operate at
30 5 fps, but can be accelerated to 20 fps during storm events which are causing extreme debris
31 loading.

32
33 The screens are washed when they are in operation, using a dual-level spray wash. Service
34 water is used as the source for the spray wash. Sodium thiosulfate is added to the wash water
35 to remove chlorine and protect organisms returned to the intake embayment. The screens are
36 washed from the side that faces the approaching flow at the splash housing, which is located
37 about 46 ft above the bottom of the intake structure. Low pressure spray, about 20 pounds per
38 square inch (psi), removes light fouling and organisms from the screen. Subsequently, a high
39 pressure wash, about 100 psi, is applied to remove heavy fouling. The low and high pressure
40 washes are about 18 to 24 in. apart. The screen rotation rate is kept slow during high
41 impingement events.

1 Impinged fish are washed into a seamless concrete fish-return sluiceway and usually returned to
2 the intake embayment approximately 300 ft east of the intake structure. The original west
3 sluiceway was installed in 1972 and was connected to the discharge canal. In 1979, the east
4 sluiceway was installed and connected to the intake embayment. During storms, the wash is
5 discharged via the original sluiceway to the discharge canal. An interchangeable baffle plate is
6 utilized to divert the flow to one sluiceway or the other from the screenhouse. The baffle plate
7 will direct organisms and debris; however, some water will flow over this structure and into the
8 alternate sluiceway. The new sluiceway was designed to maintain a minimum 6-in depth and a
9 water velocity of less than 8 fps and is covered with galvanized wire screen. Though there are
10 several turns in the sluiceway, none appear to be greater than 23 degrees. The discharge point
11 of the east sluiceway is at the mean low water (MLW) level. On occasion, the end of the east
12 sluiceway has been seen above the water level, causing an actual "free fall" scenario. The west
13 sluiceway discharge is above the MLW level in the discharge canal.
14

15 Under normal operation, seawater is heated in the condensers to approximately 27 to 30°F
16 above the intake temperature. This is within the plant's National Pollutant Discharge Elimination
17 System (NPDES) permit, which allows for as much as a 32°F temperature change. With the
18 cooling water flow being relatively constant at 311,040 gpm (693 cfs) throughout the year, the
19 discharge temperature is almost entirely a function of the intake water temperature. The
20 permitted change in temperature across the service water is 5 to 10°F. From the condensers,
21 water flows through the buried concrete conveyances to the discharge canal. The conveyances
22 are 235 ft of 13 ft by 17 ft reinforced concrete box culvert, followed by 250 ft of a concrete pipe
23 that is 10.5 ft in. diameter.
24

25 Three to five times each year, the plant is reduced to 50 percent power, and a thermal backwash
26 is conducted to control biological fouling. During the backwash, water is heated to about 105°F,
27 and two of the four traveling screens are rotated in reverse, allowing heated, non-chlorinated
28 seawater from the condensers to flow back over the screens and to the intake embayment. The
29 treatment is maintained for about 35 minutes. Scheduling of the thermal backwash treatments is
30 coordinated with the highest tide to achieve maximum coverage, preventing mussels from
31 growing in the upper elevations of the intake structure.
32

33 Upon exiting the concrete pipe, discharged water enters a 900-foot-long trapezoidal discharge
34 canal separated from the intake embayment by a breakwater. The discharge canal is created by
35 two breakwaters that are oriented perpendicular to the shoreline, one of which is shared with the
36 intake embayment. The canal sides are sloped at a 2:1 horizontal to vertical ratio. The bottom is
37 30 feet wide at an elevation of 0 feet MLW, or 4.8 feet below MSL. The canal bottom remains at
38 this elevation until it converges with the shore, which has a slope of approximately 40:1 at the
39 canal mouth. At low tide, the water in the discharge canal is several feet higher than sea level,
40 and the discharge is rapid and turbulent (estimated at 8.1 fps). At high tide, the velocity is much

Appendix E

1 lower (estimated at 1.4 fps) because the cross sectional area of flow in the canal is greater.
2 Discharge of the heated water creates a thermal plume in the nearshore area of PNPS.
3 Dredging of the discharge canal has never been conducted. The intake embayment has been
4 dredged twice, once in 1982 and again in the late 1990s. The purpose of dredging in the 1990s,
5 though unsuccessful, was to bring colder water into the cooling water system. Each dredging
6 event was individually permitted through the U.S. Army Corps of Engineers (USACE). The
7 potential dredge material was tested as part of the permit, undergoing chemical, biological, and
8 radiological analyses (see Section 2.2.5.2). The sediments were described as having relatively
9 low concentrations of the chemical parameters tested [polychlorinated biphenyls (PCBs),
10 polycyclic aromatic hydrocarbons (PAHs), pesticides, petroleum hydrocarbons, heavy metals],
11 and thus considered to be Category One material under the Massachusetts Department of
12 Environmental Protection (MDEP) dredged material classification guidelines and being suitable
13 for disposal (BSC Group 1996). Of the three potential categories of dredged material, a
14 Category One classification has the lowest amount of contaminants. The dredged material was
15 disposed of in open water, at the Massachusetts Bay Disposal Site, north of Boston.

16 17 **5.0 Potential Effects of Plant Operation on Biota and Habitat**

18
19 Operation of the PNPS cooling water system has the potential to impact marine species and
20 habitat. Water removed from Cape Cod Bay contains a variety of aquatic organisms that may be
21 impinged on plant intake structures or entrained through the plant in the circulating cooling water
22 system and subjected to thermal, mechanical, chemical, and pressure stresses. In addition to
23 being removed by the intake, the marine water column in Cape Cod Bay would experience
24 increased temperatures near the discharge area, and organisms in the bay could be exposed to
25 elevated water temperatures from the thermal discharge plume. Benthic invertebrates and
26 macroalgae may also experience physical effects due to scouring of the bottom substrate by the
27 discharge.

28 29 **5.1 Impingement**

30
31 Impingement may occur when aquatic organisms that are drawn into the intake with the cooling
32 water are trapped against the screens of the intake bays. Impinged organisms may experience
33 injury or mortality by suffocation, starvation, exhaustion, or abrasion, which can result in fatal
34 infection. Impingement can affect fish and invertebrate species.

35
36 Impingement sampling has been conducted by PNPS since the facility first began operation and
37 consists of monitoring three scheduled screen wash periods each week throughout the year.
38 The screens are not continuously turned. However, in general they are turned for 8 hours prior
39 to conducting the impingement sampling. If the screens were turned prior to sampling, a 60
40 minute sample is obtained. If the screens were not turned prior to arrival of the sampling crew, a
41 30 minute sample is scheduled (Normandeau Associates 2006b). While the screens are turning,

1 low and high pressure sprays continuously rinse debris and organisms off the screens into a
2 sluiceway, which is sampled by inserting a stainless steel collection basket into the sluiceway
3 adjacent to the traveling screens. Fish are considered to be alive if opercular movement is noted
4 and there are no obvious signs of injury. Living fauna are noted and measured for total length
5 and then returned to the sluiceway. Dead or injured specimens are preserved for later analysis
6 in the lab (Normandeau Associates 2006b).

7
8 After being rinsed off of the screens and being washed into the east sluiceway, all debris and
9 organisms are diverted via a seamless concrete sluiceway into the intake embayment,
10 approximately 300 ft from the screens. During storm events, a portion or all of the flow from the
11 screens is diverted to the discharge canal via the west sluiceway. A re-impingement study was
12 attempted in the early 1980's, but due to methodological difficulties, the study was never
13 completed.

14
15 Impingement rates are calculated by dividing the number of individuals of a given species that
16 are collected by the number of hours in the collection period. If impingement rates of greater
17 than 20 fish per hour are noted, additional samples are collected. If impingement rates continue
18 to be elevated after the second sampling period, the plant operator is notified and advised to
19 leave the screens operating until further notice (Normandeau Associates 2006b).

20
21 Since 1980, a total of 73 species of fish has been collected in the impingement sampling
22 (Normandeau Associates 2006b). In 2005, impingement samples were collected for a total of
23 440 hours spread out over the entire year. Over 300,000 fish consisting of 38 species were
24 collected (Normandeau Associates 2006b). Atlantic menhaden (*Brevoortia tyrannus*), Atlantic
25 silverside (*Menidia menidia*), rainbow smelt (*Osmerus mordax*), winter flounder
26 (*Pseudopleuronectes americanus*), and Atlantic tomcod (*Microgadus tomcod*) accounted for 98
27 percent of the annual total of impinged fish (Normandeau Associates 2006b). Atlantic menhaden
28 were the most dominant at 97 percent, followed by Atlantic silverside (3.8 percent), rainbow
29 smelt (1.3 percent) and winter flounder (1.2 percent) (Normandeau Associates 2006b).
30 Approximately 23,000 invertebrates representing 18 taxa were also collected. Sevenspine bay
31 shrimp (*Crangon septemspinosus*) was the dominant species, followed by cancer crab (*Cancer*
32 spp.), and then American lobster (*Homarus americanus*) (Normandeau Associates 2006b).

33
34 Life stages of fish collected in the impingement sampling program may include late stage larvae,
35 juveniles, and adults; however; the historical data provided in Normandeau Associates (2006b)
36 do not specify the life stages collected. Therefore, discussion of the potential impacts to EFH
37 associated with impingement are not specific to individual life stages.

38
39 Menhaden impingement rates were significantly greater in 2005 than at any other time in the
40 history of the station being impinged at a rate 25 times greater than the historical mean.
41 Impingement rates for silversides in 2005 were similar to the historical mean. Winter flounder

Appendix E

1 and rainbow smelt were impinged at rates of almost 3 times and 2 times, respectively, of their
2 historical means. Impingement rates for winter flounder have been steadily increasing since the
3 late 1990s (Normandeau Associates 2006b). There was a sharp drop in rainbow smelt
4 impingement rates in 2000, but other than that, impingement rates have remained at relatively
5 consistent levels since the 1990s (Normandeau Associates 2006b).

6
7 In 2005, there were 19 impingement events (greater than 20 fish per hour). In the majority of
8 these events, menhaden and silversides were the primary species impinged (Normandeau
9 Associates 2006b). Impingement off the Atlantic tomcod in 2005 was approximately 6 times
10 greater than the historical mean and is the second highest impingement rate in the history of
11 PNPS.

12
13 In 2005, survival of impinged organisms was higher during the 60 minute samples than during
14 the 30 minute samples. This trend is consistent with previous years (Normandeau Associates
15 2006b). Survival of the Atlantic menhaden was low during both the 60 minute samples (27
16 percent) and the 30 minute samples (18 percent). The Atlantic silverside had a much greater
17 difference in survival between the 60 minute samples and the 30 minute samples (62 percent
18 versus 15 percent, respectively). Winter flounder survival averaged 96 percent when collected
19 during the 60 minute samples, while survival was approximately 77 percent during the 30 minute
20 samples. There was also a significant difference for the rainbow smelt, with 53 percent survival
21 based on the 60 minute samples and no survival based on the 30 minute samples (Normandeau
22 Associates 2006b). Survival for the Atlantic tomcod ranges from 35 percent for the 30 minute
23 samples to 63 percent for the 60 minute samples.

24 25 **5.2 Entrainment**

26
27 Entrainment occurs when smaller objects or organisms pass through the intake screens and
28 enter the plant's cooling system with the cooling water. Organisms entrained in the water are
29 subjected to pressure changes, mechanical damage, toxic exposure from chlorine, and thermal
30 stress. For the purposes of this EFH assessment, NRC staff assumes 100 percent mortality of
31 entrained organisms.

32
33 Entrainment sampling was initiated by PNPS in 1974 and was initially conducted twice per month
34 from January to February and from October to December and conducted weekly from March
35 through September. During these events, sampling was conducted in triplicate. Beginning in
36 1994, the sampling program was modified to focus on better temporal coverage. During the
37 January to February and October to December time periods, samples are collected every other
38 week on three separate days for a total of approximately six samples per month. During the
39 March through September time frame, three separate samples have been collected every week
40 for a total of approximately 12 samples per month (Normandeau Associates 2006a).

1 Entrainment sampling is usually conducted concurrently with the impingement sampling.
2 Entrainment sampling is conducted by suspending a 60 cm (24 in.) diameter plankton net (with
3 flowmeter) in the discharge canal approximately 30 m from the headwall. Typically a standard
4 mesh of 0.333 mm (0.013 in.) is used, with the exception of the late March through late May time
5 period, when a 0.202 mm (0.008 in.) mesh is used to capture early stage larval winter flounder.
6 The sampling period typically ranges from 8-30 minutes depending upon the tide; the higher tide
7 requires a longer interval due to lower discharge stream velocities. The target is to sample a
8 minimum quantity of 100 m³ of water. Upon termination of the sampling period, samples are
9 preserved in 10 percent formalin prior to laboratory identification and enumeration (Normandeau
10 Associates 2006a).

11
12 Approximately 60 different fish species have been collected over the last 30 years of entrainment
13 monitoring at PNPS (Normandeau Associates 2006a). In this area of Cape Cod Bay, there are
14 three primary spawning seasons observed: winter-early spring, late spring-early summer, and
15 late summer-autumn.

16
17 Many of the species that spawn during the winter early spring period have demersal, adhesive
18 eggs that are not normally entrained, and as a result, more species are typically represented by
19 larvae than by eggs during this time period (Normandeau Associates 2006a). During the 2005
20 winter-early spring season (generally January to April), egg collections are dominated by Atlantic
21 cod (*Gadus morhua*), while larvae collections are dominated by the American sand lance
22 (*Ammodytes americanus*) (Normandeau Associates 2006a). In 2004, the sand lance also
23 dominated the larvae collections while the egg collection were dominated by American plaice
24 (*Hippoglossoides platessoides*), followed by Atlantic cod (Marine Research, Inc. 2005b).

25
26 The late spring early summer season is typically the most active reproductive period among the
27 temperate fishes in the PNPS area (Normandeau Associates 2006a). For entrainment sampling,
28 in both the 2004 and 2005 late spring early summer seasons (May-July), the egg collections
29 were dominated by tautog (*Tautoglabrus adspersus*), cunner (*Pleuronectes ferruginea*), and
30 yellowtail flounder (*Pleuronectes ferruginea*), while the larvae were dominated by winter flounder
31 (Marine Research, Inc. 2005a; Normandeau Associates 2006a).

32
33 The late summer-early autumn season in the PNPS area typically shows a decline in overall
34 ichthyoplankton density and number of species collected (Normandeau Associates, 2006a). The
35 2004 and 2005 late summer-early autumn seasons (August-December) were dominated by
36 tautog, cunner, and yellowtail eggs, closely followed by fourspot flounder
37 (*Paralichthys oblongus*) and windowpane flounder (*Scopthalmus aquosus*) eggs (Marine
38 Research, Inc. 2005b; Normandeau Associates 2006a). In 2005, the larval collections were
39 dominated by fourbeard rockling (*Enchelyopus cimbrius*), whereas in 2004 larval collections were
40 dominated by cunner, with the fourbeard rockling showing a much lower percentage than in 2004
41 (Marine Research, Inc. 2005b; Normandeau Associates 2006a).

Appendix E

1 According to Entergy (2006b), ichthyoplankton densities obtained in 2005 are consistent with the
2 data from the 1975-2004 time series, with the exception of Atlantic cod and Atlantic mackerel
3 eggs and larval winter flounder and rock gunnel (*Pholis gunnellus*). Both the Atlantic cod eggs
4 and larval winter flounder abundance estimates appear to have increased over long term trends,
5 whereas Atlantic mackerel eggs and larval rock gunnel appear to be relatively low compared to
6 historic data (Normandeau Associates 2006a).

7
8 Periodically through the life of the facility, there have been periods when the rate of entrainment
9 is significantly elevated. Reporting of these "significant" events is required by the facility NPDES
10 permit. Identification of these events was thought to be necessary so that it could be determined
11 whether high ichthyoplankton entrainment rates were being caused by conditions in the vicinity
12 of Rocky Point that are attributable to operation of PNPS, or whether they were attributable to
13 naturally occurring high population levels in the bay (i.e., during spawning season) (Normandeau
14 Associates 2006a) . These high entrainment events can contribute a significant percentage of
15 the overall annual entrainment numbers for certain species. For example, during the 2005
16 sampling season, there were 54 separate high entrainment events, as defined by comparison to
17 historical data sets. These included a total of 12 species of eggs and larvae, including American
18 plaice, Atlantic menhaden, Atlantic herring, American sand lance, seasnail (*Liparis atlanticus*),
19 winter flounder, radiated shanny (*Ulvaria subbifurcata*), cunner, fourbeard rockling, tautog,
20 Atlantic mackerel, and lumped hake (Normandeau Associates 2006a).

21 **5.3 Thermal Effects**

22
23
24 Aquatic organisms are potentially impacted by the thermal plume associated with PNPS
25 discharge of heated cooling water. Contact with heated discharge water may induce heat shock
26 in animals. Alternatively, organisms that have acclimated to the thermal discharge may
27 experience cold shock during plant shut down. The effects may occur to organisms within the
28 water column or to bottom-dwelling organisms within the vicinity of PNPS (ENSR 2000).

29
30 Section 316(a) of the Clean Water Act (CWA) establishes a process by which a discharger can
31 demonstrate that the established thermal discharge limitations are more stringent than necessary
32 to protect balanced, indigenous populations of fish and wildlife and obtain facility-specific thermal
33 discharge limits (33 USC 1326). The applicant has provided U.S. Environmental Protection
34 Agency (EPA) with Section 316(a) demonstrations that address compliance with the thermal
35 effluent limitations of the NPDES permit and environmental impacts of the thermal discharge.
36 The NPDES permit (EPA 1994) states that "the thermal plumes from the station: (1) shall not
37 deleteriously interfere with the natural movements, reproductive cycles, or migratory pathways of
38 the indigenous populations within the water body segment; and (2) shall have minimal contact
39 with the surrounding shorelines. To assess compliance with these requirements, there has been
40 an extensive monitoring program of the coastal environment near the PNPS site since the
41 beginning of design/construction in the late 1960s (EG&G 1995).

1 A combined Section 316(a) and (b) demonstration report for PNPS was submitted to EPA
2 Region 1 in 1975 and 1977 by the Boston Edison Company (Stone & Webster 1975, Stone &
3 Webster 1977), was accepted by EPA, and was used in determining facility-specific NPDES
4 discharge temperature limits (Entergy 2006a). That initial Section 316 demonstration report was
5 based on engineering, hydrological, and ecological data from a 3-year pre-operational period
6 (1969-1972) and a 5-year post-operational period (1972-1976). It predicted that station
7 operations would not result in long-term thermal impacts to the aquatic environment (ENSR
8 2000). Based on that report and ongoing ecological monitoring programs, EPA has issued and
9 renewed NPDES permits for PNPS for over 30 years and has determined that thermal
10 discharges from PNPS are sufficiently protective of the aquatic community of Cape Cod Bay to
11 satisfy alternative thermal effluent limitations under Section 316(a) of the CWA (ENSR 2000,
12 Entergy 2006a).

13
14 In recent years, EPA Region 1 has required all NPDES permittees affected by Section 316 to
15 submit new Section 316(a) and (b) demonstrations. A new Section 316 demonstration report for
16 PNPS was prepared in 2000 (ENSR 2000), which updated the previous report based on
17 approximately 25 years of additional engineering, hydrological, and biological data related to
18 PNPS operations and conditions in the aquatic environment of western Cape Cod Bay. EPA
19 Region 1 currently is reviewing an Entergy application for renewal of the NPDES permit for
20 PNPS, including the newest combined Section 316 demonstration report (Entergy 2006a). In the
21 interim, Entergy has continued biological monitoring. The Thermal Discharge Fish Surveillance
22 Program involves periodic visual inspections of the discharge canal during times of fish migration
23 in order to determine the presence of fish and their condition.

24
25 Studies have demonstrated that the thermal plume does cause finfish to avoid the area of the
26 plume. The plume also does not cause significant mortality, with only two individuals identified
27 as killed as a result of heat shock in the mid 1970s. Similar studies of the thermal plume impacts
28 on benthic organisms found no effects. Research trap catch data specifically collected to
29 evaluate the impact on the American lobster did not identify any measurable difference in the
30 presence of the species before or during plant operation (ENSR 2000).

31
32 An additional source of heated water discharge at PNPS is backwashing operations. Thermal
33 backwashing is a commonly used method for control of biofouling in the condenser tubes and
34 intake structures of power plants. Condenser tubes at PNPS are cleaned by backwashing on a
35 1- to 2-week interval, depending on the degree of biofouling. Because the plant electrical
36 generation must be reduced during backwashing, the procedure usually is conducted during
37 off-peak hours. The method involves reversing the flow of heated water so that organisms
38 fouling the condenser tubes and intake structure are killed by the elevated temperatures. The
39 process results in the flow of heated water out of the intake structure and into the intake
40 embayment. The thermal backwashing process generally occurs for approximately 45 to 60
41 minutes and produces elevated water temperatures averaging approximately 37.8°C. A thermal

1 survey to determine the effects of backwashing operations at PNPS found that the procedure
2 caused a relatively thin thermal plume, averaging 3 to 5 ft (0.5 to 1.5 m) in depth, that spread
3 rapidly from the intake structure across the western end of the intake embayment and along the
4 outer breakwater. The plume completely dissipated within a few hours (Normandeau Associates
5 1977).
6

7 **6.0 Potential Effects of the Proposed Action on Designated EFH and Federally**
8 **Managed Species in the Vicinity of PNPS**
9

10 PNPS is located in an area that provides EFH for species managed by the New England Fishery
11 Management Council. Also, highly migratory species managed by NMFS and their EFHs occur
12 in the vicinity of PNPS. The NRC staff has conducted an evaluation by considering all
13 designated EFH that could occur in the vicinity of PNPS, and used a screening process to
14 eliminate species and their EFHs that would not be in the scope of this assessment. Because
15 EFH is designated geographically with respect to latitude and longitude, the staff first identified
16 the geographic boundaries of Cape Cod Bay. Table 6-1 lists the 10 minute latitude by 10 minute
17 longitude geographic areas that were used to identify species to be included in the EFH
18 assessment.
19

20 Table 6-2 lists the resulting species and life stages for which designated EFH potentially occurs
21 in the vicinity of PNPS. These potentially occurring species were compiled based on the species
22 lists for the locations noted in Table 6-1. Habitat areas of particular concern (HAPCs) have not
23 been designated for any of these species in the area surrounding PNPS.
24

25 The species on this list were further evaluated to determine if EFH was designated for the
26 geographic area in which PNPS is located (i.e., Cape Cod Bay, Gulf of Maine), and also whether
27 Cape Cod Bay in the vicinity of PNPS has the salinity, depth, temperature, and substrate
28 requirements for specific life stages of an individual species. This evaluation was conducted by
29 determining whether the EFH and general habitat parameters correlate with the physical and
30 chemical environment surrounding PNPS. As described in Section 3, salinities in the vicinity of
31 PNPS range from 28 to 33 ppt, while the depths in the immediate area of PNPS range from 3 to
32 6 m (10 to 20 ft), with a maximum depth of approximately 55 m (180 ft) at the mouth of the bay.
33 Water temperatures in this area typically range from 2°C to 22°C at the surface and from 3°C to
34 12°C on the bottom, while the substrate in this area is generally sandy with the exception of two
35 offshore rocky ledges just to the north and south of PNPS.
36
37
38
39
40
41

Table 6-1. Essential Fish Habitat Areas Associated with Cape Cod Bay

	10 Minute x 10 Minute Square Coordinates				Description of Geographic Area	Source
	North	East	South	West		
1 2 3 4 5 6	42° 10.0'N	70° 30.0'W	42° 00.0'N	70° 40.0'W	Atlantic Ocean waters within Cape Cod Bay within the square east of Duxbury, MA., Kingston, MA., and Marshfield MA., from Saquish Neck in Duxbury, MA., to Rexhame Beach in Marshfield, MA., including waters affecting most of Duxbury Bay and Powder Point in Duxbury, MA.	http://www.nero.noaa.gov/hcd/ma3.html and http://www.nero.noaa.gov/hcd/STATES4/CapecodtoNH/42007030.html ://www.nero.noaa.gov/hcd/ma4.html
7	42° 10.0'N	70° 40.0'W	42° 00.0'N	70° 50.0'W	Atlantic Ocean waters within the square within Massachusetts Bay east of Kingston, MA., and Marshfield, MA. From Kingston Bay and Kingston to Powder Point in Duxbury, MA, along with Rexhame Beach in Marshfield, MA., to the North River Inlet in Marshfield, MA. Includes a disposal site just east of Plymouth Horn on the end of Gurnet Pt. at the tip of Duxbury Beach.	http://www.nero.noaa.gov/hcd/ma4.html and http://www.nero.noaa.gov/hcd/STATES4/CapecodtoNH/42007040.html
8	42° 00.0'N	70° 20.0'W	41° 50.0'N	70° 30.0'W	Atlantic Ocean waters within Cape Cod Bay within the square one square southwest of the square affecting Provincetown, MA./ tip of Cape Cod.	http://www.nero.noaa.gov/hcd/ma3.html and http://www.nero.noaa.gov/hcd/STATES4/CapecodtoNH/41507020.html
9	42° 00.0'N	70° 30.0'W	41° 50.0'N	70° 40.0'W	Waters within Cape Cod Bay within the square affecting the following: east of Plymouth, MA., and Kingston, MA., from Plymouth Harbor south to Lookout Point in Plymouth, MA., along with the southern tip of Saquish Neck in Duxbury. Also affected by these waters are Browns Bank, Duxbury Pier, Plymouth Beach, Warren Cove, Rocky Pt., White Horse Beach and Rocks, Manomet Pt., Mary Ann Rocks, Stone Horse, Rocks, Stone Hill, Stellwagen Rocks, Center Hill Pt., and Ellisville Harbor.	http://www.nero.noaa.gov/hcd/ma3.html and http://www.nero.noaa.gov/hcd/STATES4/CapecodtoNH/41507030.html
10	42° 00.0'N	70° 40.0'W	41° 50.0'N	70° 50.0'W	Cape Cod Bay waters within the square affecting the following: east of Plymouth, MA., and Kingston, MA., from the Jones River past High Cliff to Plymouth Harbor Breakwall.	http://www.nero.noaa.gov/hcd/ma4.html and http://www.nero.noaa.gov/hcd/STATES4/CapecodtoNH/41507040.html

Appendix E

Table 6-1. (contd)

10 Minute x 10 Minute Square Coordinates				Description of Geographic Area	Source
North	East	South	West		
41° 50.0'N	70° 20.0'N	41° 40.0'N	70° 30.0'W	Atlantic Ocean waters within the square within Cape Cod Bay affecting the following: north of Sandwich, MA., and Barnstable, MA. Also, these waters affect from the Cape Code Canal on the west, east to the western part of Sandy Neck, along with the Great Marshes and the western part of Barnstable Harbor. Also affected are: Town Beach, Old Harbor Creek, and Springhill Beach northeast of Sandwich, MA., Scorton Neck and Beach, Scorton Ledge, a dump site on the northwest corner, and Plowed Neck.	http://www.nero.noaa.gov/hcd/states4/capecodtoNH/41407020.html
41° 50.0'N	70° 30.0'W	41° 40.0'N	70° 40.0'W	Atlantic Ocean waters within the square within Cape Cod Bay affecting the following: the Cape Cod Canal and surrounding from Lookout Point in Plymouth, MA., southeast to the north half of Scraggy Neck, and to Great Neck and Onset, MA., except for the far end of Stony Point Dike. This square also includes waters within Buzzards Bay affecting around Bourne, MA., and the northeast part of Wareham, MA. Also affected are: Scusset Beach and Sagamore Beach.	http://www.nero.noaa.gov/hcd/ma3.html and http://www.nero.noaa.gov/hcd/STATES4/CapecodtoNH/41407030.html
Southeast Corner Boundaries				Cape Cod Bay, MA	http://www.nero.noaa.gov/hcd/ma3.html
42° 00	70° 00	41° 40	70° 10		
42° 00	70° 10	41° 40	70° 20		
42° 00	70° 20	41° 40	70° 30		
42° 00	70° 30				
41° 50	70° 00				
41° 50	70° 10				
41° 50	70° 20				
41° 50	70° 30				
41° 40	70° 00				

Table 6-2. EFH Species Potentially Occurring in the Vicinity of PNPS

Species	Eggs	Larvae	Juveniles	Adults	Spawning Adults
American plaice (<i>Hippoglossoides platessoides</i>)	M	M	M	M	M
Atlantic butterfish (<i>Peprilus triacanthus</i>)	M	M	M/E	M/E	
Atlantic cod (<i>Gadus morhua</i>)	M	M	M	M	M
Atlantic halibut (<i>Hippoglossus hippoglossus</i>)	M	M	M	M	M
Atlantic mackerel (<i>Scomber scombrus</i>)	M/E	M/E	M/E	M/E	
Atlantic sea scallop (<i>Placopecten magellanicus</i>)	M	M	M	M	M
Atlantic sea herring (<i>Clupea harengus</i>)	M	M	M/E	M/E	
Black sea bass (<i>Centropristus striata</i>)	N/A		M	M	
Bluefin tuna (<i>Thunnus thynnus</i>)			M	M	
Bluefish (<i>Pomatomus saltatrix</i>)				M/E	
Haddock (<i>Melanogrammus aeglefinus</i>)	M	M			
Little skate (<i>Leucoraja erinacea</i>)			M	M	
Longfin squid (<i>Loligo pealei</i>)	N/A	N/A	M	M	
Monkfish (<i>Lophius americanus</i>)	M	M		M	
Ocean pout (<i>Macrozoarces americanus</i>)	M	M	M	M	M
Ocean quahog (<i>Artica islandica</i>)	N/A	N/A	M	M	
Pollock (<i>Pollachius virens</i>)		M	M/E	M	
Red hake (<i>Urophycis chuss</i>)	M	M	M/E	M	M
Scup (<i>Stenotomus chrysops</i>)	M	M	M/E	M	
Shortfin squid (<i>Illex illecebrosus</i>)	N/A	N/A	M	M	
Smooth skate (<i>Malacoraja senta</i>)			M		
Spiny dogfish (<i>Squalus acanthias</i>)	N/A	N/A	M	M	
Summer flounder (<i>Paralichthys dentatus</i>)				M	
Surf clam (<i>Spisula solidissima</i>)	N/A	N/A	M	M	
Thorny skate (<i>Amblyraja radiata</i>)			M	M	
White hake (<i>Urophycis tenuis</i>)	M	M	M/E	M/E	
Whiting/Silver hake (<i>Merluccius bilinearis</i>)	M	M	M/E	M/E	M
Windowpane flounder (<i>Scophthalmus aquosus</i>)	M/E	M/E	M/E	M/E	M/E
Winter flounder (<i>Pseudopleuronectes americanus</i>)	M/E	M/E	M/E	M/E	M/E
Winter skate (<i>Leucoraja ocellata</i>)			M	E	
Witch flounder (<i>Glyptocephalus cynoglossus</i>)	M	M			
Yellowtail flounder (<i>Pleuronectes ferruginea</i>)	M	M	M	M	M

* M = EFH in marine ecosystem; E = EFH in estuarine ecosystem.

N/A = Species either have no data available on the designated life stages, or those life stages are not present in the species reproductive cycle.

Appendix E

1 The following discussions of life stages and habitat preferences for the species listed in Table 2
2 include evaluations of the potential effects of continued PNPS operations on EFH. This
3 assessment also evaluates the potential effects of continued PNPS operations on prey items of
4 the EFH species. For the purposes of this assessment, NRC staff has classified impacts as
5 having a minimal adverse effect, less than substantial adverse effect, or substantial adverse
6 effect based on evaluation of entrainment, impingement, thermal effects, and effects on prey
7 species.

8 9 **American plaice (*Hippoglossoides platessoides*)**

10
11 EFH for American plaice eggs, larvae, juveniles, adults, and spawning adults exists in the vicinity
12 of PNPS. For eggs and larvae, EFH includes surface waters of the Gulf of Maine and Georges
13 Bank. This includes areas where water temperatures are below 12 to 14°C, and water depths
14 are between 30 and 130 m (98 and 426 ft), with a wide range of salinities. EFH for juveniles,
15 adults, and spawning adults includes bottom habitats with fine-grained, sandy, or gravel
16 substrates in the Gulf of Maine (NMFS 2006). Water conditions in EFH for the juveniles, adults,
17 and spawning adults includes water temperatures below 17°C, and depths between 45 and 175
18 m (148 and 574 ft). Spawning adults are typically found in water with temperatures below 14°C,
19 and depths less than 90 m (295 ft) (NMFS 2005a).

20
21 Both the eggs and larvae of the American plaice are pelagic and are found in shallow surface
22 waters, including southern New England and Cape Cod Bay (ENSR 2000). Adults are primarily
23 benthic, but are known to migrate off of the bottom at night to prey on non-benthic species (DFO
24 1989 in Johnson 2004). Larvae prey on plankton, diatoms, and copepods found in surface water
25 layers. As larvae turn into juveniles, they feed on small crustaceans, polychaetes, and
26 cumaceans (Bigelow and Schroeder 1953 in Johnson 2004). Benthic crustaceans, mollusks,
27 and small forage fish species make up the diet of the American plaice adults. The American
28 plaice does not migrate substantially. Results from tagging studies have found that most
29 recaptured individuals were found within 30 mi from the tagging site, even as long as seven
30 years later (DFO 1989 in Johnson 2004). In 2005, an analysis of juvenile populations resulted in
31 a proposal for the designation of HAPCs for the American plaice, including areas within Cape
32 Cod Bay (Crawford et al. 2005). American plaice populations in the western North Atlantic have
33 declined dramatically since the early 1980s (Johnson 2004).

34
35 The intake and discharge at PNPS have the potential to adversely affect a small portion of EFH,
36 including prey for all life stages of the American plaice. American plaice have been impinged at
37 PNPS, but they are not a common species in the impingement sampling program (Normandeau
38 2006b). Eggs and larvae of the American plaice dominated entrainment studies at PNPS (ENSR
39 2000, Normandeau 2006a). Due to the small area affected by the thermal plume and because
40 the American plaice would exhibit behavioral avoidance if water temperatures are not within their
41 preference range, it is unlikely that the PNPS discharge would affect juvenile and adult American

1 plaice EFH. Continued operation of PNPS may also have the potential to affect prey items of
2 various life stages of the American plaice either through entrainment of phytoplankton,
3 zooplankton, or ichthyoplankton, or via impingement of small forage fish species.
4 Continued operations of PNPS may have a substantial adverse effect on EFH for American
5 plaice.

6 7 **Atlantic butterfish (*Peprilus triacanthus*)**

8
9 EFH for American butterfish eggs, larvae, juveniles, and adults exists in the vicinity of PNPS.
10 EFH for offshore areas includes pelagic waters over the continental shelf from the Gulf of Maine
11 to Cape Hatteras. Inshore EFH for the butterfish includes the mixing or saline zones of estuaries
12 where butterfish eggs, larvae, juveniles, and adults are common or abundant on the Atlantic
13 coast, from Passamaquoddy Bay, Maine to James River, Virginia (NMFS 2006). Butterfish eggs
14 and larvae are found in water with depths ranging from the shore to 6000 ft, and temperatures
15 between 48°F and 66°F. Juvenile and adult butterfish are found in waters from 33 to 1,200 ft
16 deep, and with temperatures ranging from 37°F to 82°F (NMFS 2006). Spawning occurs
17 offshore, at temperatures above 59°F (Colton 1972 in Cross et al. 1999).

18
19 All life stages, including eggs, larvae, juveniles, and adults are pelagic (Cross et al. 1999). Adult
20 butterfish prey on small fish, squid, and crustaceans, and in turn are preyed upon by many
21 species, including silver hake (*Merluccius bilinearis*), bluefish, swordfish (*Xiphias gladius*), and
22 longfinned squid (*Loligo pealei*) (ENSR 2000). In summer, the butterfish can be found over the
23 entire continental shelf from sheltered bays and estuaries, over substrates of sand, rock, or mud,
24 to a depth of 200 m (Cross et al. 1999). The butterfish migrates annually in response to
25 seasonal changes in water temperature. During the summer, they migrate inshore into southern
26 New England and Gulf of Maine waters, and in winter they migrate to the edge of the continental
27 shelf in the Mid-Atlantic Bight (Cross et al. 1999).

28
29 The PNPS intake and discharge have the potential to adversely affect egg, larvae, juvenile, and
30 adult Atlantic butterfish EFH. Atlantic butterfish eggs and larvae have been consistently
31 collected in the PNPS entrainment sampling (Normandeau 2006a). They have also been
32 collected periodically in the impingement sampling (Normandeau 2006b). However, it is unlikely
33 that PNPS intake operations are adversely affecting butterfish as the species has not been
34 reported to be entrained or impinged in high numbers (ENSR 2000). Due to the small area
35 affected by the thermal plume and because the Atlantic butterfish would exhibit behavioral
36 avoidance if water temperatures are not within their preference range, it is unlikely that the PNPS
37 discharge would affect juvenile and adult Atlantic butterfish EFH. Continued operation of PNPS
38 may also have the potential to affect prey items of various life stages of the Atlantic butterfish,
39 either through entrainment of ichthyoplankton or via impingement of squid or small forage fish
40 species. Continued PNPS operations are likely to have a less than substantial adverse effect on
41 EFH for butterfish.

1 **Atlantic cod (*Gadus morhua*)**

2
3 EFH for Atlantic cod eggs, larvae, juveniles, adults, and spawning adults exists in the vicinity of
4 PNPS. EFH for eggs of the species exists in surface waters around the perimeter of the Gulf of
5 Maine, Georges Bank, and the eastern portion of the continental shelf off southern New England
6 in water depths less than 100 m (328 ft), and in temperatures below 12°C. Larval EFH for cod
7 exists in pelagic waters of the Gulf of Maine, Georges Bank, and the eastern portion of the
8 continental shelf off southern New England in depths of 30 to 70 m (98 to 230 ft), and
9 temperatures below 10°C. EFH for juvenile, adult, and spawning adult cod includes bottom
10 habitats with substrates of rocks, cobble, or gravel in the Gulf of Maine, Georges Bank, and the
11 eastern portion of the continental shelf off southern New England. Juvenile cod EFH includes
12 depths ranging from 25 to 75 m (82 to 246 ft), and water temperatures below 20°C. Adult and
13 spawning adult EFH requirements includes water depths from 10 to 150 m (33 to 492 ft) and
14 temperatures below 10°C (NMFS 2006). Peak spawning within Massachusetts Bay occurs in
15 January and February (Lough 2004).

16
17 As the cod become juveniles and adults, they are able to withstand deeper, colder, and more
18 saline water, and become more widely distributed (Fahay et al. 1999a). Some studies have
19 shown that juveniles tend to prefer shallow areas with cobble substrates, in order to avoid
20 predation (Gotceitas and Brown 1993 in Fahay et al. 1999a). Juveniles and younger adults tend
21 to consume pelagic and benthic invertebrates, while adult cod also feed on both crustaceans and
22 other fish, including sand lance, cancer crabs, and herring (*Clupea harengus*) (Lough 2004).
23 Within the temperate part of their range, including offshore New England, cod are non-migratory
24 and only make minor seasonal movements in response to temperature changes. At the
25 extremes of their range, including Labrador and south of the Chesapeake, the cod migrate
26 annually (Fahay et al. 1999a). In 2005, an analysis of juvenile populations resulted in a proposal
27 for the designation of HAPCs for the Atlantic cod, including areas within Cape Cod Bay
28 (Crawford et al. 2005).

29
30 The intake and discharge at PNPS have the potential to adversely affect a small portion of EFH
31 for all life stages of the Atlantic cod. Eggs and larvae of the Atlantic cod dominated entrainment
32 studies at PNPS (ENSR 2000, Normandeau 2006a). Atlantic cod life stages have also been
33 observed in the PNPS impingement sampling program (Normandeau 2006b). Due to the small
34 area affected by the thermal plume and because the Atlantic cod would exhibit behavioral
35 avoidance if water temperatures are not within their preference range, it is unlikely that the PNPS
36 discharge would affect juvenile and adult Atlantic cod EFH. Continued operation of PNPS may
37 also have the potential to affect prey items of juvenile and adult life stages of the Atlantic cod as
38 several prey items of the Atlantic cod (sand lance and herring) have been commonly reported in
39 the impingement and entrainment sampling program at PNPS. Continued operations of PNPS
40 may have a substantial adverse effect on EFH for Atlantic cod.

Atlantic halibut (*Hippoglossus hippoglossus*)

EFH for Atlantic halibut eggs, larvae, juveniles, adults, and spawning adults exists in the vicinity of PNPS. EFH for eggs includes the pelagic waters and sea floor of the Gulf of Maine and Georges Bank, with water depths less than 700 m (2296 ft) and temperatures between 4 to 7°C. For larvae, the EFH consists of surface waters of the Gulf of Maine and Georges Bank. Juvenile and adult EFH for the halibut includes bottom habitats with sand, gravel, or clay substrates in the Gulf of Maine and Georges Bank. Juvenile cod are found at water depths from 20 to 60 m (66 to 197 ft) and temperatures above 2°C. Adults are found in water depths from 100 to 700 m (328 to 2296 ft) and at temperatures below 13.6°C. Spawning adult EFH consists of bottom habitats with substrates of soft mud, clay, sand, or gravel in the Gulf of Maine and Georges Bank. Spawning adults are typically found in water depths less than 700 meters, and at temperatures below 7°C (NMFS 2006). Spawning is reported to occur in late fall or spring, with peak spawning between November and December (NEFMC 1998a in ENSR 2000). However, spawning is thought to no longer occur in the Gulf of Maine (Cargnelli et al. 1999b).

The eggs of the halibut are bathypelagic, suspended within the water column at a depth of 54 to 200 m (177 to 656 ft) (Scott and Scott 1988, Blaxter et al. 1983 in Cargnelli et al. 1999b). Both the eggs and larvae are pelagic. The larvae live within surface waters until they reach juvenile stage, at which time they transform into flatfish and move to the bottom (BMLSS 1997/8 in ENSR 2000). The diet of the Atlantic halibut changes through its lifespan. Juveniles and smaller adults prey mostly on invertebrates, including annelids and crustaceans. As they grow larger, the adults prey primarily on other fish (Kohler 1967 in Cargnelli et al. 1999b). In the Gulf of Maine, the primary prey is squid, crabs, silver hake, northern sand lance (*Ammodytes dubius*), ocean pout (*Macrozoarces americanus*), and alewife (*Alosa pseudoharengus*) (Cargnelli et al. 1999b). Juveniles live within their nursery areas until the age of 3 to 4 years, and after that time perform annual migrations (Stobo et al. 1988 in Cargnelli et al. 1999b).

The PNPS intake and discharge have the potential to adversely affect egg, larvae, juvenile, adult, and spawning adult Atlantic halibut EFH. However, it is unlikely that PNPS intake operations are adversely affecting juvenile and adult halibut as the species has not been reported to be entrained or impinged (Normandeau 2006a, Normandeau 2006b). Due to the small area affected by the thermal plume and because the Atlantic halibut would exhibit behavioral avoidance if water temperatures are not within their preference range, it is unlikely that the PNPS discharge would affect juvenile and adult Atlantic halibut EFH. Continued operation of PNPS may also have the potential to affect prey items of juvenile and adult life stages of the Atlantic halibut as several prey items of the Atlantic halibut (squid, northern sand lance, and alewife) have been commonly reported in the impingement and entrainment sampling program at PNPS. Continued PNPS operations are likely to have a minimal adverse effect on EFH for halibut.

1 **Atlantic mackerel (*Scomber scombrus*)**

2
3 EFH for Atlantic mackerel eggs, larvae, juveniles, and adults exists in the vicinity of PNPS. EFH
4 for offshore areas includes pelagic waters over the continental shelf from the Gulf of Maine to
5 Cape Hatteras. Inshore EFH for the mackerel includes the mixing or saline zones of estuaries
6 on the Atlantic coast, from Passamaquoddy Bay, Maine to James River, Virginia (NMFS 2006).
7 Mackerel eggs are found in water with depths ranging from the shore to 50 ft, and temperatures
8 between 41°F and 73°F. Larvae of the species are found at water depths ranging from 33 to 425
9 ft, between temperatures of 43°F and 72°F. Juvenile and adult mackerel are found in waters
10 from shore to 1250 ft deep, and with temperatures ranging from 37°F to 72°F (NMFS 2006).
11 Cape Cod Bay is reported to be an important spawning area in the months from May to August
12 (Studholme et al. 1999).
13

14 Both the eggs and larvae of the species are pelagic and transition from drifting pelagic to active
15 swimming when they reach a size of 30 to 50 mm (1.2 to 2 in.) (Sette 1943 in Studholme et al.
16 1999). The adult mackerel can feed both by filter feeding and by preying on individuals. The
17 prey consists of plankton such as amphipods, euphausiids, shrimp, crab larvae, small squid, and
18 fish eggs (Scott and Scott 1988 in ENSR 2000). The mackerel perform annual migrations, with
19 movement generally northeast and inshore in the spring, and offshore to deeper water in the
20 winter (ENSR 2000). Migration is closely related to seasonal temperature changes, as the
21 mackerel prefers to live in waters between temperatures of 6°C and 15°C (Overholtz and
22 Anderson 1976 in Studholme et al. 1999).
23

24 The intake and discharge at PNPS have the potential to adversely affect a small portion of EFH
25 for eggs, larvae, juvenile, and adult Atlantic mackerel. Eggs and larvae of the Atlantic mackerel
26 dominated entrainment samples at PNPS (ENSR 2000; Normandeau 2006a). Atlantic mackerel
27 have also been observed occasionally in the PNPS impingement sampling program
28 (Normandeau 2006b). Due to the small area affected by the thermal plume and because the
29 Atlantic mackerel would exhibit behavioral avoidance if water temperatures are not within their
30 preference range, it is unlikely that the PNPS discharge would affect juvenile and adult Atlantic
31 mackerel EFH. Continued operation of PNPS may also have the potential to affect prey items of
32 adult mackerel as several of its prey items (small squid and fish eggs) are commonly reported in
33 the impingement and entrainment sampling program at PNPS. Continued operations of PNPS
34 may have a substantial adverse effect on EFH for Atlantic mackerel.
35

36 **Atlantic sea herring (*Clupea harengus*)**

37
38 EFH for Atlantic sea herring eggs, larvae, juveniles, and adults exists in the vicinity of PNPS.
39 EFH for eggs is found in bottom habitats with substrates of gravel, sand, cobbles, or shell
40 fragments in the Gulf of Maine and Georges Bank. Eggs are typically found adhering to the
41 bottom at water depths of 20 to 80 m (66 to 262 ft), at temperatures below 15°C, and where tidal

1 currents result in well-mixed water. Larvae EFH includes pelagic waters of the Gulf of Maine,
2 Georges Bank, and southern New England that comprise 90 percent of the observed range of
3 the species. These areas typically have water depths ranging from 50 to 90 m (164 to 295 ft),
4 and water temperatures below 16°C. Juvenile and adult EFH exists for herring in pelagic water
5 and bottom habitats in the Gulf of Maine, Georges Bank, southern New England and the mid-
6 Atlantic region south to Cape Hatteras. These areas include water depths from 15 to 135 m
7 (49 to 443 ft), and water temperatures below 10°C. EFH for spawning adults exists in bottom
8 habitats with substrates of gravel, sand, cobble, and shell fragments in the Gulf of Maine,
9 Georges Bank, southern New England and the mid-Atlantic region south to Delaware Bay.
10 Spawning occurs in water depths of 20 to 80 m (66 to 262 ft), at temperatures below 15°C
11 (NMFS 2006). Spawning occurs in high energy environments with strong tidal action (Iles and
12 Sinclair 1982 in Stevenson and Scott 2005). In the Gulf of Maine and Georges Bank, spawning
13 occurs from July to December (Stevenson and Scott 2005).

14
15 The Atlantic sea herring lays eggs on the bottom, in gravel, rock, or shell substrates. The eggs
16 adhere to the bottom in layers and form beds (Bigelow and Schroeder 1953, Mansueti and Hardy
17 1967 in ENSR 2000). As juveniles, Atlantic herring form large aggregations in coastal areas.
18 Both the larvae and juveniles feed on zooplankton, including copepods (ENSR 2000). The
19 Atlantic herring of all life stages is preyed upon by other fishes, including cod, pollock
20 (*Pollachuis virens*), haddock (*Melanogrammus aeglefinus*), silver hake, mackerel, dogfish, fin
21 whales (*Balaenoptera physalus*), and squid (Hildenbrand 1963, Bigelow and Schroeder 1953 in
22 ENSR 2000), as well as other marine mammals and birds. Adult Atlantic herring feed on
23 zooplankton and capture prey by direct, predatory snapping action (Blaxter and Holliday 1963 in
24 ENSR 2000). There is an annual migration of adult Atlantic herring from summer feeding areas
25 along the Maine coast to southern New England (Stevenson and Scott 2005).

26
27 The intake and discharge at PNPS have the potential to adversely affect a small portion of EFH
28 for eggs, larvae, juvenile, and adult Atlantic sea herring. Larvae of the Atlantic sea herring
29 dominated entrainment samples at PNPS (ENSR 2000, Normandeau 2006a). Atlantic sea
30 herring have not been observed in the impingement sampling program at PNPS (Normandeau
31 2006b). Due to the small area affected by the thermal plume and because the Atlantic sea
32 herring would exhibit behavioral avoidance if water temperatures are not within their preference
33 range, it is unlikely that the PNPS discharge would affect juvenile and adult Atlantic sea herring
34 EFH. Continued operation of PNPS may also have the potential to affect prey items of larval,
35 juvenile, and adult stages of the Atlantic sea herring as it is a filter feeder on plankton and
36 entrainment by the plant removes plankton from the local environment. Continued operations of
37 PNPS are likely to have a less than substantial adverse effect on EFH for the Atlantic sea
38 herring.

1 **Atlantic sea scallop (*Placopecten magellanicus*)**

2
3 EFH for Atlantic sea scallop eggs, larvae, juveniles, adults, and spawning adults exists in the
4 vicinity of PNPS. EFH for eggs includes bottom habitats in the Gulf of Maine, Georges Bank,
5 and southern New England, with water temperatures below 17°C. Larvae EFH includes pelagic
6 waters and bottom habitats, in areas with substrates of gravelly sand, shell fragments, and
7 pebbles in the Gulf of Maine, Georges Bank, and south to North Carolina. EFH for juveniles,
8 adults, and spawning adults includes bottom habitats with cobble, shell, or sand in the Gulf of
9 Maine, Georges Bank, and south to North Carolina. Juveniles, adults, and spawning adults are
10 found at water depths from 18 to 110 m (59 to 361 ft), with temperatures generally below 21°C
11 (NMFS 2006). Spawning peaks between May and June in the mid Atlantic and in September
12 and October in Georges Bank, usually in water with temperatures below 16°C (NEFMC 1998a).
13

14 Eggs are not buoyant and remain on the substrate until hatching into free-swimming larvae
15 (NEFMC 1998a). Larvae occupy pelagic waters and bottom habitats of gravel, shell litter, algae,
16 or sedentary benthic infauna (NEFMC 1998a). North of Cape Cod, the sea scallop is generally
17 found at depths of less than 20 m (65 ft) on hard substrates of cobble, shell litter, or coarse
18 gravel/sand (NEFMC 1998a, Lai and Rago 1998 in ENSR 2000). Sea scallops are suspension
19 filter feeders and their diet typically consists of phytoplankton and microzooplankton (Hart and
20 Chute 2004).

21 The PNPS intake and discharge have the potential to adversely affect egg, larvae, juvenile,
22 adult, and spawning adult Atlantic sea scallop EFH. It is unlikely that PNPS intake operations
23 are adversely affecting eggs or larval sea scallops as the species has not been reported to be
24 entrained or impinged (ENSR 2000, Normandeau 2006a, Normandeau 2006b). The thermal
25 discharge is unlikely to affect sea scallop juveniles and adults because the affected area makes
26 up a tiny portion of their EFH. Continued operation of PNPS may also have the potential to
27 affect prey items of the Atlantic sea scallop as it is a filter feeder on plankton and entrainment by
28 the plant removes plankton from the local environment. Continued PNPS operations are likely to
29 have a minimal adverse effect on EFH for sea scallop.
30

31 **Black sea bass (*Centropristus striata*)**

32
33 EFH for juvenile and adult black sea bass exists in the vicinity of PNPS. Offshore EFH for both
34 juveniles and adults includes demersal waters over the continental shelf from the Gulf of Maine
35 to Cape Hatteras. For inshore areas, EFH is found in estuaries where black sea bass are found
36 to be common or abundant in the Estuarine Living Marine Resource (ELMR) database for the
37 mixing and seawater salinity zones. Both juveniles and adults prefer warm water (greater than
38 43°F), in areas where the bottom substrate includes rough bottom, shellfish, eelgrass beds, or
39 man-made or natural structured habitats (NMFS 2006, Jury et al. 1994). Spawning occurs on
40 the inner continental shelf, at water depths of 20 to 50 m (66 to 164 ft), between the Chesapeake

1 Bay and Long Island (Steimle et al. 1999d). Larvae have been reported in Cape Cod Bay, but
2 these are interpreted to have been spawned in Buzzards Bay and moved through the Cape Cod
3 Canal (MAFMC 1996b in Steimle et al. 1999d). Spawning in Massachusetts coastal waters
4 occurs on sandy bottoms broken by rocky ledges (Kolek 1990, MAFMC 1996b in Steimle et al.
5 1999d).

6
7 Eggs and larvae of the black sea bass are pelagic and are found in spawning areas on the
8 continental shelf (Steimle 1999d). As juveniles, the species moves inshore, where they form
9 nurseries in estuaries (et al. Able and Fahay 1998 in Steimle et al. 1999d). Juveniles mature as
10 females, and then change to males as they grow larger (Lavenda 1949 in Steimle et al. 1999d).
11 Larval black sea bass probably prey on zooplankton (Steimle et al. 1999d). The juveniles are
12 visual predators that feed on benthic crustaceans and small fish (Richards 1963, Allen et al.
13 1978, Werme 1981 in Steimle et al. 1999d). The species is primarily a warm-water fish and
14 begins to migrate offshore to depths of 30 to 240 m (98 to 787 ft) as bottom-water temperatures
15 reach 7°C (Steimle et al. 1999d).

16
17 The PNPS intake and discharge have the potential to adversely affect juvenile and adult black
18 sea bass EFH. However, it is unlikely that PNPS intake operations are adversely affecting
19 juvenile and adult black sea bass as the species has not been reported to be commonly
20 entrained or impinged (ENSR 2000, Normandeau 2006a, Normandeau 2006b). Due to the small
21 area affected by the thermal plume and because the black sea bass would exhibit behavioral
22 avoidance if water temperatures are not within their preference range, it is unlikely that the PNPS
23 discharge would affect juvenile and adult black sea bass EFH. Continued operation of PNPS
24 may also have the potential to affect prey items of various life stages of the black sea bass,
25 either through entrainment of zooplankton or ichthyoplankton, or via impingement of small forage
26 fish species. Continued PNPS operations are likely to have a minimal adverse effect on EFH for
27 black sea bass.

28 **Bluefin tuna (*Thunnus thynnus*)**

29
30
31 EFH for juvenile and adult bluefin tuna exists in the vicinity of PNPS. For juveniles, EFH includes
32 the inshore and pelagic waters warmer than 12°C in the Gulf of Maine and Cape Cod Bay, and
33 south to Florida. Adult EFH includes pelagic waters from the Gulf of Maine south to Texas, at
34 water depths greater than 50 m (164 ft) (NMFS 2006). Spawning for the bluefin tuna occurs from
35 mid-April to June in the Gulf of Mexico and Florida Straits (NMFS 2005c).

36
37 The prey of the bluefin tuna includes mackerel, herring, whiting (*Merluccius bilinearis*), and squid
38 (Buck 1995). The species is endothermic, meaning it generates heat internally, which allows it to
39 dive to deeper and colder waters in search of prey (NMFS 1999). The tuna can live in water
40 ranging from 7°C to 30°C (NMFS 1999). The bluefin tuna migrates extensively. Following

Appendix E

1 spawning in the Gulf of Mexico area in spring and early summer, the species migrates north
2 along the U.S. coast to waters off of Canada (Buck 1995).

3
4 The PNPS intake and discharge have the potential to adversely affect juvenile and adult bluefin
5 tuna EFH. However, it is unlikely that PNPS intake operations are adversely affecting juvenile
6 and adult bluefin tuna as the species has not been reported to be entrained or impinged (ENSR
7 2000, Normandeau 2006a, Normandeau 2006b). Due to the small area affected by the thermal
8 plume and because the bluefin tuna would exhibit behavioral avoidance if water temperatures
9 are not within their preference range, it is unlikely that the PNPS discharge would affect juvenile
10 and adult bluefin tuna EFH. Continued operation of PNPS may also have the potential to affect
11 prey items of juvenile or adult life stages of the bluefin tuna as several prey items of the bluefin
12 tuna (mackerel, herring, whiting, and squid) have been commonly reported in the impingement
13 and entrainment sampling program at PNPS. Continued PNPS operations are likely to have a
14 minimal adverse effect on EFH for bluefin tuna.

15 **Bluefish (*Pomatomus saltatrix*)**

16
17
18 EFH for adult bluefish exists in the vicinity of PNPS (EFH for eggs, larvae, and juveniles does not
19 occur as far north as Cape Cod Bay) (NMFS 2006). EFH for adults includes all major estuaries
20 from Penobscot Bay, Maine to St. Johns River, Florida; also, north of Cape Hatteras EFH for
21 adults includes continental shelf waters north to Cape Cod Bay. Adult bluefish are typically in
22 North Atlantic estuaries from June to October. EFH requirements for adult bluefish include
23 saline, pelagic waters with temperatures between 14 °C and 16 °C.

24
25 Bluefish is a migratory, pelagic species found in temperate coastal zones throughout the world
26 and are very common along along the east coast of the U.S. (Shepherd 2000b). Within the
27 western Atlantic, bluefish are found from Maine to Florida, migrating northward in the spring and
28 southward in the fall (ENSR 2000). Bluefish migrate in response to temperature changes in
29 order to remain in water with temperatures above 14 to 16 °C (Bigelow and Schroeder 1953 in
30 Shepherd and Packer 2006). They live in southern New England waters in spring and summer,
31 and migrate to waters off the southeastern U.S. in autumn (Shepherd and Packer 2006).
32 Bluefish reach sexual maturity at the age of two years (Deuel 1964, in Shepherd and Packer
33 2006; ENSR 2000). Spawning occurs in the area from New York south to Florida (Shepherd and
34 Packer 2006). Bluefish eggs and larvae are buoyant and live within surface waters, only within
35 open oceanic waters (Able and Fahay 1998 in Shepherd and Packer 2006). The larvae feed on
36 surface plankton until they reach juvenile stage, and then migrate to coastal nursery areas to
37 feed on other fish species (Kendall and Watford 1979, in ENSR 2000; Sheperd and Packer
38 2006). Adult bluefish are voracious predators, and prey on squid, shrimp, crabs, alewives,
39 menhaden, silver hake, butterfish and smaller bluefish (ENSR 2000).

1 The intake and discharge at PNPS have the potential to adversely affect EFH for adult bluefish.
2 Bluefish juveniles and adults are reported to have been observed in the vicinity of PNPS (ENSR
3 2000). No life stages of the bluefish have ever been observed in the PNPS entrainment
4 sampling. Juveniles and/or adults have been observed in the PNPS impingement sampling
5 program. Due to the small area affected by the thermal plume and because the bluefish would
6 exhibit behavioral avoidance if water temperatures are not within their preference range, it is
7 unlikely that the PNPS discharge would affect adult bluefish EFH. Some prey species are
8 entrained and impinged at PNPS; however, because adult bluefish opportunistically feed on
9 many invertebrate and vertebrate species, the effect of reduced prey availability is expected to
10 be negligible. Continued PNPS operations are likely to have a minimal adverse effect on EFH
11 for bluefish.

12 13 **Haddock (*Melanogrammus aeglefinus*)**

14
15 EFH for haddock eggs and larvae exists in the vicinity of PNPS. EFH for eggs of the species is
16 found in coastal areas of the Gulf of Maine in water with temperatures below 10°C and depths
17 from 50 to 90 m (164 to 295 ft). Larval EFH includes surface waters from Georges Bank south to
18 Delaware Bay, in water with temperatures below 14°C and depths ranging from 35 to 100 m (115
19 to 328 ft) (NMFS 2006). Spawning varies by location and time of year, with spawning generally
20 occurring from February to May in the Gulf of Maine. The largest spawning area in U.S waters is
21 Georges Bank, and for the Gulf of Maine stock, spawning occurs at the Jeffrey's Ledge and
22 Stellwagen Bank areas (Brodziak 2005 in Cargnelli et al. 1999e).

23
24 Eggs, larvae, and juveniles all live within the upper part of the water column until the juveniles
25 reach a size of 3 to 10 cm (1.2 to 3.9 in.) (Brodziak 2005 in Cargnelli et al. 1999e). At that time,
26 juveniles travel to the bottom, identify suitable habitat, and become demersal (Klein-MacPhee
27 2002 in Cargnelli et al. 1999e). The diet of haddock changes through their life cycle. Larvae and
28 small juveniles feed on phytoplankton, copepods, and invertebrate eggs suspended in the water
29 column. Once juveniles move to the bottom, they primarily eat small crustaceans, polychaetes,
30 and small fish. As adults, haddock feed primarily on benthic organisms such as echinoderms,
31 crustaceans, polychaetes, and mollusks (Brodziak 2005 in Cargnelli et al. 1999e). There are
32 data that suggest larvae drift with currents from Canadian waters as far south as Cape Cod, and
33 then live a portion of their lives in this area (Colton and Temple 1961 in Cargnelli et al. 1999e).
34 Haddock are not migratory, with only minor movements shoreward in summer and to deeper
35 water in winter (Brodziak 2005 in Cargnelli et al. 1999e).

36
37 The PNPS intake and discharge have the potential to adversely affect egg and larval haddock
38 EFH. However, it is unlikely that PNPS intake operations are adversely affecting haddock as
39 eggs and larvae are not common in entrainment sampling program (Normandeau 2006a). None
40 of the haddock life stages have been observed in the PNPS impingement monitoring program
41 (Normandeau 2006b). Continued operation of PNPS may also have the potential to affect prey

Appendix E

1 items of various life stages of the haddock, either through entrainment of plankton, or via
2 impingement of small forage fish species. Continued PNPS operations are likely to have a
3 minimal adverse effect on EFH for haddock.
4

5 **Little skate (*Leucoraja erinacea*)**

6

7 EFH for little skate juveniles and adults exists in the vicinity of PNPS. In the 2003 FMP for the
8 Northeast Skate Complex (NEFMC 2003), EFH was designated for the little skate. This
9 designation included bottom habitats with substrates of sand, gravel, and mud in Cape Cod Bay
10 for both juveniles and adults (NEFMC 2003). Little skate have a reported depth range of 0 to 137
11 m (449 ft), with most being found less than about 100 m (328 ft) deep (Bigelow and Schroeder
12 1953,; McEachran and Musick 1975 in Packer et al. 2003b). The corresponding water
13 temperature ranges from 1 to 21°C (Bigelow and Schroeder 1953; Tyler 1971; McEachran and
14 Musick 1975 in Packer et al. 2003b). Little skates typically prefer sandy or gravelly substrates
15 (Bigelow and Schroeder 1953 in Packer et al. 2003b) and are known to bury themselves in
16 depressions during the day (Michalopoulos 1990 in Packer et al. 2003b).
17

18 Eggs of all skates are encapsulated in a leathery capsule that rests on the bottom (Sosebee
19 2000; Packer et al. 2003b). The eggs hatch fully developed, so there is no larval stage (Sosebee
20 2000; McEachran 2002 in Packer et al. 2003b). Adults are estimated to reach sexual maturity at
21 the age of 4 years (Packer et al. 2003b). Spawning may occur at any time during the year, with
22 a peak in southern New England from July to September (Bigelow and Schroeder 1953 in
23 Packer et al. 2003b). The major prey reported for the little skate in the Gulf of Maine area
24 includes decapod crustaceans, amphipods, and polychaetes (McEachran 1973; McEachran et
25 al. 1976 in Packer et al. 2003b). Skates do not migrate substantially but do generally move
26 offshore in summer and early autumn and onshore during winter and spring (Sosebee 2000).
27 Bottom trawl surveys found juvenile little skates in heavy concentrations nearshore in Cape Cod
28 Bay in the spring (Packer et al. 2003b). Adults were also found in Cape Cod Bay during the
29 spring, summer, and fall (Packer et al. 2003b).
30

31 The PNPS intake and discharge have the potential to adversely affect EFH for the little skate.
32 However, it is unlikely that PNPS intake operations are adversely affecting juvenile and adult
33 little skate as the species has not been reported to be entrained (Normandeau 2006a). The little
34 skate has been observed in the impingement sampling program at PNPS; however, it is not
35 common (Normandeau 2006b). Due to the small area affected by the thermal plume and
36 because the little skate would exhibit behavioral avoidance if water temperatures are not within
37 their preference range, it is unlikely that the PNPS discharge would affect juvenile and adult little
38 skate EFH. It is unlikely that continued operation of PNPS would have an impact on prey items of
39 the little skate, as its diet consists primarily of benthic invertebrates. Continued PNPS operations
40 are likely to have a minimal adverse effect on EFH for the little skate.
41

Longfin squid (*Loligo pealei*)

EFH for longfin squid juveniles and adults exists in the vicinity of PNPS. EFH for both juveniles and adults includes pelagic waters over the continental shelf from the Gulf of Maine to Cape Hatteras. Both juveniles and adults are typically found in water with temperatures ranging from 39°F to 81°F, and in water depths ranging from the shore to 700 ft (for juveniles) and shore to 1000 ft (for adults) (NMFS 2006). The species is known to spawn year-round, which can vary geographically (Brodziak et al. 1996, and Hatfield et al. 2002 in Jacobson 2005).

Food habits of longfin squid depend on size: small individuals consume planktonic organisms (Vovk 1972, Tibbetts 1977 in Cargnelli et al. 1999a), whereas larger individuals consume crustaceans and small fish (Vinogradov and Noskov 1979 in Cargnelli et al. 1999a). Seasonal and inshore/offshore variances in the diets of longfin squid were demonstrated by Maurer and Bowman (1985 in Cargnelli et al. 1999a). Longfin squid are typically observed in waters with temperatures of at least 9°C (Lange and Sissenwine 1980 in Cargnelli et al. 1999a). During late autumn to winter, longfin squid migrate to warmer waters along the edge of the continental shelf (Cadrin 2000 in ENSR 2000). During the spring and early summer, the species moves inshore to spawn (Cadrin 2000 in ENSR 2000).

The intake and discharge at PNPS have the potential to adversely affect a small portion of EFH for juvenile and adult longfin squid. The longfin squid is reported to be one of the most commonly impinged species identified in impingement studies at PNPS (ENSR 2000). It has not been observed in the entrainment sampling at PNPS (Normandeau 2006a). Due to the small area affected by the thermal plume and because the longfin squid would exhibit behavioral avoidance if water temperatures are not within their preference range, it is unlikely that the PNPS discharge would affect juvenile and adult longfin squid EFH. Continued operation of PNPS may also have the potential to affect prey items of juvenile or adult longfin squid, either through entrainment of plankton, or via impingement of small forage fish species. Continued operations of PNPS are likely to have a less than substantial adverse effect on EFH for the longfin squid.

Monkfish (*Lophius americanus*)

EFH for eggs, larval, and adult monkfish exists in the vicinity of PNPS. EFH for monkfish eggs includes surface waters of the Gulf of Maine, Georges Bank, and southern New England to North Carolina. The eggs are mostly found in water depths ranging from 15 to 1000 m (49 to 3281 ft), and at temperatures below 18°C. Larval EFH exists in pelagic waters of the Gulf of Maine, Georges Bank, and southern New England to North Carolina. This includes areas where water temperatures are below 18°C and water depth ranges from 25 to 1000 m (82 to 3281 ft). Adult monkfish EFH is found in bottom habitats with substrates of sand-shell mix, algae covered rocks, hard sand, pebbly gravel, or mud in the Gulf of Maine, Georges Bank, and southern New

Appendix E

1 England to the mid-Atlantic. Adult monkfish typically live in water depths from 25 to 200 m (82 to
2 656 ft), and at temperatures below 15°C (NMFS 2006).

3
4 Spawning occurs in locations including inshore shoals and offshore surface water, in
5 temperatures below 18°C, in the months from May to June within the Gulf of Maine (Scott and
6 Scott 1988, Hartley 1995 in Steimle et al. 1999b). Eggs are buoyant and are laid in rafts that
7 may be up to 6 to 12 m (20 to 39 ft) long (Steimle et al. 1999b). Larvae and juveniles are also
8 pelagic and eventually descend to the bottom to live their adult lifespan as benthic fish (NOAA
9 1998a in ENSR 2000). Once they have settled to the bottom, juveniles prefer a substrate of
10 sand-shell mix, algae covered rocks, hard sand, pebbly gravel, or mud, with water temperatures
11 below 15°C (NEFMC 1998a in ENSR 2000). Adults spend most of their lives resting on the
12 bottom in depressions within sandy sediment (Steimle et al. 1999b). The larvae feed on
13 zooplankton, including copepods and crustacean larvae, while juveniles eat smaller fish,
14 including sand lance, and shrimp and squid (Bigelow and Schroeder 1953 in Steimle et al.
15 1999b). Adults eat a variety of benthic and pelagic species, sea birds, and even younger
16 monkfish, and they capture prey with an ambush or sudden rush (Steimle et al. 1999b). The
17 monkfish has annual migrations in response to spawning preference and food availability.

18
19 The PNPS intake and discharge have the potential to adversely affect egg, larvae, and adult
20 monkfish EFH. Monkfish eggs and larvae have been consistently collected in the PNPS
21 entrainment sampling program (Normandeau 2006a). They are only infrequently collected as
22 part of the PNPS impingement sampling program (Normandeau 2006b). Due to the small area
23 affected by the thermal plume and because the monkfish would exhibit behavioral avoidance if
24 water temperatures are not within their preference range, it is unlikely that the PNPS discharge
25 would affect adult monkfish EFH. Continued operation of PNPS may also have the potential to
26 affect prey items of various life stages of the monkfish, as several prey items of the monkfish
27 (zooplankton, sand lance, and squid) have been commonly reported in the impingement and
28 entrainment sampling program at PNPS. Continued PNPS operations are likely to have a less
29 than substantial adverse effect on EFH for the monkfish.

30 31 **Ocean pout (*Macrozoarces americanus*)**

32
33 EFH for ocean pout eggs, larvae, juveniles, adults, and spawning adults exists in the vicinity of
34 PNPS. EFH for eggs, larvae, juveniles, and adults includes bottom habitats in the Gulf of Maine,
35 Georges Bank, southern New England and the mid-Atlantic region south to Delaware Bay. Eggs
36 and larvae are typically found at water depths less than 50 m (164 ft), and at temperatures below
37 10°C. EFH for juveniles and adults includes water depths up to 110 m (361 ft) and temperatures
38 below 15°C (NMFS 2006). Spawning adult EFH consists of areas with hard bottom substrates,
39 including artificial reefs or shipwrecks, in the Gulf of Maine, Georges Bank, southern New
40 England, and the mid-Atlantic region south to Delaware Bay. Spawning usually occurs in water
41 less than 50 m (164 ft) deep and at temperatures below 10°C.

1 The species lays eggs in nests, which it then guards until they hatch (Steimle et al. 1999c). Both
2 the larvae and adults are demersal and are not known to form schools (Steimle et al. 1999c).
3 There are differing reports on how the ocean pout feeds. According to a report by MacDonald
4 (1983 in Steimle et al. 1999c), ocean pout feed by sorting through mouthfuls of sediment for
5 fauna contained within the sediment and do not appear to visually follow prey or leave the bottom
6 to feed. However, Auster (1985 in Steimle et al. 1999c) reported that ocean pout hide within
7 sediment depressions to wait for prey to swim or drift by. The prey is reported to consist of
8 echinoderms, crustaceans, and other benthic invertebrates (Anderson 1994 in ENSR 2000). The
9 ocean pout does not migrate, although it moves seasonally within a limited region (Bigelow and
10 Schroeder 1953 in Steimle et al. 1999c). Juvenile ocean pout were reported to be commonly
11 found in saline water (greater than 25 ppt) in many estuaries and coastal areas, including Cape
12 Cod Bay, throughout the year (Jury et al. 1994 in Steimle et al. 1999c).
13

14 The PNPS intake and discharge have the potential to adversely affect egg, larvae, juvenile,
15 adult, and spawning adult ocean pout EFH. It is unlikely that PNPS intake operations are
16 adversely affecting ocean pout as the species has not been reported to be entrained
17 (Normandeau 2006a). It has only been infrequently observed in the impingement sampling
18 program (Normandeau 2006b). Due to the small area affected by the thermal plume and
19 because the ocean pout would exhibit behavioral avoidance if water temperatures are not within
20 their preference range, it is unlikely that the PNPS discharge would affect juvenile and adult
21 ocean pout EFH. It is unlikely that continued operation of PNPS would have a impact on prey
22 items of the ocean pout, as its diet consists primarily of benthic invertebrates. Continued PNPS
23 operations are likely to have a minimal adverse effect on EFH for the ocean pout.
24

25 **Ocean quahog (*Artica islandica*)**

26

27 EFH for ocean quahog juveniles and adults exists in the vicinity of PNPS. EFH for both juveniles
28 and adults includes the substrate to a depth of 3 ft below the sediment/water interface from the
29 eastern edge of the Georges Bank and Gulf of Maine throughout the Atlantic exclusive economic
30 zone (EEZ). Both juveniles and adults are typically found in water with temperatures below 60°F,
31 and in water depths ranging from 30 to 800 feet (NMFS 2006). In the Gulf of Maine region, they
32 are found in relatively nearshore waters (Weinberg 2001).
33

34 Similar to surf clams, ocean quahogs are planktivorous siphon feeders and are preyed upon by
35 moon snails, boring snails, and predatory fish such as haddock and cod (Cargnelli et al. 1999d).
36 Estimates for attaining sexual maturity have ranged from 9 to 13 years (Cargnelli et al. 1999d).
37

38 The PNPS intake and discharge have the potential to adversely affect juvenile and adult ocean
39 quahog EFH. However, it is unlikely that PNPS intake operations are adversely affecting eggs or
40 larval ocean quahog as the species has not been reported to be entrained or impinged (ENSR
41 2000, Normandeau 2006a, Normandeau 2006b). The thermal discharge is unlikely to affect

Appendix E

1 ocean quahog juveniles and adults because the affected area makes up a tiny portion of their
2 EFH. Due to the small area affected by the thermal plume and because the ocean quahog
3 would exhibit behavioral avoidance if water temperatures are not within their preference range, it
4 is unlikely that the PNPS discharge would affect juvenile and adult ocean quahog EFH.
5 Continued operation of PNPS may also have the potential to affect prey items of the ocean
6 quahog as it is a filter feeder on plankton and entrainment by the plant removes plankton from
7 the local environment.

8
9 Continued PNPS operations are likely to have a minimal adverse effect on EFH for the ocean
10 quahog.

11 **Pollock (*Pollachius virens*)**

12
13
14 EFH for pollock larvae, juveniles, and adults exists in the vicinity of PNPS. EFH for eggs and
15 larval pollock includes pelagic waters of the Gulf of Maine and Georges Bank in water depths
16 from 10 to 270 m (33 to 886 ft) and at water temperatures below 17°C. Juvenile, adult, and
17 spawning adult EFH consists of bottom habitats with hard substrates, including artificial reefs,
18 sand, mud, or rocks in the Gulf of Maine and Georges Bank. Juvenile pollock are found at water
19 depths from 0 to 250 m (820 ft) and at temperatures below 18°C. Adult and spawning adult
20 pollock are found at water depths ranging from 15 to 365 m (49 to 1197 ft), and temperatures
21 below 14°C (adults) and 8°C (spawning adults) (NMFS 2006). The western Gulf of Maine,
22 including Massachusetts Bay, is one of the principal spawning sites for pollock (Cargnelli et al.
23 1999g). Spawning in the Gulf of Maine occurs from November to February (Steele 1963, Colton
24 and Marak 1969 in Cargnelli et al. 1999e), at water temperatures from 4.5°C to 6°C (Cargnelli et
25 al. 1999g). Eggs are spawned on hard substrates in water depths between 10 and 365 m (33 to
26 1197 ft) (NEFMC 1998a in ENSR 2000).

27
28 Pollock eggs and larvae are pelagic until the larvae reach an age of about 3 to 4 months. At that
29 time, the small juveniles migrate inshore and inhabit rocky subtidal and intertidal zones. At the
30 end of their second year, the juveniles move offshore, where they remain through their adult life
31 (Cargnelli et al. 1999g). Larvae living in near-surface waters feed on larval copepods (Steele
32 1963 in Cargnelli et al. 1999g), while juvenile pollock feed on crustaceans (Cargnelli et al.
33 1999g) and fish, including young Atlantic herring (Ojeda and Dearborn 1991 in Cargnelli et al.
34 1999g). The primary food source for adults is euphausiids (*Meganyctiphanes norvegica*) and
35 Atlantic herring (Cargnelli et al. 1999g). Pollock is a schooling species, but do not have
36 substantial migration, expect for small movements related to temperature change (Hardy 1978 in
37 Cargnelli et al. 1999g).

38
39 The PNPS intake and discharge have the potential to adversely affect juvenile and adult pollock
40 EFH. However, it is unlikely that PNPS intake operations are adversely affecting pollock as eggs
41 and larvae are only periodically entrained (Normandeau 2006a) and other life stages have also

1 not been commonly reported in the impingement sampling program (Normandeau 2006b). Due
2 to the small area affected by the thermal plume and because the pollock would exhibit behavioral
3 avoidance if water temperatures are not within their preference range, it is unlikely that the PNPS
4 discharge would affect juvenile and adult pollock EFH. Continued operation of PNPS may also
5 have the potential to affect prey items of various life stages of the pollock, as several prey items
6 of the pollock (zooplankton and herring) have been commonly reported in the impingement and
7 entrainment sampling program at PNPS. Continued PNPS operations are likely to have a
8 minimal adverse effect on EFH for the pollock.
9

10 **Red hake (*Urophycis chuss*)**

11
12 EFH for red hake eggs, larvae, juveniles, and adults exists in the vicinity of PNPS. EFH for eggs
13 and larval red hake includes surface waters of the Gulf of Maine, Georges Bank, the continental
14 shelf off southern New England, and the mid-Atlantic region south to Cape Hatteras. Red hake
15 eggs are found in water at temperatures below 10°C. Larvae are found at water depths less than
16 200 m (656 ft) and at temperatures below 19°C. Juveniles, adults, and spawning adults are all
17 found in bottom habitats, with juveniles preferring substrates of shell fragments and live scallops,
18 and adults and spawning adults being found near substrates of sand and mud. The juveniles,
19 adults, and spawning adults are all typically found in waters less than 100 m (328 ft) deep and in
20 water temperatures below about 16°C (NMFS 2006). Spawning occurs in water at temperatures
21 of 5°C to 10°C (Steimle et al. 1999a), within depressions in muddy or sandy substrates (NEFMC
22 1998a in ENSR 2000). The primary spawning grounds include the southern edge of Georges
23 Bank and shallow areas off of the southern New England coast (Sosebee 1998 in ENSR 2000).
24

25 Both the eggs and larvae of the red hake are pelagic, occurring in surface waters less than 10°C
26 (eggs) and 19°C (larvae) (NEFMC 1998a in ENSR 2000). Shelter is an important habitat
27 requirement for red hake (Steiner et al. 1982 in Steimle et al. 1999a). When the fish become
28 juveniles, they migrate to shallower waters along the coast and live among shell litter or live
29 scallop beds (Cohen et al. 1990, NEFMC 1998a in ENSR 2000). Adult red hake typically live in
30 areas with soft sediment bottoms and, less commonly, near gravel or rock bottoms (Steimle et al.
31 1999a). Larvae feed mainly on copepods and other micro-crustaceans (Steimle et al. 1999a).
32 Juvenile red hake feed primarily on crustaceans such as amphipods and shrimp. The adults
33 feed on amphipods and shrimp, as well as squid, herring, various flatfish species, and mackerel
34 (Cohen et al. 1990 in ENSR 2000). Red hake migrate extensively due to seasonal and
35 temperature variations. During winter, they live offshore in water greater than 100 m (328 ft)
36 deep, but in summer, red hake migrate into shallow coastal water and estuaries of the Gulf of
37 Maine, and live in water less than 10 m (33 ft) deep (Steimle et al. 1999a).
38

39 The PNPS intake and discharge have the potential to adversely affect egg, larvae, juvenile,
40 adult, and spawning adult red hake EFH. Eggs and larvae have been consistently observed in
41 the PNPS entrainment sampling program (Normandeau 2006a). Red hake have also been

Appendix E

1 commonly observed in the PNPS impingement sampling program (Normandeau 2006b). However
2 the area affected by the intake system is small and, thus, impacts to red hake EFH are not
3 expected. Due to the small area affected by the thermal plume and because the red hake would
4 exhibit behavioral avoidance if water temperatures are not within their preference range, it is
5 unlikely that the PNPS discharge would affect juvenile and adult red hake EFH. Continued
6 operation of PNPS may also have the potential to affect prey items of various life stages of the
7 red hake, as several prey items of the red hake (zooplankton, squid, herring, flatfish species, and
8 mackerel) have been commonly reported in the impingement and entrainment sampling program
9 at PNPS. Continued PNPS operations may have a substantial adverse effect on EFH for the red
10 hake.

11 **Scup (*Stenotomus chrysops*)**

12
13
14 EFH for scup eggs, larvae, juvenile, and adults exists in the vicinity of PNPS. For eggs and
15 larvae, EFH includes estuaries where scup were identified as common or abundant in the ELMR
16 database for the mixing and seawater salinity zones (NMFS 2006, Jury et al. 1994). EFH for
17 juveniles and adults in offshore areas includes demersal waters over the Continental Shelf from
18 the Gulf of Maine to Cape Hatteras. EFH for juveniles and adults in inshore areas includes
19 estuaries where scup are identified as being common or abundant in the ELMR database for the
20 mixing and seawater salinity zones (NMFS 2006, Jury et al. 1994). Both juvenile and adult scup
21 EFH occurs in waters where temperatures are greater than 45°F (NMFS 2006). Southern New
22 England, including Massachusetts Bay, is considered to be a primary spawning area for scup
23 (Steimle et al. 1999f). Scup spawn in shallow shoal waters less than 10 m (33 ft) deep until late
24 June, and then move to deeper water (MAFMC 1996a in Steimle et al. 1999f).

25
26 Both eggs and larvae are pelagic, and the larvae become demersal in shoal areas in early July
27 (Able and Fahay 1998 in Steimle et al. 1999f). The adults can occupy a variety of benthic
28 habitats, from open water to structured areas (Steimle et al. 1999f). Both juvenile and adult scup
29 are benthic feeders. Adults eat small crustaceans, polychaetes, mollusks, small squid,
30 vegetable detritus, insect larvae, sand dollars, and small fish (Bigelow and Schroeder 1953,
31 Morse 1978, Sedberry 1983 in Steimle et al. 1999f). Smaller scup are frequently found in bays
32 and estuaries, but larger adult scup usually live in deeper water ranging from 70 to 180 m (230 to
33 590 ft) (Steimle et al. 1999f). Larval scup were reported in Cape Cod Bay in May through
34 September, in water with temperatures of 14°C to 22°C (MAFMC 1996a in Steimle et al. 1999f).

35
36 The PNPS intake and discharge have potential to adversely affect egg, larvae, juvenile, and
37 adult scup EFH. However, it is unlikely that PNPS intake operations are adversely affecting scup
38 as eggs and larvae have only been infrequently observed in the entrainment sampling program
39 (Normandeau 2006a) and are not common in the impingement sampling program (Normandeau
40 2006b). Due to the small area affected by the thermal plume and because the scup would
41 exhibit behavioral avoidance if water temperatures are not within their preference range, it is

1 unlikely that the PNPS discharge would affect juvenile and adult scup EFH. Continued operation
2 of PNPS may also have the potential to affect prey items of various life stages of the scup, as
3 several prey items of the scup (squid and small fish species) have been commonly reported in
4 the impingement and entrainment sampling program at PNPS. Continued PNPS operations are
5 likely to have a minimal adverse effect on EFH for the scup.

6 7 **Shortfin squid (*Illex illecebrosus*)**

8
9 EFH for shortfin squid juveniles and adults exists in the vicinity of PNPS. EFH for both juveniles
10 and adults includes pelagic waters over the continental shelf from the Gulf of Maine to Cape
11 Hatteras. Both juveniles and adults are typically found in water with temperatures ranging from
12 39°F to 73°F, and at water depths ranging from the shore to 600 ft (NMFS 2006).

13 The shortfin squid is highly migratory and is found primarily in the offshore waters of the
14 continental shelf and slope from Florida to Labrador (Hendrickson 2000 in ENSR 2000).
15 Individuals experience an extensive spawning migration to warmer waters south of Cape
16 Hatteras during the autumn (Hendrickson 2000 in ENSR 2000). Peak spawning occurs during
17 the winter, and larvae and juveniles are conveyed northward in the warm waters of the Gulf
18 Stream (Hendrickson 2000 in ENSR 2000). The squid that spawned throughout the winter will
19 migrate during late spring onto the continental shelf (Hendrickson 2000 in ENSR 2000). The diet
20 of the shortfin squid typically consists of fish and crustaceans (Squires 1957; Froerman 1984,
21 Mauer and Bowman 1985; Dawe 1988 in Cargnelli et al. 1999a).

22 The PNPS intake and discharge have the potential to adversely affect juvenile and adult shortfin
23 squid EFH. It is unlikely that PNPS intake operations are adversely affecting juvenile and adult
24 shortfin squid as the species has not been entrained or impinged at PNPS (Normandeau 2006a;
25 Normandeau 2006b). Due to the small area affected by the thermal plume and because the
26 shortfin squid would exhibit behavioral avoidance if water temperatures are not within their
27 preference range, it is unlikely that the PNPS discharge would affect juvenile and adult shortfin
28 squid EFH. Continued operation of PNPS may also have the potential to affect prey items of
29 various life stages of the shortfin squid, as one of their prey items (small fish species) have been
30 commonly reported in the impingement and entrainment sampling program at PNPS.
31 Continued PNPS operations are likely to have a minimal adverse effect on EFH for the shortfin
32 squid.

33 34 **Smooth skate (*Malacoraja senta*)**

35
36 EFH for smooth skate juveniles exists in the vicinity of PNPS. In the 2003 FMP for the Northeast
37 Skate Complex (NEFMC 2003), EFH was designated for the smooth skate. This designation
38 included bottom habitats with substrates of sand, gravel, broken shell, pebbles, and soft mud in
39 the Gulf of Maine, including portions of Cape Cod Bay, for juveniles (NEFMC 2003). The water

Appendix E

1 depth range for the smooth skate is from 31 to 874 m (102 to 2867 ft), with most being found
2 from 110 to 457 m (361 to 1499 ft) (McEachran and Musick 1975, McEachran 2002 in Packer et
3 al. 2003d). The temperature range of the species is from 2°C to 13°C for juveniles and adults,
4 with most found between temperatures of 4°C to 8°C (Packer et al. 2003d). The smooth skate is
5 found mostly on bottom substrates of soft mud and fine sediments (Bigelow and Schroeder 1953,
6 McEachran and Musick 1975, Scott 1982 in Packer et al. 2003d).

7
8 Little information is known of the life history of the smooth skate (Packer et al. 2003d). Eggs of
9 all skates are known to be encapsulated in a leathery capsule that rests on the bottom (Sosebee
10 2000, Packer et al. 2003d). The eggs hatch fully developed, so there is no larval stage
11 (Sosebee 2000, McEachran 2002 in Packer et al. 2003d). Females with fully formed egg
12 capsules are found in both summer and winter (McEachran 2002 in Packer et al. 2003d), but no
13 other information on spawning times or locations is available. The primary food source for the
14 smooth skate is epifaunal crustaceans, with decapod shrimps and mysids also being important
15 (McEachran 1973, McEachran et al. 1976, Bowman et al. 2000, McEachran 2002 in Packer et al.
16 2003d). Skates do not migrate substantially, but do generally move offshore in summer and
17 early autumn, and onshore during winter and spring (Sosebee 2000). No seasonal trends in
18 abundance were identified by McEachran and Musick (1975 in Packer et al. 2003d). Inshore
19 trawl surveys in Massachusetts identified juveniles in both the spring and fall near Cape Cod Bay
20 (Packer et al. 2003d).

21
22 The PNPS intake and discharge have the potential to adversely affect EFH for the smooth skate.
23 However, it is unlikely that PNPS intake operations are adversely affecting juvenile smooth
24 skate as the species has not been entrained or impinged at PNPS (Normandeau 2006a,
25 Normandeau 2006b). Due to the small area affected by the thermal plume and because the
26 smooth skate would exhibit behavioral avoidance if water temperatures are not within their
27 preference range, it is unlikely that the PNPS discharge would affect juvenile smooth skate EFH.
28 It is unlikely that continued operation of PNPS would have a impact on prey items of the smooth
29 skate, as its diet consists primarily of benthic invertebrates. Continued PNPS operations are
30 likely to have a minimal adverse effect, if any, on EFH for the smooth skate.

31 32 **Spiny dogfish (*Squalus acanthias*)**

33
34 EFH for spiny dogfish juveniles and adults exists in the vicinity of PNPS. EFH for both juveniles
35 and adults includes both offshore and inshore habitats. The offshore EFH includes waters of the
36 continental shelf in areas that encompass the highest 90 percent of all ranked 10-minute squares
37 for the area where juvenile dogfish were collected in the NEFSC trawl surveys. Inshore EFH
38 encompasses the saline portions of the estuaries where dogfish are common or abundant on the
39 Atlantic coast, from Passamaquoddy Bay, Maine to Cape Cod Bay, Massachusetts. Both
40 juveniles are typically found in water with temperatures ranging from 37°F to 82°F, and at water
41 depths ranging from 33 to 1476 ft (NMFS 2006).

1 The adult spiny dogfish is a voracious and opportunistic predator and is reported to prey on a
2 variety of fish, mollusks, and crustaceans. The species travels in large packs and attacks
3 schools of fish, including cod, haddock, capelin (*Mallotus villasus*), mackerel, herring, and sand
4 lance (McMillan and Morse 1999). Spiny dogfish migrate annually in schools from winter habitat
5 on the edge of the continental shelf to summer habitat in the Gulf of Maine and Georges Bank.
6 Trawl surveys conducted in Massachusetts identified an abundance of adult spiny dogfish within
7 Cape Cod Bay in the spring. Both juveniles and adults were abundant within Cape Cod Bay in
8 the fall (McMillan and Morse 1999).

9
10 The PNPS intake and discharge have the potential to adversely affect juvenile and adult spiny
11 dogfish EFH. However, it is unlikely that PNPS intake operations are adversely affecting juvenile
12 and adult spiny dogfish as the species has not been reported to be entrained at PNPS
13 (Normandeau 2006a). The spiny dogfish has also only been periodically observed in the PNPS
14 impingement sampling program (Normandeau 2006b). Due to the small area affected by the
15 thermal plume and because the spiny dogfish would exhibit behavioral avoidance if water
16 temperatures are not within their preference range, it is unlikely that the PNPS discharge would
17 affect juvenile and adult spiny dogfish EFH. Continued operation of PNPS may also have the
18 potential to affect prey items of juvenile and adult spiny dogfish, as several prey items of the
19 spiny dogfish (cod, haddock, mackerel, herring, and sand lance) have been commonly reported
20 in the impingement and entrainment sampling program at PNPS. Continued PNPS operations
21 are likely to have a minimal adverse effect on EFH for the spiny dogfish.

22 **Summer flounder (*Paralichthys dentatus*)**

23
24
25 EFH for summer flounder adults exists in the vicinity of PNPS. Offshore EFH includes demersal
26 waters of the continental shelf from the Gulf of Maine to Cape Hatteras, and inshore EFH
27 includes estuaries where summer flounder are identified as being common or abundant.
28 Summer flounder adults typically live in water depths shallower than 500 ft (NMFS 2006). In
29 southern New England and the mid Atlantic, spawning occurs primarily in September (Berrien
30 and Sibunka 1999 in Packer et al. 1999). Spawning occurs in open ocean areas of the shelf
31 (Packer et al. 1999), in waters ranging from 30 to 200 m (98 to 656 ft) deep (ENSR 2000). The
32 timing of spawning coincides with maximum production of autumn plankton, which is the primary
33 food source for larvae (Morse 1981 in Packer et al. 1999).

34
35 Both eggs and larvae of the species are buoyant and pelagic. Eggs are most abundant in the
36 northwest Atlantic in October and November, and larvae are most abundant from October to
37 December (Able et al. 1990 in Packer et al. 1999). The larvae are transported toward coastal
38 areas by the prevailing water currents, and development of post-larvae and juveniles occurs
39 primarily within bays and estuarine areas (ENSR 2000). Juvenile summer flounder feed upon
40 crustaceans and polychaetes, and as they grow larger they begin to feed more on fish (Packer et
41 al. 1999). Adults are opportunistic feeders, preying mostly on fish and crustaceans (Packer et al.

Appendix E

1 1999). Species preyed upon include windowpane flounder, winter flounder, Atlantic menhaden,
2 red hake, silver hake, scup, Atlantic silverside, and bluefish, among others (Packer et al. 1999).
3 Adult summer flounder in Massachusetts migrate inshore in May and migrate to offshore waters in
4 late fall (Packer et al. 1999). The shoal waters of Cape Cod Bay, including estuaries and harbors,
5 are considered to be critically important habitat for the species (Packer et al. 1999).
6

7 The PNPS intake and discharge have the potential to adversely affect adult summer flounder
8 EFH. However, it is unlikely that PNPS intake operations are adversely affecting adult summer
9 flounder as eggs and larvae of the species have not been commonly entrained at PNPS
10 (Normandeau 2006a), and summer flounder have only been infrequently observed in the
11 impingement sampling program (Normandeau 2006b). Due to the small area affected by the
12 thermal plume and because the summer flounder would exhibit behavioral avoidance if water
13 temperatures are not within their preference range, it is unlikely that the PNPS discharge would
14 affect juvenile and adult summer flounder EFH. Continued operation of PNPS may also have the
15 potential to affect prey items of adult summer flounder, as several prey items of the summer
16 flounder (windowpane flounder, winter flounder, Atlantic menhaden, red hake, silver hake, scup,
17 and Atlantic silverside) have been commonly reported in the impingement and entrainment
18 sampling program at PNPS. Continued PNPS operations are likely to have a less than
19 substantial adverse effect on EFH for the summer flounder.
20

21 **Surf clam (*Spisula solidissima*)**

22

23 EFH for surf clam juveniles and adults exists in the vicinity of PNPS. EFH for both juveniles and
24 adults includes the substrate to a depth of 3 ft below the sediment/water interface from the
25 eastern edge of Georges Bank and the Gulf of Maine throughout the Atlantic EEZ. Both juveniles
26 and adults are typically found in water depths ranging from the beach zone to 200 ft (NMFS
27 2006).
28

29 Surf clams are planktivorous siphon feeders whose diet includes diatoms and ciliates (Cargnelli et
30 al. 1999c). They are preyed upon by moon snails, boring snails, and predatory fish such as
31 haddock and cod. Surf clams are capable of reproduction in their first year of life, although they
32 may not reach full maturity until the second year (Weinberg 2000). Water currents in areas where
33 planktonic surf clam larvae live are important in determining eventual patterns of distribution and
34 settlement for developing juveniles (ENSR 2000).
35

36 The PNPS intake and discharge have the potential to adversely affect juvenile and adult surf clam
37 EFH. However, it is unlikely that PNPS intake operations are adversely affecting eggs or larval
38 surf clams as the species has not been reported to be entrained or impinged at PNPS
39 (Normandeau 2006a, Normandeau 2006b). The thermal discharge is unlikely to affect surf clam
40 juveniles and adults because the affected area makes up a tiny portion of their EFH. Continued
41 operation of PNPS may also have the potential to affect prey items of the surf clam as it is a filter

1 feeder on plankton and entrainment by the plant removes plankton from the local environment.
2 Continued PNPS operations are likely to have a minimal adverse effect on EFH for the surf clam.

3 4 **Thorny skate (*Amblyraja radiata*)**

5
6 EFH for thorny skate juveniles and adults exists in the vicinity of PNPS. In the 2003 FMP for the
7 Northeast Skate Complex (NEFMC 2003), EFH was designated for the thorny skate. This
8 designation included bottom habitats with substrates of sand, gravel, broken shell, pebbles, and
9 soft mud in the Gulf of Maine, including portions of Cape Cod Bay, for both juveniles and adults
10 (NEFMC 2003). The water depth of the thorny skate habitat can range from 18 to 1200 m (59 to
11 3937 ft) (McEachran 2002 in Packer et al. 2003c). Trawl surveys in the Gulf of Maine found most
12 adults in the range from 71 to 300 m (233 to 984 ft), and at temperatures between 4°C and 9°C
13 (Packer et al. 2003c). The species can be found over a variety of substrates, including sand,
14 gravel, broken shell, pebbles, and soft mud (Bigelow and Schroeder 1953 in Packer et al. 2003c).

15
16 Eggs of all skates are known to be encapsulated in a leathery capsule that rests on the bottom
17 (Sosebee 2000, Packer et al. 2003c). The eggs hatch fully developed, so there is no larval stage
18 (Sosebee 2000, McEachran 2002 in Packer et al. 2003c). Based on the capture of females with
19 fully formed egg capsules, spawning is thought to occur throughout the year, but with a peak
20 during the summer (Templeman 1982a, McEachran 2002 in Packer et al. 2003c). The primary
21 prey for the thorny skate is fish, including haddock, sand lance, and redfish (*Sebastes* Spp.)
22 (Templeman 1982b in Packer et al. 2003c). Skates do not migrate substantially, but do generally
23 move offshore in summer and early autumn, and onshore during winter and spring (Sosebee
24 2000).

25
26 The PNPS intake and discharge have the potential to adversely affect EFH for the thorny skate.
27 However, it is unlikely that PNPS intake operations are adversely affecting juvenile and adult
28 thorny skate as the species has not been reported to be entrained or impinged at PNPS
29 (Normandeau 2006a, Normandeau 2006b). Due to the small area affected by the thermal plume
30 and because the thorny skate would exhibit behavioral avoidance if water temperatures are not
31 within their preference range, it is unlikely that the PNPS discharge would affect juvenile and adult
32 thorny skate EFH. Continued operation of PNPS may also have the potential to affect prey items
33 of juvenile and adult thorny skate, as one of the prey items of the thorny skate (sand lance) has
34 been commonly reported in the impingement and entrainment sampling program at PNPS.
35 Continued PNPS operations are likely to have a minimal adverse effect on EFH for thorny skate.

36 37 **White hake (*Urophycis tenuis*)**

38
39 EFH for white hake eggs, larvae, juveniles, and adults exists in the vicinity of PNPS. EFH for
40 eggs is found in surface waters of the Gulf of Maine, Georges Bank, and southern New England.
41 EFH for both larvae and pelagic juveniles is identified as pelagic waters of the Gulf of Maine, the

Appendix E

1 southern edge of Georges Bank, and southern New England to the mid Atlantic. Demersal
2 juvenile and adult EFH includes bottom habitats with substrates of seagrass, mud, or fine-grained
3 sand in the Gulf of Maine, the southern edge of Georges Bank, and southern New England to the
4 mid Atlantic. Demersal juveniles and adults live in water from 5 to 325 m (16 to 1066 ft) deep,
5 and with a temperature below 19°C (for juveniles) and 14°C (for adults) (NMFS 2006). The white
6 hake spawning grounds are centered on the Gulf of St. Lawrence, the southern Georges Bank,
7 and Mid Atlantic Bight. The contribution of the Gulf of Maine as a spawning ground is reported to
8 be negligible (Fahay and Able 1989 in Chang et al. 1999a). The eggs, larvae, and early juvenile
9 stages of the white hake are pelagic (Chang et al. 1999a), and are found in surface waters of the
10 Gulf of Maine, Georges Bank and southern New England (NEFMC 1998a in ENSR 2000).
11 Juvenile white hake feed mainly on polychaetes, shrimp, and other crustaceans, and adults feed
12 primarily on crustaceans and other fish, including juvenile white hakes (Langston et al. 1994 in
13 Chang et al. 1999a). Migration of adults occurs annually, with adults moving to shallower waters
14 in the spring to spawn, and then moving offshore in the autumn. A summary of annual NMFS
15 Bottom Trawl Survey data identified no white hake in Cape Cod Bay during the fall between 1979
16 and 2003, and only a few limited occurrences in the bay during the spring in those years
17 (GOMCML 2006).

18
19 The PNPS intake and discharge have the potential to adversely affect egg, larvae, juvenile, and
20 adult white hake EFH. White hake eggs and larvae are frequently observed in the PNPS
21 entrainment sampling program (Normandeau 2006a). Life stages of the white hake have also
22 been observed in the PNPS impingement sampling program continually over its operating history
23 (Normandeau 2006b). However, it is unlikely that PNPS intake operations are adversely affecting
24 juvenile and adult white hake as the area affected by the intake system is small. Due to the small
25 area affected by the thermal plume and because the white hake would exhibit behavioral
26 avoidance if water temperatures are not within their preference range, it is unlikely that the PNPS
27 discharge would affect juvenile and adult white hake EFH. Continued operation of PNPS may
28 also have the potential to affect prey items of adult white hake, as the adults are known to prey on
29 juveniles, which have been commonly reported in the impingement sampling program
30 at PNPS. Continued PNPS operations are likely to have a less than substantial adverse effect on
31 EFH for the white hake.

32 33 **Whiting/Silver hake (*Merluccius bilinearis*)**

34
35 EFH for eggs, larvae, juveniles, adults, and spawning adults of the whiting (also known as silver
36 hake) exists in the vicinity of PNPS. EFH for eggs includes surface waters of the Gulf of Maine,
37 Georges Bank, the continental shelf off southern New England, and the mid-Atlantic region south
38 to Cape Hatteras, with water depths between 50 to 150 m (164 to 492 ft) and temperatures below
39 20°C. For larvae, the EFH consists of surface waters of the Gulf of Maine, Georges Bank, the
40 continental shelf off southern New England, and the mid-Atlantic region south to Cape Hatteras.
41 Larvae also are found at water depths between 50 to 150 m (164 to 492 ft) and temperatures

1 below 20°C. Juvenile, adult, and spawning adult EFH for the whiting includes bottom habitats of
2 all substrate types in the Gulf of Maine, on Georges Bank, the continental shelf off southern New
3 England, and the mid-Atlantic region south to Cape Hatteras. Juveniles and adults typically live in
4 water between 20 and 325 m (66 to 1066 ft) deep and temperatures below 22°C. Spawning
5 typically occurs in water depths between 30 and 325 m (98 to 1066 ft) and at temperatures below
6 13°C (NMFS 2006). The adults spawn over a variety of substrates in the Gulf of Maine, Georges
7 Bank, and the southern New England area south of Martha's Vineyard (Lock and Packer 2004).
8 Spawning within the Gulf of Maine generally begins in June, with a peak in July to August (Lock
9 and Packer 2004).

10
11 Whiting eggs and larvae are pelagic, existing in the water column at depths between 50 and 150
12 m (164 and 492 ft) (NEFMC 1998a in ENSR 2000). As larvae mature into juveniles, they settle to
13 the bottom (Lock and Packer 2004). As adults, whiting are found in water at depths ranging from
14 shallow to greater than 400 m (1312 ft) (Dery 1988, Bolles and Begg 2000 in Lock and Packer
15 2004). Juvenile whiting feed mainly on crustaceans (Cohen et al. 1990 in ENSR 2000), and the
16 adults feed on both fish and pelagic invertebrates, such as shrimp and squid (Mayo 1998 in
17 ENSR 2000). Whiting are a dominant predator species on the continental shelf in the northwest
18 Atlantic, and their dominant biomass and high prey consumption help to regulate the ecosystem
19 (Bowman 1984, Garrison and Link 2000 in Lock and Packer 2004). The migration of whiting is
20 seasonal. The northern stock moves to the deep basins of the Gulf of Maine during the winter,
21 and migrates into nearshore waters in the Gulf of Maine in the spring and summer (Lock and
22 Packer 2004). Trawl surveys conducted for whiting in 1999 identified concentrations of whiting in
23 Cape Cod Bay in spring and autumn (Reid et al. 1999 in Lock and Packer 2004). A summary of
24 annual NMFS Bottom Trawl Survey data identified substantial numbers of whiting in Cape Cod
25 Bay during the fall every year between 1979 and 2003, but found a more limited number in the
26 bay during the spring in those years (GOMCML 2006).

27
28 The PNPS intake and discharge have the potential to adversely affect egg, larvae, juvenile,
29 adults, and spawning adult EFH for whiting. Whiting eggs and larvae are frequently observed in
30 the PNPS entrainment sampling program (Normandeau 2006a). Life stages of the whiting have
31 also been observed in the PNPS impingement sampling program continually over the operating
32 history of the facility (Normandeau 2006b). However, it is unlikely that PNPS intake operations
33 are adversely affecting whiting as the area affected by the intake system is small. Due to the
34 small area affected by the thermal plume and because the whiting would exhibit behavioral
35 avoidance if water temperatures are not within their preference range, it is unlikely that the PNPS
36 discharge would affect juvenile and adult whiting EFH. Continued operation of PNPS may also
37 have the potential to affect prey items of adult whiting, as several prey items of the whiting (small
38 fish and squid) have been commonly reported in the impingement and entrainment sampling
39 program at PNPS. Continued PNPS operations may have a substantial adverse effect on EFH for
40 the whiting.
41

1 **Windowpane flounder (*Scopthalmus aquosus*)**

2
3 EFH for windowpane flounder eggs, larvae, juveniles, adults, and spawning adults exists in the
4 vicinity of PNPS. EFH for eggs includes surface waters on the perimeter of the Gulf of Maine,
5 Georges Bank, southern New England, and the mid-Atlantic region south to Cape Hatteras. EFH
6 for larvae includes pelagic waters, with water depths between 50 to 150 m (164 to 492 ft) and
7 temperatures below 20°C. For larvae, the EFH consists of surface waters on the perimeter of the
8 Gulf of Maine, Georges Bank, southern New England, and the mid-Atlantic region south to Cape
9 Hatteras. Both eggs and larvae are found in water depths less than 70 m (230 ft), and in water
10 temperatures below 20°C. Juvenile, adult, and spawning adult EFH includes bottom habitats with
11 substrates of mud or fine-grained sand on the perimeter of the Gulf of Maine, Georges Bank,
12 southern New England, and the mid-Atlantic region south to Cape Hatteras. These areas are
13 generally 1 to 100 m (3 to 328 ft) deep and have water temperatures below 26°C (NMFS 2006).
14 The windowpane flounder prefers a soft bottom substrate for spawning, and generally spawns
15 between April and December, with peak spawning activity in July and August on Georges Bank
16 and in May in the mid-Atlantic region (NEFMC 1998a, Hendrickson 1998 in ENSR 2000).
17 Both the eggs and larvae are pelagic, and exist in surface waters cooler than 20°C (NEFMC
18 1998a in ENSR 2000). The prey for the windowpane flounder is small benthic invertebrates,
19 including polychaete worms and amphipods. The species may also prey on small forage bony
20 fish species (Langston and Bowman 1981 in ENSR 2000). Juveniles living in shallow waters tend
21 to move to deeper waters as they mature (Chang et al. 1999b). In studies in Massachusetts,
22 juveniles were most abundant in inshore waters at depths of less than 20 m (66 ft) and at water
23 temperatures between 5°C to 12°C in the spring and between 12°C to 19°C in the fall (Chang et
24 al. 1999b).

25
26 The intake and discharge at PNPS have the potential to adversely affect a small portion of EFH
27 for eggs, larvae, juvenile, adults, and spawning adult windowpane flounder. Eggs of the
28 windowpane flounder dominated entrainment samples at PNPS (ENSR 2000, Normandeau
29 2006a). Larvae have also been consistently collected in the plant's entrainment sampling
30 program throughout the history of the facility (Normandeau 2006a). In addition, windowpane
31 flounder have been continually observed in the PNPS impingement sampling program throughout
32 the history of the facility (Normandeau 2006b). Due to the small area affected by the thermal
33 plume and because the windowpane flounder would exhibit behavioral avoidance if water
34 temperatures are not within their preference range, it is unlikely that the PNPS discharge would
35 affect juvenile and adult windowpane flounder EFH. Continued operation of PNPS may also have
36 the potential to affect prey items of the windowpane flounder, as one of its prey items (small fish)
37 has been commonly reported in the impingement and entrainment sampling program at PNPS.
38 Continued operations of PNPS may have a adverse effect substantial effect on EFH for the
39 windowpane flounder.

1 Winter flounder (*Pseudopleuronectes americanus*)

2
3 EFH for winter flounder eggs, larvae, juveniles, adults, and spawning adults exists in the vicinity of
4 PNPS. EFH for eggs includes bottom habitats with substrates of sand, muddy sand, and gravel
5 on the Georges Bank, the inshore areas of the Gulf of Maine, southern New England, and the
6 mid-Atlantic region south to Delaware Bay. Eggs are typically found in water at depths less than
7 5 m (16 ft), and in water with temperatures less than 10°C. Larval EFH occurs in pelagic and
8 bottom waters of Georges Bank, inshore areas of the Gulf of Maine, southern New England, and
9 the mid-Atlantic region south to Delaware Bay. Larval EFH includes water less than 6 m (20 ft)
10 deep and with temperatures below 15°C. EFH for juvenile winter flounder includes bottom
11 habitats with substrates of mud or fine-grained sand on Georges Bank, inshore areas of the Gulf
12 of Maine, southern New England, and the mid-Atlantic region south to Delaware Bay. Young of
13 year juveniles are found at water depths from 0.1 to 10 m (0.3 to 33 ft) and temperatures below
14 28°C. Age 1+ juveniles are found at water depths ranging from 1 to 50 m (3 to 164 ft) and at
15 temperatures below 25°C. EFH for both adults and spawning adults includes bottom habitats,
16 including estuaries, with substrates of mud, muddy sand, sand, and gravel on Georges Bank,
17 inshore areas of the Gulf of Maine, southern New England, and the mid-Atlantic region south to
18 the Delaware Bay. Adult winter flounder live in water at depths ranging from 1 to 100 m (3 to 328
19 ft) with temperatures below 25°C. Spawning adults are found at water depths less than 6 m (262
20 ft), except for on Georges Bank, where they spawn as deep as 80 m. Water temperatures for
21 spawning adults are typically below 15°C (NMFS 2006). Spawning takes place at night over
22 sandy bottoms in shallow estuaries starting in mid December and ending in May, with a peak in
23 the February to March time frame.

24
25 The various life stages of winter flounder can generally be found in areas where the bottom
26 habitat has a substrate of mud, sand, or gravel (NEFMC 1998b). Winter flounder eggs are
27 demersal, adhesive, and stick together in clusters, and hatching may occur in 2 to 3 weeks,
28 depending upon the water temperature (Bulloch 1986; Pereira et al.1999). Larvae are initially
29 planktonic, but, as metamorphosis continues, they settle to the bottom. Newly metamorphosed
30 young of year fish take up residence in shallow water. Pereira et al. (1999) describes winter
31 flounder as omnivorous or opportunistic feeders, consuming a wide variety of prey, with
32 polychaetes and amphipods making up the majority of their diet. Typically adult winter flounder
33 migrate inshore in the fall and early winter and spawn in later winter and early spring. Then they
34 may leave inshore areas if the water temperature exceeds 15°C, although there may be
35 exceptions to this due to water temperature and food availability (Pereira 1999). Winter flounder
36 may move significant distances (Pereira et al. 1999); however, they also can exhibit a high degree
37 of fidelity and, in general, their movement patterns are localized (Nitschke et al. 2000). Studies
38 done by PNPS have shown that winter flounder in the area immediately surrounding PNPS (i.e.,
39 in Plymouth Outer Harbor) have relatively localized movements and are basically confined to
40 inshore waters (Lawton et al. 1999), resulting in highly localized populations (Lawton et al. 2000).

41

Appendix E

1 The intake and discharge at PNPS have the potential to adversely affect a small portion of EFH
2 for eggs, larvae, juvenile, adults, and spawning adult winter flounder. The winter flounder eggs
3 and larvae dominated entrainment samples at PNPS (Normandeau 2006a). Impingement of
4 winter flounder has consistently occurred throughout the operating history of the facility; however,
5 the impingement rates are considered to be low. Due to the small area affected by the thermal
6 plume and because the winter flounder would exhibit behavioral avoidance if water temperatures
7 are not within their preference range, it is unlikely that the PNPS discharge would affect juvenile
8 and adult winter flounder EFH. Continued operation of PNPS may also have the potential to
9 affect prey items of the winter flounder, as they have been described as omnivores preying on a
10 variety of fish and invertebrates species, many of which have been commonly reported in the
11 impingement and entrainment sampling program at PNPS. However, there is a potential that
12 continued operations of the PNPS intake system may have a substantial, adverse effect on EFH
13 for winter flounder.

14 **Winter skate (*Leucoraja ocellata*)**

15
16
17 EFH for winter skate juveniles and adults exists in the vicinity of PNPS. In the 2003 FMP for the
18 Northeast Skate Complex (NEFMC 2003), EFH was designated for the winter skate. This
19 designation included bottom habitats with substrates of sand, gravel, and mud in Cape Cod Bay
20 for both juveniles and adults (NEFMC 2003). Winter skates in the Gulf of Maine primarily live at
21 depths of 46 to 64 m (151 to 210 ft) (Bigelow and Schroeder 1953; McEachran 2002 in Packer et
22 al. 2003a). The species can live in a variety of water temperatures and are reported near the
23 Massachusetts coast in water from 1°C to 20°C (Bigelow and Schroeder 1953 in Packer et al.
24 2003a). The species prefers sandy and gravel bottom substrates (Scott 1982a in Packer et al.
25 2003a).

26
27 Little information on the life history of the winter skate exists. Eggs of all skates are known to be
28 encapsulated in a leathery capsule that rests on the bottom (Sosebee 2000, Packer et al. 2003a).
29 The eggs hatch fully developed, so there is no larval stage (Sosebee 2000, McEachran 2002 in
30 Packer et al. 2003a). Off of Nova Scotia and in the Gulf of Maine, spawning occurs during
31 summer and fall (Bigelow and Schroeder 1953 in Packer et al. 2003a). The predominant food
32 source for winter skates is polychaetes and amphipods, with additional feeding upon decapods,
33 isopods, bivalves, and fish (McEachran 1973 in Packer et al. 2003a). Fish species that are prey
34 for the winter skate include smaller skates, eels (*Anguilla rostrata*), alewives, blueback herring
35 (*Alosa aestivalis*), menhaden, smelt, sand lance, chub mackerel (*Scomber colias*), butterfish,
36 cunners, and silver hake (Bigelow and Schroeder 1953 in Packer et al. 2003a). Skates do not
37 migrate substantially, but do generally move offshore in summer and early autumn and onshore
38 during winter and spring (Sosebee 2000).

39
40 The PNPS intake and discharge have the potential to adversely affect EFH for the winter skate.
41 However, it is unlikely that PNPS intake operations are adversely affecting juvenile and adult

1 winter skate as the species has not been reported to be entrained at PNPS (Normandeau 2006a)
2 and it has only been periodically observed in the PNPS impingement sampling program
3 (Normandeau 2006b). Due to the small area affected by the thermal plume and because the
4 winter skate would exhibit behavioral avoidance if water temperatures are not within their
5 preference range, it is unlikely that the PNPS discharge would affect juvenile and adult winter
6 skate EFH. Continued operation of PNPS may also have the potential to affect prey items of the
7 winter skate, as several of its prey items (small skates, alewife, menhaden, smelt, sand lance,
8 butterfish, cunner, and silver hake) have been commonly reported in the impingement and
9 entrainment sampling program at PNPS. Continued PNPS operations are likely to have a less
10 than substantial adverse effect on EFH for winter skate.

11 **Witch flounder (*Glyptocephalus cynoglossus*)**

12
13
14 EFH for witch flounder eggs and larvae exists in the vicinity of PNPS. EFH for eggs of the
15 species includes surface waters of the Gulf of Maine, Georges Bank, the continental shelf off
16 southern New England, and the mid-Atlantic region south to Cape Hatteras. EFH for larvae is
17 found in surface waters to a depth of 250 m (820 ft) in the Gulf of Maine, Georges Bank, the
18 continental shelf off southern New England, and the mid-Atlantic region south to Cape Hatteras.
19 Both eggs and larvae are found in water with temperatures below 13°C (NMFS 2006). Spawning
20 occurs from March to November, with peak spawning during the summer, at temperatures from 0
21 to 10°C (Bigelow and Schroeder 1953 in Cargnelli et al. 1999h). The western and northern areas
22 of the Gulf of Maine are reported to be the most active spawning areas for the species (Burnett et
23 al. 1992 in Cargnelli et al. 1999h).

24
25 Eggs are released on the bottom, but are pelagic and rise to the surface. Larvae are also pelagic,
26 and juveniles descend to the bottom at the age of 4 to 12 months (Bigelow and Schroeder 1953,;
27 Evseenko and Nevinsky 1975 in Cargnelli et al. 1999h). The primary prey for the witch flounder is
28 polychaetes and crustaceans, with additional contribution from mollusks and echinoderms
29 (Cargnelli et al. 1999h). All life stages of witch flounder are common in Massachusetts Bay.
30 Eggs were found to be abundant in Massachusetts Bay in the months of May and June, and the
31 highest larval densities found were observed in Massachusetts Bay (Cargnelli et al. 1999h).
32 Bottom trawl surveys and inshore surveys found the greatest concentrations of juveniles on
33 Stellwagen Bank in Massachusetts Bay. Adults were found in the highest concentrations in
34 Massachusetts Bay in the autumn, including some catches in Cape Cod Bay (Cargnelli et al.
35 1999h).

36
37 The PNPS intake and discharge have the potential to adversely affect egg and larvae witch
38 flounder EFH. Witch flounder eggs and larvae have been observed in the PNPS entrainment
39 sampling program throughout the operating history of the facility (Normandeau 2006a), while the
40 witch flounder has not been observed in the PNPS impingement sampling program (Normandeau
41 2006b). However, it is unlikely that PNPS intake operations are adversely affecting witch flounder

Appendix E

1 as the area makes up a tiny portion of their EFH. The thermal plume is unlikely to affect EFH for
2 witch flounder eggs and larvae. It is unlikely that continued operation of PNPS would have a
3 impact on prey items of the witch flounder, as its diet consists primarily of benthic invertebrates.
4 Continued PNPS operations are likely to have a minimal adverse effect on EFH for the witch
5 flounder.

6 7 **Yellowtail flounder (*Pleuronectes ferruginea*)**

8
9 EFH for yellowtail flounder eggs, larvae, juveniles, adults, and spawning adults exists in the
10 vicinity of PNPS. EFH for eggs and larval yellowtail flounder includes surface waters of Georges
11 Bank, Massachusetts Bay, Cape Cod Bay, and the southern New England continental shelf south
12 to Delaware Bay. Eggs and larvae are found in water at depths between 10 to 90 m (33 to 295
13 ft), and temperatures below 17°C. Juvenile, adult, and spawning adult EFH occurs in bottom
14 habitats with substrates of sand or mud on Georges Bank, the Gulf of Maine, and the southern
15 New England shelf south to Delaware Bay. Juveniles and adults live in water at depths ranging
16 from 20 to 50 m (66 to 164 ft) and temperatures below 15°C. Spawning occurs in water at depths
17 from 10 to 125 m (33 to 410 ft) and temperatures below 17°C (NMFS 2006). Spawning occurs in
18 the Gulf of Maine, Georges Bank, and the southern New England shelf during the spring and
19 summer months (Overholtz and Cadrin 1998; NEFMC 1998a in ENSR 2000).

20
21 Both the eggs and larvae of the yellowtail flounder reside in the water column and are found in
22 surface waters between mid March and July, peaking between April and June. Larvae may drift in
23 surface waters before developing into juveniles and dropping to the bottom (Overholtz and Cadrin
24 1998 in ENSR 2000). Adult yellowtail flounder feed on small benthic invertebrates such as
25 polychaete worms, isopods, shrimp, and amphipods, and also can feed on small forage fish
26 (Cooper et al. 1998 in ENSR 2000). Mark and recapture studies have shown that the yellowtail
27 flounder do not migrate, other than minor movements between shallow and deeper water in
28 response to seasonal temperature variation (Royce et al. 1959; Lux 1964 in Johnson et al. 1999).

29
30 The PNPS intake and discharge have the potential to adversely affect egg, larvae, juvenile,
31 adults, and spawning adult yellowtail flounder EFH. Yellowtail flounder eggs and larvae have
32 been consistently collected in the PNPS entrainment sampling program throughout the operating
33 history of the plant (Normandeau 2006a). The yellowtail flounder has also been periodically
34 collected in the PNPS impingement sampling program (Normandeau 2006b). However, it is
35 unlikely that PNPS intake operations are adversely affecting yellowtail flounder as the area
36 affected by the intake system is small. Due to the small area affected by the thermal plume and
37 because the yellowtail flounder would exhibit behavioral avoidance if water temperatures are not
38 within their preference range, it is unlikely that the PNPS discharge would affect juvenile and adult
39 yellowtail flounder EFH. Continued operation of PNPS may also have the potential to affect prey
40 items of the yellowtail flounder, as one of its prey items (small fish) has been commonly reported

1 in the impingement and entrainment sampling program at PNPS. Continued PNPS operations
2 are likely to have a less than substantial adverse effect on EFH for the yellowtail flounder.
3

4 **7.0 Impact Avoidance, Minimization, and Mitigation Measures**

5

6 Operation of the PNPS once-through cooling system may adversely affect EFH in Cape Cod Bay.
7 The NPDES permit allows the PNPS cooling system to operate if it does not exceed specified
8 entrainment, impingement, and discharge limits. The NPDES permit also requires mitigation
9 measures, which are in place at PNPS.

10
11 The staff has identified a variety of measures that could mitigate potential impacts resulting from
12 continued operation of the PNPS cooling water system.^(a) These could include:
13

- 14 • Behavioral barriers
 - 15 • Diversion devices
 - 16 • Alternative intake systems
 - 17 • Alternative intake screen systems
 - 18 • Closed cycle systems
 - 19 • Variable speed pumps
 - 20 • Cooling water flow adjustments
 - 21 • Scheduled outages
 - 22 • Movement of fish return
 - 23 • Habitat restoration
 - 24 • Fish stocking
- 25

26 The NRC staff has not conducted an analysis of each of these measures relative to their
27 applicability to PNPS. This discussion is only meant to provide a brief overview of these
28 technologies. ENSR (2000) conducted an analysis of several of these technologies in the 316(b)
29 demonstration report as required by Section 316 of the Clean Water Act. It is expected that a
30 more thorough analysis of the costs and benefits of these technologies would be conducted as
31 part of the 316(b) comprehensive demonstration study currently being conducted by PNPS in
32 support of the NPDES permit renewal.
33

(a) It should be noted that the NRC cannot impose mitigation requirements on the applicant. The Atomic Safety and Licensing Appeal Board, in the "Yellow Creek" case determined that EPA has sole jurisdiction over the regulation of water quality with respect to the withdrawal and discharge of waters for nuclear power stations, and that the NRC is prohibited from placing any restrictions or requirements upon the licensees of these facilities with regards to water quality [Tennessee Valley Authority (Yellow Creek Nuclear Plant, Units 1 and 2), ALAB-515, 8 NRC 702, 712-13 (1978)].

Appendix E

1 Behavioral barriers are designed to cause fish to actively avoid entry into an area. These may
2 include sound, light, or air bubbles (Clay 1995). Sound barriers, which would be located at an
3 intake structure, would include low-frequency, infra-wave sound; pneumatic or mechanically
4 generated low-frequency sounds; or transducer-generated sound. Light barriers may emit a
5 constant or strobe-type beam of light, while air bubble curtains produce a continuous, dense chain
6 of bubbles. Both barrier types may deter some species of fish from entering the intake structure.
7 ENSR (2000) determined that, of the behavioral barriers evaluated, light barriers would be the
8 most effective as several studies have shown that some fish species are attracted to light.
9 However, this technology is still considered to be experimental in nature and will only be effective
10 on species/life stages that can actively respond to a stimulus (i.e., not fish eggs, early larval life
11 stages, or other planktonic organisms).

12
13 Diversion devices are the most commonly used barriers and are physical structures such as
14 louvers, barrier nets, or chains and cables that are designed to guide fish away from a certain
15 area, such as the intake (Clay 1995). Louvers consist of a series of evenly spaced vertical slats
16 which create localized turbulence that fish can detect and actively avoid. Louvers typically have a
17 smaller spacing between the slats or bars than a standard trash rack. Barrier nets are simply nets
18 placed across an intake channel to prevent fish from access to an intake structure. The design of
19 a barrier net system has to finely balance the mesh size with the intake requirements.^(b) Chains or
20 cables may be vertically hung in an intake structure to form a physical and visible barrier to fish.
21 However, similar to barrier nets, they may alter hydraulic flow patterns in an intake (ENSR 2000).
22 These types of structures also only affect those organisms that can actively respond and would
23 not impact entrainment or impingement of fish eggs, larvae, or other planktonic organisms.

24
25 Another type of mitigation measure may be an alternative intake system. An alternate surface
26 water intake system could include an offshore intake structure with a velocity cap. Vertical
27 placement of the offshore intake within the water column would be a major factor in impingement
28 and entrainment reduction. For example, ENSR (2000) conducted an evaluation of this type of
29 structure and determined that it would result in lower fish impingement but an increased
30 entrainment rate, especially for winter flounder as later stages of winter flounder larvae (stages 3
31 and 4) tend to settle on the bottom substrate. The Seabrook Station Nuclear Power Plant utilizes
32 a similar structure, however, the intake structure opening is at mid-depth. Based on an analysis
33 by Saila et al., (1997), the losses due to entrainment at this facility are less than the losses
34 observed at other facilities. Groundwater could also be potentially used as a cooling water
35 source. According to EPA Region 1, the Keyspan North Point Station is currently conducting a
36 pilot study to evaluate the feasibility of using offshore groundwater extraction as a cooling water
37 source (Earth Tech 2006a).

(b) EPA has suggested the Gunderboom fabric barrier as a potential mitigation measure. However, NRC staff does not consider it as an option because it could present safety issues at intakes of nuclear power plants.

1 Alternative intake screen systems may include Ristroph traveling screens, wedgewire screens,
2 and/or fine-mesh screens. Ristroph screens are traveling screens fitted with fish buckets that
3 collect fish and lift them out of the water where they are gently sluiced away prior to debris
4 removal with a high pressure spray. They have been approved as the best available technology
5 in several states (Siemens 2006). Recent studies have shown survival of species exceeding 95
6 percent when using the Ristroph screen (EPRI 2006). Wedgewire screens are constructed of
7 wire of triangular cross sections so that the surface of the screen is smooth while the screen
8 openings widen inwards (ENSR 2000). This type of screen has been widely used for hydropower
9 diversion structures and has been shown to essentially eliminate impingement and reduce larval
10 entrainment (ENSR 2000). Fine mesh screens are simply wire screens with the mesh sized to
11 minimize ichthyoplankton entrainment. As reported in ENSR (2000), fine mesh screens have not
12 proven effective at reducing winter flounder larvae entrainment losses. However, as with any
13 screen, the smaller the mesh the more clogging and fouling problems. Another potential
14 mitigation strategy related to the cooling system would be to rotate the existing screens more
15 often or on a continual basis. This would increase the survival of impinged organisms, but it
16 would have no impact on the impingement rate or entrainment.

17
18 Closed-cycle systems recycle cooling water in a closed piping system and utilize evaporative
19 cooling (such as is in a cooling tower or pond) as a means of dissipating the heat from the
20 condensers. Wet and hybrid cooling towers would still require withdrawal of water from the bay to
21 make up for water losses due to blowdown and evaporation. However, the water withdrawal rate
22 would be significantly lower than the current once-through cooling system. A dry cooling tower
23 utilizes ambient air to dissipate heat, essentially acting as an automobile radiator (ENSR 2000).
24 No make-up water is required for this type of system as the steam is condensed in a closed cycle.
25 However, this results in lower plant efficiency, thus requiring more fuel to produce the same
26 amount of electricity (ENSR 2000).

27
28 Adjustments to the flow of cooling water through the plant is another type of mitigation strategy
29 that may be applicable to PNPS. This could include the use of variable speed pumps, cooling
30 water bypass flow, or rotating the existing screens more often or continuously. Variable-speed
31 pumps would reduce the intake flow during periods of peak entrainment or impingement. These
32 have been shown to be effective at reducing impingement and entrainment, but by reducing the
33 amount of cooling water moving through the system, power generating efficiency may decrease
34 and the thermal plume may increase in size (ENSR 2000). Cooling water bypass flow would
35 reduce the cooling water flow rate through the condensers and add a corresponding amount of
36 bypass flow into the discharge canal (ENSR 2000). This alternative assumes that mortality in the
37 discharge canal would be less than the condensers. It would most likely reduce entrainment but
38 not impingement (ENSR 2000).

39

Appendix E

1 Another potential mitigation strategy may be to schedule outages for performing regular
2 inspection, maintenance, and refueling during the peak spawning season of specific fish species
3 such as the winter flounder, Atlantic menhaden, or rainbow smelt.
4

5 Movement of the fish return sluiceway discharge point may also provide some mitigation benefits
6 as impinged fish are currently returned to the intake canal where potentially stunned, disoriented,
7 or injured fish may not be able to actively avoid reentering the intake structure.
8

9 Habitat restoration and fish stocking are also potential mitigation strategies. However, these are
10 compensatory measures as opposed to preventative measures, which are the preferred mitigation
11 strategies of Federal and State resource agencies. Several studies have been funded by Entergy
12 over the last few years to evaluate these options. A monitoring pilot program has been conducted
13 by Entergy to assess the feasibility of improving the local winter flounder stock by releasing
14 flounder into the Plymouth area. Up to 25,000 young of year winter flounder, ranging from 26 to
15 34 mm (1 to 1.3 in.) in length, have been released into Plymouth Harbor on an annual basis since
16 2001. Post-release sampling has indicated that the released fish do survive and grow well when
17 released earlier in the season (Marine Research, Inc. 2006). No genetic studies have been
18 conducted to determine if released hatchery fish breed with the wild stock. Stocking of young of
19 year fish or eggs may be a proven mitigation strategy; however, both the EPA and MDMF have
20 stated that re-stocking is not a preferred mitigation alternative (Earth Tech 2006a).
21

22 **8.0 Conclusions**

23
24 The potential impacts of PNPS on Federally managed species and their EFH in the vicinity of
25 PNPS have been evaluated. Known distributions and records of those species, the ecological
26 impacts of the operations and maintenance activities of PNPS, and the mitigation measures that
27 Entergy has implemented to avoid, minimize, and mitigate impacts to the various life history
28 stages of these species have been considered in this EFH assessment.
29

30 Continued operation of the PNPS cooling water system was determined to have a minimal
31 adverse effect on EFH for 17 species, a less than substantial adverse effect on EFH for 8
32 species, and a substantial adverse effect on EFH for 7 species. However, within the overall Cape
33 Cod Bay ecosystem, the staff has determined that continued operation of the PNPS cooling water
34 system would have a minimal adverse effect on EFH.
35

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Appendix F

GEIS Environmental Issues Not Applicable to Pilgrim Nuclear Power Station

Appendix F

GEIS Environmental Issues Not Applicable to Pilgrim Nuclear Power Station

1 Table F-1 lists those environmental issues listed in the *Generic Environmental Impact*
 2 *Statement for License Renewal of Nuclear Plants* (GEIS) (NRC 1996; 1999)^(a) and 10 CFR
 3 Part 51, Subpart A, Appendix B, Table B-1, that are not applicable to Pilgrim Nuclear Power
 4 Station (PNPS) because of plant or site characteristics.

5

6 **Table F-1.** GEIS Environmental Issues Not Applicable to Pilgrim Nuclear Power Station (PNPS)

7

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	Category	GEIS Sections	Comment
SURFACE WATER QUALITY, HYDROLOGY, AND USE (FOR ALL PLANTS)			
11 Altered thermal stratification of lakes	1	4.2.1.2.2 4.4.2.2	PNPS does not discharge into a lake.
12 Eutrophication	1	4.2.1.2.3 4.4.2.2	PNPS does not discharge into a lake.
13 Discharge of sanitary wastes and 14 minor chemical spill	1	4.2.1.2.4 4.4.2.2	PNPS does not discharge sanitary waste to surface waters.
15 Water-use conflicts (plants with 16 cooling ponds or cooling towers using 17 makeup water from a small river with 18 low flow)	2	4.3.2.1 4.4.2.1	PNPS does not have a cooling tower or a cooling pond and does not use make-up water from a small river with low flow.

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

Appendix F

	ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	Category	GEIS Sections	Comment
1	AQUATIC ECOLOGY (FOR ALL PLANTS)			
2				
3	Premature emergence of aquatic	1	4.2.2.1.7	Aquatic insects are primarily of concern in freshwater environments.
4	insects		4.4.3	
5	AQUATIC ECOLOGY (FOR PLANTS WITH COOLING TOWER BASED HEAT DISSIPATION SYSTEMS)			
6	Entrainment of fish and shellfish in	1	4.3.3	This issue is related to heat-dissipation systems that are not installed at PNPS.
7	early life stages			
8	Impingement of fish and shellfish	1	4.3.3	This issue is related to heat-dissipation systems that are not installed at PNPS.
9	Heat shock	1	4.3.3	This issue is related to heat-dissipation systems that are not installed at PNPS.
10	GROUNDWATER USE AND QUALITY			
11	Groundwater use conflicts (potable	2	4.8.1.1	PNPS does not use groundwater for cooling water purposes.
12	and service water, and dewatering;		4.8.2.1	
13	plants that use >100 gpm and plants			
14	that use < 100 gpm)			
15	Groundwater-use conflicts (plants	2	4.8.1.3	This issue is related to heat-dissipation systems that are not installed at PNPS.
16	using cooling towers withdrawing		4.4.2.1	
17	makeup water from a small river)			
18	Groundwater-use conflicts (Ranney	2	4.8.1.4	PNPS does not have or use Ranney wells.
19	wells)			
20	Groundwater quality degradation	1	4.8.2.2	PNPS does not have or use Ranney wells.
21	(Ranney wells)			

	ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	Category	GEIS Sections	Comment
1 2	Groundwater quality degradation (cooling ponds in salt marshes)	1	4.8.3	PNPS does not use cooling ponds.
3 4	Groundwater quality degradation (cooling ponds at inland sites)	2	4.8.3	PNPS is not located at an inland site.
5	TERRESTRIAL RESOURCES			
6 7	Cooling tower impacts on crops and ornamental vegetation	1	4.3.4	This issue is related to a heat-dissipation system that is not installed at PNPS.
8 9	Cooling tower impacts on native plants	1	4.3.5.1	This issue is related to a heat-dissipation system that is not installed at PNPS.
10	Bird collisions with cooling towers	1	4.3.5.2	This issue is related to a heat-dissipation system that is not installed at PNPS.
11 12	Cooling pond impacts on terrestrial resources	1	4.4.4	This issue is related to a heat-dissipation system that is not installed at PNPS.
13	HUMAN HEALTH			
14 15	Microbial organisms (occupational health)	1	4.3.6	This issue is related to a heat-dissipation system that is not installed at PNPS.
16 17 18 19 20 21 22	Microbial organisms (public health) (plants using lakes or canals, or cooling towers or cooling ponds that discharge to a small river).	2	4.3.6	This issue is related to a heat-dissipation system that is not installed at PNPS.

1 **F.1 References**

2
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11 *Summary of findings on NEPA issues for license renewal of nuclear power plants, Final Report.*
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Appendix G

U.S. Nuclear Regulatory Commission Staff Evaluation of Severe Accident Mitigation Alternatives for Pilgrim Nuclear Power Station

Appendix G

U.S. Nuclear Regulatory Commission Staff Evaluation of Severe Accident Mitigation Alternatives for Pilgrim Nuclear Power Station

G.1 Introduction

Entergy Nuclear Operations, Inc. (Entergy) submitted an assessment of severe accident mitigation alternatives (SAMAs) for Pilgrim Nuclear Power Station (PNPS) as part of the environmental report (ER) (Entergy 2006a). This assessment was based on the most recent PNPS probabilistic safety assessment (PSA) available at that time, a plant-specific offsite consequence analysis performed using the MELCOR Accident Consequence Code System 2 (MACCS2) computer code, and insights from the PNPS individual plant examination (IPE) (BEC0 1992) and individual plant examination of external events (IPEEE) (BEC0 1994). In identifying and evaluating potential SAMAs, Entergy considered SAMAs that addressed the major contributors to core damage frequency (CDF) and population dose at PNPS, as well as SAMA candidates for other operating plants which have submitted license renewal applications. Entergy identified 281 potential SAMA candidates. This list was reduced to 59 unique SAMA candidates by eliminating SAMAs that: are not applicable to PNPS due to design differences, have already been implemented at PNPS, or are similar in nature and could be combined with another SAMA candidate. Entergy assessed the costs and benefits associated with each of the 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 a request for additional information (RAI) to Entergy by letter dated May 22, 2006 (NRC 2006a). Key questions concerned: findings of the Boiling Water Reactor Owners Group (BWROG) and the independent assessment team reviews of the PNPS PSA; changes to the Level 2 PSA model since the IPE; justification for the multiplier used for external events; further information on several specific candidate SAMAs and low cost alternatives; and details for several of the cost estimates provided. Entergy submitted additional information by letters dated July 5, 2006, August 30, 2006, and October 6, 2006 (Entergy 2006b, 2006c, 2006d). In the responses, Entergy provided: information regarding the findings of the BWROG and independent assessment team reviews; a discussion of the Level 2 analysis and the process for assigning severe accident source terms; a revised assessment of the baseline SAMA benefits considering a modified multiplier to account for external events exclusive of uncertainties; additional information regarding several specific SAMAs; and additional information pertaining to the cost estimates. Entergy's responses addressed the NRC staff's concerns. An assessment of SAMAs for PNPS is presented below.

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G.2 Estimate of Risk for Pilgrim Nuclear Power Station

Entergy's estimates of offsite risk at PNPS are summarized in Section G.2.1. The summary is followed by the NRC staff's review of Entergy's risk estimates in Section G.2.2.

G.2.1 Entergy's Risk Estimates

Two distinct analyses are combined to form the basis for the risk estimates used in the SAMA analysis: (1) the PNPS Level 1 and 2 PSA model, which is an updated version of the IPE (BEC0 1992), and (2) a supplemental analysis of offsite consequences and economic impacts (essentially a Level 3 PSA model) developed specifically for the SAMA analysis. The SAMA analysis is based on the most recent PNPS Level 1 and 2 PSA model available at the time of the ER, referred to as the PNPS PSA (Revision 1, April 2003 model). The scope of the PNPS PSA does not include external events.

The baseline CDF for the purpose of the SAMA evaluation is approximately 6.4×10^{-6} per year. The CDF is based on the risk assessment for internally-initiated events. Entergy did not include the contribution from external events within the PNPS risk estimates; however, it did account for the potential risk reduction benefits associated with external events by multiplying the estimated benefits for internal events by a factor of 5.^(a) This is discussed further in Section G.6.2.

The breakdown of CDF by initiating event is provided in Table G-1. As shown in this table, events initiated by loss of direct current (DC) buses and loss of offsite power are the dominant contributors to CDF. Station blackout (SBO) sequences contribute 1.5×10^{-7} per year (about 2 percent of the total internal events CDF), while anticipated transient without scram (ATWS) sequences are insignificant contributors to CDF (5.3×10^{-8} per year).

(a) In the ER, Entergy bounded the combined impact of external events and uncertainties by applying a multiplier of 6 to the estimated SAMA benefits for internal events. In response to an RAI, Entergy revised the analysis to include a multiplier of 5 to account for potential SAMA benefits in both internal and external events, and provided a separate accounting of uncertainties (Entergy 2006b).

Table G-1. PNPS Core Damage Frequency

Initiating Event	CDF (Per Year)	% Contribution to CDF
Loss of DC power buses	3.1×10^{-6}	48
Loss of offsite power	1.3×10^{-6}	20
Loss of alternating current (AC) power buses	8.8×10^{-7}	14
Loss of salt service water	3.9×10^{-7}	6
Transients	3.6×10^{-7}	6
Loss of coolant accidents	1.8×10^{-7}	3
Station blackout	1.5×10^{-7}	2
Anticipated transient without scram	5.3×10^{-8}	1
Interfacing system loss-of-coolant (LOCA)	3.6×10^{-8}	<1
Internal flooding	1.3×10^{-8}	<1
Total CDF (from internal events)	6.4×10^{-6}	100

The Level 2 PNPS PSA model that forms the basis for the SAMA evaluation represents a complete revision of the original IPE Level 2 model. The current Level 2 model utilizes a single containment event tree (CET) containing both phenomenological and systemic events. The Level 1 core damage sequences are binned into one of 48 Plant Damage State (PDS) bins which provide the interface between the Level 1 and Level 2 analysis. CET nodes are evaluated using supporting fault trees and logic rules.

The result of the Level 2 PSA is a set of 19 Collapsed Accident Progression Bins (CAPBs) with their respective frequency and release characteristics. The results of this analysis for PNPS are provided in Table E.1-11 of the ER (Entergy 2006a). The frequency of each CAPB was obtained by summing the frequency of the individual PDS accident progression CET endpoints binned into the CAPB. The release characteristics for each CAPB were obtained by frequency-weighting the release characteristics for each PDS contributing to the CAPB.

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 a

Appendix G

1 50-mile (mi) radius) for the year 2032, emergency response evacuation modeling, and
2 economic data. The core radionuclide inventory is derived from an Oak Ridge Isotope
3 Generator (ORIGEN) calculation assuming a 4.65 percent enrichment and average burnup
4 (Entergy 2006b). The magnitude of the onsite impacts (in terms of clean-up and
5 decontamination costs and occupational dose) is based on information provided in
6 NUREG/BR-0184 (NRC 1997b).

7
8 In the ER, Entergy estimated the dose to the population within 50 miles of the PNPS site to be
9 approximately 0.136 person-sievert (Sv) [13.6 person-roentgen equivalents (person-rem)] per
10 year. The breakdown of the total population dose by containment release mode is summarized
11 in Table G-2. Containment failures within the late time frame (greater than 7.5 hours following
12 event initiation) dominate the population dose risk at PNPS.

13
14 **Table G-2.** Breakdown of Population Dose by Containment Release Mode

Containment Release Mode	Population Dose (Person-Rem¹ Per Year)	Percent Contribution
Late Containment Failure	12.7	93
Early Containment Failure	0.7	5
Containment Bypass	0.2	2
Intact Containment	negligible	negligible
Total	13.6	100

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23 ¹One person-rem = 0.01 person-Sv
24

25 **G.2.2 Review of Entergy's Risk Estimates**

26
27 Entergy's determination of offsite risk at PNPS is based on the following three major elements of
28 analysis:

- 29
- 30 • The Level 1 and 2 risk models that form the bases for the 1992 IPE submittal (BEC0
31 1992) and the external event analyses of the 1994 IPEEE submittal (BEC0 1994)
 - 32 • The major modifications to the IPE model that have been incorporated in the PNPS
33 PSA, and
 - 34 • The MACCS2 analyses performed to translate fission product source terms and release
35 frequencies from the Level 2 PSA model into offsite consequence measures.
36
37

1 Each of these analyses was reviewed to determine the acceptability of Entergy's risk estimates
2 for the SAMA analysis, as summarized below.
3

4 The NRC staff's review of the PNPS IPE is described in an NRC report dated October 30, 1996
5 (NRC 1996). Based on a review of the IPE submittal and responses to RAIs, the NRC staff
6 concluded that the IPE submittal met the intent of Generic Letter (GL) 88-20 (NRC 1988); that
7 is, the applicant IPE process is capable of identifying the most likely severe accidents and
8 severe accident vulnerabilities. However, the NRC staff identified weaknesses in the human
9 reliability analysis that would limit the use of the IPE for regulatory purposes other than GL 88-
10 20.
11

12 No vulnerabilities were identified in the IPE. However, the applicant noted that a number of
13 modifications to the plant had been previously made as a result of a safety enhancement
14 program. These improvements included: provision of a hardened containment vent, addition of
15 a fire water cross-tie, installation of a third diesel generator, installation of a backup nitrogen
16 supply system, modifications to the automatic depressurization system (ADS), and
17 implementation of Revision 4 of the BWROG emergency operating procedures (EOPs). The
18 applicant also noted that the IPE insights resulted in improvements to procedures related to
19 load shedding of AC buses on loss of DC supplies, and the use of fire water for containment
20 sprays.
21

22 There have been two revisions to the IPE model since the 1992 IPE submittal, specifically, a
23 1995 revision to the IPE in response to NRC RAIs and a complete revision of the model in 2003
24 in response to the BWROG peer review. (The 1995 IPE revision was cited in the NRC IPE
25 evaluation report, but was not reviewed in detail.) A comparison of internal events CDF
26 between the 1995 IPE revision and the current PSA models indicates a decrease of about a
27 factor of four in the total CDF (from 2.8×10^{-5} per year to 6.4×10^{-6} per year). Entergy attributes
28 the decrease to improved plant performance, more realistic success criteria based on Modular
29 Accident Analysis Program (MAAP) analyses, and improvements in data handling (Entergy
30 2006a). A comparison of the contributors to the total CDF indicates that some have increased
31 while others have decreased. A summary listing of those changes that resulted in the greatest
32 impact on the internal events CDF was provided in the ER and is summarized in Table G-3.

Appendix G

Table G-3. PNPS PSA Historical Summary

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PSA Version	Summary of Changes from Prior Model	CDF (per year)
1992	IPE Submittal	5.85×10^{-5}
1995	<ul style="list-style-type: none"> IPE revised in response to NRC RAIs - removed high pressure coolant injection (HPCI) room cooling dependency - revised ADS success criteria - improved historical performance of HPCI/reactor core isolation cooling (RCIC) - eliminated low pressure injection after containment failure - added 3 recovery actions 	2.84×10^{-5}
2003	<ul style="list-style-type: none"> Completely revised in response to BWROG peer review - updated failure rate, test and maintenance data - completely revised event trees - incorporated Revision 4 of BWROG EOPs - revised thermal hydraulic analysis to support success criteria - completely revised system fault tree models to reflect as-built configuration - completely revised operator error evaluation - completely revised internal flooding analysis - revised quantification to include evaluation of human error and recovery actions in cutsets 	6.41×10^{-6}

The CDF value for the 1995 IPE revision (2.8×10^{-5} per year) is near the average of the CDF values reported in the IPEs for boiling water reactor (BWR) 3/4 plants. Figure 11.2 of NUREG-1560 shows that the IPE-based total internal events CDF for BWR 3/4 plants ranges from 9×10^{-8} to 8×10^{-5} per year, with an average CDF for the group of 2×10^{-5} per year (NRC 1997a). It is recognized that other plants have updated the values for CDF subsequent to the IPE submittals to reflect modeling and hardware changes. The current internal events CDF results for PNPS are comparable to or somewhat lower than that for other plants of similar vintage and characteristics.

The NRC staff considered the peer reviews performed for the PNPS PSA, and the potential impact of the review findings on the SAMA evaluation. In the ER, Entergy described the previous peer reviews, including the BWROG Peer Review of the 1992 IPE model conducted in March of 2000, and the independent consultant team review of the 2003 model. In response to an RAI, Entergy stated that the BWROG Peer Review included the 1992 IPE as well as the changes incorporated in the 1995 revision (Entergy 2006b). The BWROG review concluded

1 that the PNPS PSA can be effectively used to support applications after significant issues are
2 addressed. Entergy stated that all major issues and observations from the BWROG Peer
3 Review have been addressed and incorporated into the current PSA.
4

5 In response to an RAI, Entergy described steps taken to ensure the technical adequacy of the
6 2003 PSA model (Entergy 2006b). In addition to internal reviews, the 2003 model was reviewed
7 by a team of independent consultants prior to issuance. This team reviewed the major elements
8 of the PSA including: event trees, fault trees, human reliability, and the Level 2 model (Entergy
9 2006c). Recommended changes were examined with the review team and changes were made
10 to the analysis and the report. Entergy stated that the remaining changes would not impact the
11 conclusions of the SAMA analysis. In addition, subsequent to issuance, the 2003 PSA model
12 was reviewed by an independent team of PSA analysts from Entergy South against the
13 requirements of NEI-00-02, "Probabilistic Risk Assessment Peer Review Process Guidance."
14 The team concluded that the 2003 model addressed the appropriate elements and that the
15 update process was implemented in a manner that properly documents the model and
16 supporting analysis.
17

18 Given that the PNPS internal events PSA model has been peer-reviewed and the peer review
19 findings were either addressed or judged to have no adverse impact on the SAMA evaluation,
20 and that Entergy has satisfactorily addressed NRC staff questions regarding the PSA, the NRC
21 staff concludes that the internal events Level 1 PSA model is of sufficient quality to support the
22 SAMA evaluation.
23

24 As indicated above, the current PNPS PSA does not include external events. In the absence of
25 such an analysis, Entergy used the PNPS IPEEE to identify the highest risk accident sequences
26 and the potential means of reducing the risk posed by those sequences, as discussed below.
27

28 The PNPS IPEEE was submitted in July 1994 (BEC0 1994), in response to Supplement 4 of
29 Generic Letter 88-20 (NRC 1991). The applicant did not identify any fundamental weaknesses
30 or vulnerabilities to severe accident risk in regard to the external events related to seismic, fire,
31 or other external events. In a letter dated October 1, 1999, the NRC staff concluded that the
32 submittal met the intent of Supplement 4 to Generic Letter 88-20, and that the applicant's IPEEE
33 process is capable of identifying the most likely severe accidents and severe accident
34 vulnerabilities (NRC 1999).
35

36 The PNPS IPEEE seismic analysis employed a seismic probabilistic risk assessment (PRA)
37 with a simplified quantitative seismic containment performance analysis. The overall seismic
38 approach employed plant walkdowns by seismic review teams to identify components and
39 structures to be modeled, development of seismic fragility values for components and
40 structures, and risk quantification by fault tree analysis and integration of the plant logic model
41 with the seismic hazard curve. A relay chatter evaluation was performed assuming that low

Appendix G

1 ruggedness relays identified in the Unresolved Safety Issue (USI) A-46 program have been
2 replaced. The applicant determined the seismic risk to be 5.82×10^{-5} per year and found the
3 plant's high confidence low probability of failure (HCLPF) to be 0.25g peak ground acceleration
4 [(PGA) the acceleration due to the gravitation force (g)] including random and human errors,
5 and 0.32g PGA excluding the random and human error contributions. The applicant did not
6 identify any seismic vulnerabilities; however, in the process of performing the analysis, several
7 improvements were identified. These improvements involve structural modifications to the
8 station blackout diesel, the main transformer, and bus A8. The structural improvements were
9 subsequently implemented. The NRC review and closure of USI A-46 for PNPS are
10 documented in a letter dated February 7, 2002 (NRC 2002).

11
12 In the ER, Entergy indicates that the seismic CDF was recently re-evaluated to be 3.22×10^{-5}
13 per year. This updated CDF reflects a number of plant modifications and additional analyses
14 performed subsequent to the original seismic PRA. These include elimination of room cooling
15 requirements for HPCI, RCIC, Core Spray and residual heat removal (RHR) areas based on
16 updated room heat up calculations, updated random component failure probabilities, and
17 replacement of certain relays with seismically-rugged models.

18
19 In the ER, Entergy identified a number of conservatisms in the updated seismic model and
20 concluded that, based on engineering judgement, a more realistic seismic CDF would be at
21 least a factor of two lower than the revised seismic CDF, or about 1.61×10^{-5} per year. In
22 response to an NRC staff RAI, Entergy presented the results of a sensitivity analysis in which
23 the impact of removing two of these conservatisms was evaluated. The sensitivity case
24 included credit for reactor vessel depressurization via the safety relief valves (SRVs) (which was
25 not included in the updated model due to nitrogen makeup system fragility concerns), and a
26 more realistic estimate of the failure to align torus cooling or drywell sprays for containment
27 decay heat removal. The result was a factor of 1.9 reduction in seismic CDF. Based on the
28 information provided by the applicant, the NRC staff finds the use of a seismic CDF of 1.61×10^{-5}
29 per year to be reasonable for the purposes of the SAMA analysis.

30
31 The PNPS IPEEE fire analysis employed a combination of a probabilistic risk analysis and
32 Electric Power Research Institute's fire-induced vulnerability evaluation (FIVE) methodology.
33 The evaluation was performed in four phases: (1) qualitative screening, (2) quantitative
34 screening, (3) fire damage evaluation screening, and (4) fire scenario evaluation and
35 quantification. Each phase focused on those fire areas that did not screen out in the prior
36 phases. The final phase involved using the IPE model for internal events to quantify the CDF
37 resulting from a fire-initiating event. The CDF for each area was obtained by multiplying the
38 frequency of a fire in a given fire area by the conditional core damage probability associated
39 with that fire area including, where appropriate, the impact of fire suppression and fire
40 propagation. In most cases, it was assumed that all equipment in the area was damaged by the

1 fire. The potential impact on containment performance and isolation was evaluated following
2 the core damage evaluation.

3
4 The total fire CDF was estimated to be 2.2×10^{-5} per year (BEC0 1994). In the ER, Entergy
5 indicates that the IPEEE fire CDF was subsequently revised to 1.9×10^{-5} per year based on use
6 of updated equipment failure probabilities and unavailabilities. The applicant lists the following
7 ten fire areas as the dominant contributors to the fire risk:
8

	<u>Fire Area</u>	<u>Area Description</u>	<u>CDF (per year)</u>	
			<u>IPEEE</u>	<u>Revised</u>
10	13	Train B Switchgear Room	6.1×10^{-6}	6.9×10^{-6}
11	2B	Turbine Building Heater Bay	2.1×10^{-6}	2.7×10^{-6}
12	9	Vital Motor Generator Set Room	2.4×10^{-6}	2.4×10^{-6}
13	12	Train A Switchgear Room	3.1×10^{-6}	2.3×10^{-6}
14	3A	Train B reactor building closed cooling water/turbine building closed cooling water (RBCCW/TBCCW) Pump and Heat	2.0×10^{-6}	1.3×10^{-6}
15	6	Control Room	1.6×10^{-6}	8.9×10^{-7}
16	1E	Reactor Building West. El. 21	9.7×10^{-7}	8.3×10^{-7}
17	7	Cable Spreading Room	9.5×10^{-7}	7.9×10^{-7}
18	26	Main Transformer	1.5×10^{-6}	7.6×10^{-7}
19	4A	Train A RBCCW/TBCCW Pump and Heat	9.8×10^{-7}	3.0×10^{-7}
20	TOTAL		2.2×10^{-5}	1.9×10^{-5}

21
22 In the ER, Entergy states that the above CDF values are screening values and that a more
23 realistic fire CDF may be about a factor of 3 lower (or 6.37×10^{-6} per year) based on the NRC
24 staff estimate for another license renewal application. In response to an NRC staff RAI to justify
25 the factor of 3 reduction for PNPS, Entergy stated that the fire analysis is conservative in
26 several areas, including: (1) omission of fire severity factors, (2) use of an older PSA model to
27 obtain conditional core damage probabilities (CCDP), (3) no rigorous evaluation of plant
28 operating procedures during fire events, and (4) use of a simple fire suppression analysis.
29 Entergy presented the results of a sensitivity analysis which accounts for removal of two of the
30 conservatisms mentioned above. The sensitivity case included fire severity factors for the
31 dominant fire areas, and a requantified CCDP value for the transformer fire (Entergy 2006b).
32 This reduces the fire CDF to 6.11×10^{-6} per year. Entergy noted that this fire CDF could be
33 further reduced by addressing the remaining conservatisms listed above. Based on the results

Appendix G

1 of the sensitivity analysis and the existence of remaining conservatisms, the NRC staff finds the
2 use of a fire CDF of 6.37×10^{-6} per year to be reasonable for the purposes of the SAMA
3 analysis.

4
5 The IPEEE analysis of high winds, floods and other external events followed the screening and
6 evaluation approaches specified in Supplement 4 to GL 88-20 (NRC 1991) and did not identify
7 any significant sequences or vulnerabilities (BEC0 1994). Based on this result, Entergy
8 concluded that these other external hazards would not be expected to impact the conclusions of
9 the SAMA analysis and did not consider them further.

10
11 Based on the aforementioned results, the external events CDF is approximately 3.5 times the
12 internal events CDF (based on a seismic CDF of 1.61×10^{-5} per year, a fire CDF of 6.37×10^{-6}
13 per year, and an internal events CDF of 6.4×10^{-6} per year). Accordingly, the total CDF (from
14 internal and external event would be approximately 4.5 times the internal events CDF. In
15 revised SAMA analyses submitted in response to an RAI, Entergy multiplied the benefit that was
16 derived from the internal events model by a factor of 5 to account for the combined contribution
17 from internal and external events. The NRC staff agrees with the applicant's overall conclusion
18 concerning the impact of external events and concludes that the applicant's use of a multiplier
19 of 5 to account for external events is reasonable for the purposes of the SAMA evaluation.

20
21 The NRC staff reviewed the general process used by Entergy to translate the results of the
22 Level 1 PSA into containment releases, as well as the results of the Level 2 analysis, as
23 described in the ER and in response to NRC staff requests for additional information (Entergy
24 2006a, 2006b, and 2006c). The current Level 2 model utilizes a single CET containing both
25 phenomenological and systemic events. The Level 1 core damage sequences are binned into
26 one of 48 PDS bins based on binning criteria reflecting the state of the reactor, containment and
27 cooling systems as the accident progresses. The PDSs provide the interface between the Level
28 1 and Level 2 analysis. CET nodes are evaluated using supporting fault trees and logic rules.

29
30 Entergy characterized the releases for the spectrum of possible radionuclide release scenarios
31 using a set of 19 CAPBs based on the occurrence of core damage, the occurrence of vessel
32 breach, primary system pressure at vessel breach, the location of containment failure, the timing
33 of containment failure, and the occurrence of core-concrete interactions. The frequency of each
34 CAPB was obtained by summing the frequency of the individual PDS accident progression CET
35 endpoints binned into the CAPB. The release characteristics for each CAPB were obtained by
36 frequency weighting the release characteristics for each PDS contributing to the CAPB. The
37 source term release fractions for the PDS accident progression CET endpoints were estimated
38 using a source term algorithm which separately accounts for in-vessel and ex-vessel fission
39 product releases, and fission product removal mechanisms appropriate for the release
40 pathways. The inputs to the source term algorithm were based on the results of plant-specific
41 analyses of the dominant CET scenarios using the MAAP (MAAP4.04) computer program, and

1 fission product decontamination factors from the analysis of the Peach Bottom plant reported in
2 NUREG-1150 (NRC 1990). The CAPBs, their frequencies and release characteristics are
3 presented in Tables E.1-9 and E.1-11 of the ER (Entergy 2006a).
4

5 In response to an RAI, Entergy provided the results of consequence analyses to support the
6 process of frequency weighting the release fraction and other release characteristics of the
7 individual PDS accident progression CET endpoints binned into each CAPB (Entergy 2006c).
8 This analysis for CAPB-14, which is the dominant contributor to risk, indicates that the
9 frequency weighting process leads to a slight (about 8 percent) over-estimate in population
10 dose risk (person-rem per year) and a slight (about 6 percent) under-estimate in offsite
11 economic cost risk (dollars per year). The process is considered acceptable by the NRC staff
12 for the purposes of the SAMA analysis.
13

14 The NRC staff's review of the Level 2 IPE concluded that it addressed the most important
15 severe accident phenomena normally associated with the Mark I containment type, and
16 identified no significant problems or errors (NRC 1996). It should be noted, however, that the
17 current Level 2 model is a complete revision to that of the IPE. The Level 2 PSA model was
18 included in the independent consultant team review and the Entergy South review mentioned
19 previously. Based on the NRC staff's review of the Level 2 methodology, and the fact that the
20 Level 2 model was reviewed in more detail as part of an independent consultant review and a
21 more recent Entergy South review, and updated to address the review findings, the NRC staff
22 concludes that the Level 2 PSA provides an acceptable basis for evaluating the benefits
23 associated with various SAMAs.
24

25 Even though Entergy used the MACCS2 code and scaled the reference BWR core inventory for
26 PNPS plant-specific power level, the NRC staff requested that Entergy evaluate the impact on
27 population dose if the core inventory were based on the plant-specific burnup and enrichment
28 (NRC 2006a). In response to the NRC staff's request, Entergy derived a best estimate
29 inventory of long-lived isotopes (such as Sr-90, Cs-134 and Cs-137) from an ORIGEN
30 calculation assuming 4.65 percent enrichment and average burnup based on expected fuel
31 management practices. This resulted in an increase of approximately 25 percent in the
32 inventories of the aforementioned radionuclides (Entergy 2006b), an increase in the total
33 population dose from 13.6 to 14.6 person-rem per year, and an increase in the annual offsite
34 economic risk monetary equivalent (discussed later) from \$45,900 to \$52,600 (Entergy 2006d).
35 As part of their response, Entergy provided revised benefit estimates for each SAMA based on
36 the revised inventory values. The revised benefit estimates are presented and discussed in
37 Section G. 6.
38

39 The NRC staff reviewed the process used by Entergy to extend the containment performance
40 (Level 2) portion of the PSA to an assessment of offsite consequences (essentially a Level 3
41 PSA). This included consideration of the source terms used to characterize fission product

Appendix G

1 releases for the CAPBs and the major input assumptions used in the offsite consequence
2 analyses. The MACCS2 code was utilized to estimate offsite consequences. The consequence
3 results reported in the ER are based on use of MACCS2, Version 1.12. However, in response
4 to an RAI, Entergy provided revised SAMA benefit estimates based on use of MACCS2, Version
5 1.13.1 (NRC 2006b). Plant-specific input to the code includes the source terms for each
6 release category and the reactor core radionuclide inventory (both discussed above), site-
7 specific meteorological data, projected population distribution within a 50-mi radius for the year
8 2032, emergency evacuation modeling, and economic data. This information is provided in
9 Attachment E to the ER (Entergy 2006a).

10
11 Entergy used site-specific meteorological data for the 2001 calendar year as input to the
12 MACCS2 code. The data were collected from the onsite meteorological monitoring system and
13 the Automated Surface Observatory system at Plymouth Airport. In response to an RAI,
14 Entergy stated that it considered the year 2001 data to be the most current and complete set of
15 data at the time of the SAMA analysis (Entergy 2006b). Missing data were obtained from either
16 the lower tower or from estimates based on adjacent valid measurements of the missing hour.
17 The NRC staff notes that previous SAMA analyses results have shown little sensitivity to year-
18 to-year differences in meteorological data and concludes that the use of the 2001
19 meteorological data in the SAMA analysis is reasonable.

20
21 The population distribution the applicant used as input to the MACCS2 analysis was estimated
22 for the year 2032, based on the U.S. Census Bureau year 2000 population data together with
23 Massachusetts and Rhode Island population projection data. The 2000 population was adjusted
24 to account for transient population. These data were used to project county-level resident
25 populations to the year 2032 using a least squares fit method. The NRC staff considers the
26 methods and assumptions for estimating population reasonable and acceptable for purposes of
27 the SAMA evaluation.

28
29 The emergency evacuation model was modeled as a single evacuation zone extending out
30 10 mi from the plant. Entergy assumed that 100 percent of the population would move at an
31 average speed of approximately 2.17 mi per hour with a delayed start time of 40 minutes
32 (Entergy 2006a). This assumption is similar to the NUREG-1150 study (NRC 1990), which
33 assumed evacuation of 99.5 percent of the population within the emergency planning zone.
34 Sensitivity analyses were performed in which the evacuation delay time was increased to two
35 hours, and the evacuation speed was decreased to 0.69 meters per second (1.5 mi per hour).
36 The results were less than a one percent increase in the total population dose. The NRC staff
37 notes that the evacuation speeds used in the SAMA analysis were based on an evacuation time
38 estimate (ETE) study performed in 1998 (KLD 1998), and that an update of this study was
39 completed in 2004 (KLD 2004). However, use of the later study would not impact the SAMA
40 assessment. The average evacuation speeds from the updated study are essentially
41 unchanged from the earlier study. Also, the slowest evacuation speed from the updated study

1 (based on the most limiting combination of season, day of the week, time of day, and weather)
2 is equal to the evacuation speed used in Entergy's low evacuation speed sensitivity analysis.
3 The NRC staff concludes that the evacuation assumptions and analysis are reasonable and
4 acceptable for the purposes of the SAMA evaluation.
5

6 Much of the site-specific economic data was provided from the 1997 Census of Agriculture
7 (USDA 1998). These included the value of farm and non-farm wealth. Other data such as daily
8 cost for an evacuated person, population relocation cost, daily cost for a person who is
9 relocated, cost of farm and non-farm decontamination, and property depreciation were provided
10 from the Code Manual for MACCS2 (NRC 1997c). The data from the default values given in the
11 MACCS2 code manual were adjusted using the consumer price index of 177.1. Information on
12 regional crops were obtained from the New England Agricultural Statistics, 2001. Crops for
13 Massachusetts and Rhode Island were mapped into the seven MACCS2 crop categories.
14

15 The NRC staff concludes that the methodology used by Entergy to estimate the offsite
16 consequences for PNPS provides an acceptable basis from which to proceed with an
17 assessment of risk reduction potential for candidate SAMAs. Accordingly, the NRC staff based
18 its assessment of offsite risk on the CDF and offsite doses reported by Entergy.
19

20 **G.3 Potential Plant Improvements**

21
22 The process for identifying potential plant improvements, an evaluation of that process, and the
23 improvements evaluated in detail by Entergy are discussed in this section.
24

25 **G.3.1 Process for Identifying Potential Plant Improvements**

26
27 Entergy's process for identifying potential plant improvements (SAMAs) consisted of the
28 following elements:
29

- 30 • Review of the most significant basic events from the current, plant-specific PSA;
- 31 • Review of potential plant improvements identified in the PNPS IPE and IPEEE;
- 32 • Review of Phase II SAMAs from license renewal applications for six other U.S. nuclear
33 sites; and
- 34 • Review of other NRC and industry documentation discussing potential plant
35 improvements, e.g., NUREG-1560.
36
37
38
39

Appendix G

1 Based on this process, an initial set of 281 candidate SAMAs, referred to as Phase I SAMAs,
2 was identified. In Phase I of the evaluation, Entergy performed a qualitative screening of the
3 initial list of SAMAs and eliminated SAMAs from further consideration using the following
4 criteria:

- 5
- 6 • The SAMA is not applicable at PNPS due to design differences,
- 7
- 8 • The SAMA has already been implemented at PNPS, or
- 9
- 10 • The SAMA is similar in nature and could be combined with another SAMA candidate.
- 11

12 Based on this screening, 222 SAMAs were eliminated leaving 59 for further evaluation. The
13 remaining SAMAs, referred to as Phase II SAMAs, are listed in Table E.2-1 of the ER (Entergy
14 2006a). In Phase II, a detailed evaluation was performed for each of the 59 remaining SAMA
15 candidates, as discussed in Sections G.4 and G.6 below. To account for the potential impact of
16 external events, the estimated benefits based on internal events were multiplied by a factor of 5,
17 as discussed previously.

18 **G.3.2 Review of Entergy's Process**

19
20
21 Entergy's efforts to identify potential SAMAs focused primarily on areas associated with internal
22 initiating events. The initial list of SAMAs generally addressed the accident sequences
23 considered to be important to CDF from functional, initiating event, and risk reduction worth
24 (RRW) perspectives at PNPS, and included selected SAMAs from prior SAMA analyses for
25 other plants.

26
27 Entergy provided a tabular listing of the PSA basic events sorted according to their RRW
28 (Entergy 2006a). SAMAs impacting these basic events would have the greatest potential for
29 reducing risk. Entergy used a RRW cutoff of 1.005, which corresponds to about a one-half
30 percent change in CDF given 100-percent reliability of the SAMA. This equates to a benefit of
31 approximately \$20,000 (after the benefits have been multiplied to account for external events).
32 Entergy correlated the basic events with highest risk importance in the Level 1 PSA with the
33 SAMAs evaluated in Phase I or Phase II, and showed that all of the significant basic events are
34 addressed by one or more SAMAs (Entergy 2006a).

35
36 For a number of the Phase II SAMAs listed in the ER, the information provided did not
37 sufficiently describe the proposed modification. Therefore, the NRC staff asked the applicant to
38 provide more detailed descriptions of the modifications for several of the Phase II SAMAs
39 candidates (NRC 2006a). In response to the RAI, Entergy provided the requested information
40 (Entergy 2006b).

1
2 The NRC staff questioned the ability of some of the candidate SAMAs to accomplish their
3 intended objectives (NRC 2006a). In response to the RAIs, Entergy addressed the NRC staff's
4 concerns by either re-evaluating the existing SAMA using revised modeling assumptions, or by
5 evaluating an alternative (additional) SAMA (Entergy 2006b). This is discussed further in
6 Section G.6.2.

7
8 The NRC staff also questioned Entergy about lower cost alternatives to some of the SAMAs
9 evaluated, including the use of a redundant diesel fire pump for core injection, the use of a
10 portable generator to power the battery chargers, and the use of a portable generator to provide
11 alternate DC power feeds (NRC 2006a). In response to the RAIs, Entergy addressed the
12 suggested lower cost alternatives, some of which are covered by an existing procedure, or are
13 addressed by a new SAMA (Entergy 2006b). This is discussed further in Section G.6.2.

14
15 In the ER, Entergy states that in both the IPE and IPEEE, several enhancements related to
16 severe accident insights were recommended and implemented, and that these enhancements
17 were included in the comprehensive list of Phase I SAMA candidates. However, the list of
18 Phase I SAMA candidates was not provided in the ER. Therefore, the NRC staff requested that
19 the applicant indicate whether the enhancement has been implemented, and whether credit for
20 the enhancement is taken in the current PSA model (used for the SAMA analysis) (NRC 2006a).
21 In response to the RAI, Entergy indicated that Phase I SAMAs 248 through 281 include
22 enhancements recommended in the IPE and IPEEE. Entergy indicated that most of these
23 SAMAs have been implemented. Those enhancements that have not been implemented were
24 retained for consideration during Phase II.

25
26 Based on this information, the NRC staff concludes that the set of SAMAs evaluated in the ER,
27 together with those identified in response to NRC staff RAIs, addresses the major contributors
28 to internal event CDF.

29
30 In response to an NRC staff RAI, Entergy reviewed the list of important seismic faults identified
31 in the IPEEE to identify potential SAMAs. Most of the important contributors are assumed
32 correlated failures of relatively rugged (seismic capacities greater than 1.0 g). The only
33 component (other than piping) with a median capacity of less than 1.0 g is the Emergency
34 Diesel Generator (EDG) building, but this is not in the list of important components due to the
35 presence of the SBO diesel. One block wall included in the list of important faults has a
36 conservatively determined capacity of 1.06 g. As a result of this review, Entergy did not identify
37 any candidate SAMAs for further evaluation. Based on the applicant's IPEEE efforts to identify
38 and address seismic outliers and the expected cost associated with further seismic risk analysis
39 and potential plant modifications, the NRC staff concludes that the opportunity for seismic-
40 related SAMAs has been adequately explored and that there are no cost-beneficial, seismic-
41 related SAMA candidates.

Appendix G

1 Entergy also did not identify PNPS-specific candidate SAMAs for fire events. The fire risk at
2 PNPS is dominated by ten fire areas, the largest contributor being the Train B switchgear room.
3 The NRC staff asked the applicant to explain what measures were taken to further reduce risk
4 and why the fire risk cannot be further reduced in a cost effective manner (NRC 2006a). In
5 response to this request, Entergy stated that five fire areas from the revised IPEEE produced
6 fire CDF contributions in excess of 1×10^{-6} per year, and that these were due to modeling
7 conservatism. Application of the severity factors from the Electric Power Institute's Fire PRA
8 Implementation Guide (EPRI 1995), as discussed previously, reduced the individual CDF
9 contributions for all fire areas to below the 1×10^{-6} per year threshold. Therefore, modifications
10 to further reduce the fire CDF are unlikely to be cost beneficial (Entergy 2006b). Entergy also
11 stated that the risk significant fire areas are equipped with a fire detection system that alarms in
12 the control room, and that several of the areas are equipped with a fire suppression system.
13 Therefore, no cost-effective hardware changes were identified. As stated earlier, other external
14 hazards (high winds, external floods, and transportation and nearby facility accidents) are below
15 the threshold screening frequency and are not expected to impact the conclusions of the SAMA
16 analysis; therefore, no plant modifications were identified for these external hazards. The NRC
17 staff concludes that the applicant's rationale for eliminating these enhancements from further
18 consideration is reasonable.

19
20 The NRC staff notes that the set of SAMAs submitted is not all-inclusive, since additional,
21 possibly even less expensive, design alternatives can always be postulated. However, the NRC
22 staff concludes that the benefits of any additional modifications are unlikely to exceed the
23 benefits of the modifications evaluated and that the alternative improvements would not likely
24 cost less than the least expensive alternatives evaluated, when the subsidiary costs associated
25 with maintenance, procedures, and training are considered.

26
27 The NRC staff concludes that Entergy used a systematic and comprehensive process for
28 identifying potential plant improvements for PNPS, and that the set of potential plant
29 improvements identified by Entergy is reasonably comprehensive and therefore acceptable.
30 This search included reviewing insights from the plant-specific risk studies and reviewing plant
31 improvements considered in previous SAMA analyses. While explicit treatment of external
32 events in the SAMA identification process was limited, it is recognized that the prior
33 implementation of plant modifications for seismic events and the absence of external event
34 vulnerabilities reasonably justifies examining primarily the internal events risk results for this
35 purpose.

36 37 **G.4 Risk Reduction Potential of Plant Improvements**

38
39 Entergy evaluated the risk-reduction potential of the 59 remaining SAMAs (Phase II) that were
40 applicable to PNPS. The majority of the SAMA evaluations were performed in a bounding

1 fashion in that the SAMA was assumed to completely eliminate the risk associated with the
2 proposed enhancement. Such bounding calculations overestimate the benefit and are
3 conservative.

4
5 Entergy used model re-quantification to determine the potential benefits. The CDF and
6 population dose reductions were estimated using the PNPS PSA model. The changes made to
7 the model to quantify the impact of SAMAs are detailed in Section E.2.3 of Attachment E to the
8 ER (Entergy 2006a). Table G-4 lists the assumptions considered to estimate the risk reduction
9 for each of the evaluated SAMAs, the estimated risk reduction in terms of percent reduction in
10 CDF and population dose, and the estimated total benefit (present value) of the averted risk.
11 The estimated benefits reported in Table G-4 reflect the combined benefit in both internal and
12 external events, as well as a number of changes to the analysis methodology subsequent to the
13 ER. The determination of the benefits for the various SAMAs is further discussed in Section
14 G.6.

15
16 The NRC staff questioned the assumptions used in evaluating the benefits or risk reduction
17 estimates of certain SAMAs provided in the ER (NRC 2006a). SAMAs 002 and 019, both
18 concerning installing a filtered vent, indicated no reduction in offsite dose. In response to an
19 unrelated RAI, Entergy stated that the original values for these SAMAs were in error, and
20 provided revised results along with more details of the analysis of the benefits (Entergy 2006b).
21 In response to a subsequent request for clarification, Entergy provided additional information
22 that resolved the staff's concerns (Entergy 2006c).

23
24 For SAMA 53, control containment venting within a narrow band of pressure, the staff noted that
25 the analysis assumptions were not directly related to the impact of the SAMA on CDF. In
26 response to an RAI and a subsequent request for clarification, Entergy described a new
27 analysis that appropriately considered the impact of the SAMA and resulted in an increase in
28 the assessed benefit (Entergy 2006b, 2006c).

29
30 For SAMA 27, modification for improving DC bus reliability, the staff noted that the proposed
31 modification was identified to address the loss of DC bus initiators which contribute almost 50
32 percent to the CDF. However, SAMA 27 was estimated to reduce CDF by less than 5 percent.
33 In response to an RAI and subsequent request for clarification, Entergy reevaluated the benefit
34 by eliminating the occurrence of a loss of a 125 volt DC (VDC) bus initiator which resulted in a
35 24 percent reduction in CDF rather than the 5 percent reduction reported in the ER (Entergy
36 2006b).

37
38 The NRC staff has reviewed Entergy's bases for calculating the risk reduction for the various
39 plant improvements and concludes that the rationale and assumptions for estimating risk
40 reduction are reasonable and generally conservative (i.e., the estimated risk reduction is higher

1 than what would actually be realized). Accordingly, the NRC staff based its estimates of averted
2 risk for the various SAMAs on Entergy's risk reduction estimates.

3 4 **G.5 Cost Impacts of Candidate Plant Improvements**

5
6 Entergy estimated the costs of implementing the 59 candidate SAMAs through the application of
7 engineering judgment and use of other licensees' estimates for similar improvements. The cost
8 estimates conservatively did not include the cost of replacement power during extended
9 outages required to implement the modifications, nor did they include contingency costs
10 associated with unforeseen implementation obstacles. The cost estimates provided in the ER
11 did not account for inflation. For those SAMAs whose implementation costs were originally
12 developed for severe accident mitigation design alternative analyses (i.e., during the design
13 phase of the plant), additional costs associated with performing design modifications to the
14 existing plant were not included.

15
16 The NRC staff reviewed the bases for the applicant's cost estimates (presented in Section E.2.3
17 of Attachment E to the ER). For certain improvements, the NRC staff also compared the cost
18 estimates to estimates developed elsewhere for similar improvements, including estimates
19 developed as part of other licensees' analyses of SAMAs for operating reactors and advanced
20 light-water reactors. The NRC staff noted that several of the cost estimates provided by the
21 applicant were drawn from previous SAMA analyses for a dual-unit site. As such, the cost
22 estimates reflect implementation for two units. Also, some of the cost estimates provided (as
23 taken from other SAMA analyses) are specific to a plant's design, such as the number of valves
24 or batteries that would need to be replaced. Therefore, the NRC staff asked the applicant to
25 provide appropriate cost estimates that are specific to PNPS (NRC 2006a). In response to the
26 staff's request, Entergy provided revised cost estimates for several SAMAs (Entergy 2006b).
27 For those cost estimates that were taken from a dual-unit SAMA analysis, Entergy reduced the
28 estimated costs by half. For those SAMAs that required a more plant-specific cost estimate,
29 Entergy provided new cost estimates along with a brief explanation of what the cost estimates
30 include. Revision of these cost estimates had no impact on the original conclusions (Entergy
31 2006b). The staff reviewed the costs and subsequent cost revisions and found them to be
32 reasonable, and generally consistent with estimates provided in support of other plants'
33 analyses.

34
35 The NRC staff concludes that the cost estimates provided by Entergy are sufficient and
36 appropriate for use in the SAMA evaluation.

Table G-4. SAMA Cost/Benefit Screening Analysis for PNPS ^(a)

	SAMA	Assumptions	% Risk Reduction		Total Benefit Using 7% Discount Rate (\$) ^(b)	Total Benefit Using 3% Discount Rate (\$) ^(b)	Cost (\$)
			CDF	Population Dose			
			<hr/>				
4	Decay Heat Removal Capability – Torus Cooling	Completely eliminate loss of torus cooling mode of RHR system events	5	5	234,000	319,000	
6	1 - Install an independent method of suppression pool cooling						5,800,000
8	14 - Dedicated suppression pool cooling						5,800,000
9	Decay Heat Removal Capability – Drywell Spray	Completely eliminate loss of drywell spray mode of RHR system events	5	5	236,000	322,000	5,800,000
12	9 - Install a passive containment spray system						
14	Filtered Vent ^(c)	Reduce successful torus venting accident progression source terms by a factor of two	0	18	872,000	1,220,000	
15	2 - Install a filtered containment vent to provide fission product scrubbing.						3,000,000
17	Option 1: Gravel bed filter						
18	Option 2: Multiple venturi scrubber						
19	19 - Install a filtered vent						3,000,000
20	Containment Vent for ATWS Decay Heat Removal	Completely eliminate ATWS sequences associated with containment bypass	1	1	57,000	79,000	
22	3 - Install a containment vent large enough to remove ATWS decay heat						>2,000,000
24	47 - Install an ATWS sized vent						>2,000,000

Draft NUREG-1437, Supplement 29

G-19

December 2006

Table G-4. (contd)

SAMA	Assumptions	% Risk Reduction		Total Benefit Using 7% Discount Rate	Total Benefit Using 3% Discount Rate	Cost (\$)
		CDF	Population Dose	(\$) ^(b)	(\$) ^(b)	
Molten Core Debris Removal	Completely eliminate containment failures due to core-concrete interaction (not including liner failure)	0	49	2,410,000	3,360,000	
4 - Create a large concrete crucible with heat removal potential under the base mat to contain molten core debris						>100,000,000
5 - Install a core retention device inside the reactor pedestal area						19,000,000
8 - Create a core melt source reduction system						>5,000,000
23 - Install a reactor cavity flooding system						8,750,000
Flooding the Rubble Bed	Completely eliminate dry core-concrete interactions	0	23	1,125,000	1,570,000	
22 - Provide a means of flooding the rubble bed on the drywell floor						2,500,000
Base Mat Melt-Through	Completely eliminate containment failures due to base mat melt-through	0	1	27,000	38,000	>5,000,000
11 - Increase the depth of the concrete base mat or use an alternative concrete material to ensure melt-through does not occur						
Reactor Vessel Exterior Cooling	Reduce probability of vessel failure by a factor of two	0	~0	5,000	8,000	
12 - Provide a reactor vessel exterior cooling system						2,500,000

December 2006

G-20

Draft NUREG-1437, Supplement 29

Appendix G

Table G-4. (contd)

	SAMA	Assumptions	% Risk Reduction		Total Benefit Using 7%	Total Benefit Using 3%	Cost (\$)
			CDF	Population Dose	Discount Rate (\$) ^(b)	Discount Rate (\$) ^(b)	
5	Drywell Head Flooding	Completely eliminate drywell head failures due to high temperature	~0	~0	0	0	
6	G-21	6 - Provide modification for flooding the drywell head					>1,000,000
8		18 - Increase the temperature margin for seals					12,000,000
10		20 - Provide a method of drywell head flooding					>1,000,000
12	Reactor Building Effectiveness	Reactor building is available for all accidents, i.e., completely eliminate reactor building failures	0	1	59,000	83,000	
13	December 2006	7 - Enhance fire protection system and standby gas treatment system (SGTS) hardware and procedures					>2,500,000
16		13 - Construct a building connected to primary containment that is maintained at a vacuum					>2,000,000
19		21 - Use alternate method of reactor building spray					>2,500,000

Table G-4. (contd)

1 2 3	SAMA	Assumptions	% Risk Reduction		Total Benefit Using 7% Discount Rate (\$) ^(b)	Total Benefit Using 3% Discount Rate (\$) ^(b)	Cost (\$)
			CDF	Population Dose			
			4	5	6	7	
4	Strengthen Containment	Completely eliminate all energetic containment failure modes direct containment heating (DCH), steam explosions, late over-pressurization)	0	26	1,150,000	1,610,000	
5	10 - Strengthen primary and secondary containment						12,000,000
6							
7	15 - Create a larger volume in containment						8,000,000
8	16 - Increase containment pressure capability (sufficient pressure to withstand severe accidents)						12,000,000
9							
10							
11	24 - Add ribbing to the containment shell						12,000,000
12	Vacuum Breakers	Completely eliminate vacuum breaker failures are completely eliminated	~0	~0	0	0	>1,000,000
13							
14	17 - Install improved vacuum breakers (redundant valves in each line)						
15							
16	DC Power	Increase time available to recover offsite power (before HPCI and RCIC are lost) from 14 to 24 hours during SBO scenarios	1	3	133,000	183,000	
17	25 - Provide additional DC battery capacity						500,000
18	26 - Use fuel cells instead of lead-acid batteries						>1,000,000 ^(d)
19							

December 2006

G-22

Draft NUREG-1437, Supplement 29

Table G-4. (contd)

SAMA	Assumptions	% Risk Reduction		Total Benefit Using 7% Discount Rate (\$) ^(b)	Total Benefit Using 3% Discount Rate (\$) ^(b)	Cost (\$)
		CDF	Population Dose			
28 - Provide 16-hour SBO injection						500,000
33 - Install fuel cells						>1,000,000 ^(d)
35 - Extended SBO provisions						500,000
Improved DC System						
27 - Modification for improving DC bus reliability ^(e)	Completely eliminate loss of 125 VDC bus B initiator	24	16	839,000	1,130,000	1,950,000
34 - Enhance procedures to make use of DC bus cross-ties	Completely eliminate failures of DC buses D16 and D17	5	2	110,000	145,000	13,000
Dedicated DC Power and Additional Batteries and Divisions	Completely eliminate loss of DC bus D17 and loss of one division of DC power events	24	16	833,000	1,120,000	
31 - Add a dedicated DC power supply						3,000,000
32 - Install additional batteries or divisions						3,000,000
Improved AC Power System						
30 - Enhance procedures to make use of AC bus cross-ties	Completely eliminate loss of motor control centers (MCCs) B17, B18, and B15 events	11	8	427,000	577,000	146,000
Alternate Pump Power Source	Completely eliminate SBO diesel generator failures	2	5	248,000	342,000	
29 - Provide an alternate pump power source						>1,000,000 ^(d)

Draft NUREG-1437, Supplement 29

G-23

December 2006

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Table G-4. (contd)

December 2006

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G-24
Draft NUREG-1437, Supplement 29

SAMA	Assumptions	% Risk Reduction		Total Benefit Using 7% Discount Rate (\$) ^(b)	Total Benefit Using 3% Discount Rate (\$) ^(b)	Cost (\$)	
		CDF	Population Dose				
Locate RHR Inside Containment	Completely eliminate all RHR interface system loss-of-coolant accident (ISLOCA) sequences	<1	~0	8,000	11,000		
36 - Locate RHR inside containment							>500,000
ISLOCA	Completely eliminate all ISLOCA events	1	1	26,000	35,000		
37 - Increase frequency of valve leak testing							100,000
Main Stream Isolation Valve (MSIV) Design	Completely eliminate containment bypass due to MSIV leakage failures	~0	~0	0	0		
38 - Improve MSIV design							n/a ^(d)
Diesel to Condensate Storage Tank (CST) Makeup Pumps	Completely eliminate switchover from CST to torus failures	~0	~0	0	0		
39 - Install an independent diesel for the CST makeup pumps							135,000
High Pressure Injection System	HPCI system is always available	3	2	103,000	137,000		
40 - Provide an additional high pressure injection pump with independent diesel							>1,000,000 ^(d)
41 - Install independent AC high pressure injection system							>1,000,000 ^(d)
42 - Install a passive high pressure system							>1,000,000 ^(d)
44 - Install an additional active high pressure system							>1,000,000 ^(d)
45 - Add a diverse injection system						>1,000,000 ^(d)	

Table G-4. (contd)

	SAMA	Assumptions	% Risk Reduction		Total Benefit Using 7% Discount Rate (\$) ^(b)	Total Benefit Using 3% Discount Rate (\$) ^(b)	Cost (\$)
			CDF	Population Dose			
4	Improve the Reliability of High Pressure Injection System	Reduce HPCI system failure probability by a factor of 3	2	1	69,000	92,000	
7	43 - Improved high pressure systems						>1,000,000 ^(d)
8	SRVs Reseat	Completely eliminate stuck open SRV events	2	1	48,000	64,000	
10	46 - Increase SRV reseat reliability						1,800,000 ^(d)
11	Reliability of SRVs	Completely eliminate SRVs failing to open when required by reactor pressure vessel overpressure conditions	1	1	32,000	43,000	
13	49 - Increase reliability of SRVs by adding signals to open them automatically						>1,500,000
15	Improved SRV Design	Completely eliminate SRVs failing to open during reactor pressure vessel (RPV) depressurization events	5	3	173,000	232,000	
17	50 - Improve SRV design						1,500,000 ^(d)
18	Diversity of Explosive Valves	Completely eliminate common cause failures of standby liquid control (SLC) explosive valves	~0	~0	0	0	
20	48 - Diversify explosive valve operation						>200,000
21	Self-Cooled Emergency Core Cooling System (ECCS) Pump Seals	Completely eliminate RHR pump failures	<1	1	30,000	41,000	
24	51 - Provide self-cooled ECCS pump seals						>200,000
25	Large Break LOCA	Completely eliminate large break LOCAs	~0	~0	1,000	1,000	
28	52 - Provide digital large break LOCA protection						>100,000

Draft NUREG-1437, Supplement 29

G-25

December 2006

Table G-4. (contd)

SAMA	Assumptions	% Risk Reduction		Total Benefit Using 7% Discount Rate (\$) ^(b)	Total Benefit Using 3% Discount Rate (\$) ^(b)	Cost (\$)
		CDF	Population Dose			
Controlled Containment Venting	Credit continued vessel injection from low pressure	3	5	242,000	334,000	
53 - Control containment venting within a narrow band of pressure ^(f)	core injection (LPCI) or core spray for sequences with successful venting and failure of alternative injection systems after venting					300,000
ECCS Low Pressure Interlock	Completely eliminate sensor failure, low pressure permissive logic failure, and miscalibration events	<1	1	24,000	32,000	
54 - Install a bypass switch to bypass the low reactor pressure interlocks of LPCI or core spray injection valves						1,000,000
Improve the Reliability of salt service water (SSW) and RBCCW Pumps	Completely eliminate common cause failures of SSW and RBCCW pumps	4	7	335,000	460,000	
55 - Increase the reliability of SSW and RBCCW pumps						>5,000,000
Redundant DC Power Supplies to Direct Torus Vent (DTV) Valves	Completely eliminate failures of DTV valves AO-5042B and AO-5025 due to failure of DC power supply	9	3	200,000	265,000	
56 - Provide redundant DC power supplies to DTV valves						112,000
Proceduralize the Use of Diesel Fire Pump hydro turbine	Completely eliminate loss of offsite power (LOOP) and failure of either EDG A or fuel oil transfer pump P-141	2	3	157,000	215,000	
57 - Proceduralize use of the diesel fire pump hydro turbine in the event of EDG A failure or unavailability						26,000

December 2006

G-26

Draft NUREG-1437, Supplement 29

Table G-4. (contd)

SAMA	Assumptions	% Risk Reduction		Total Benefit Using 7% Discount Rate (\$) ^(b)	Total Benefit Using 3% Discount Rate (\$) ^(b)	Cost (\$)
		CDF	Population Dose			
Proceduralize Alignment of Bus B3 to Feed Bus B1 Loads of Bus B4 to Bus B2	Completely eliminate loss of 4.16 kilovolts (kV) bus A5 events	5	3	175,000	237,000	
58 - Proceduralize the operator action to feed B1 loads via B3 when A5 is unavailable post-trip. Similarly, feed B2 loads via B4 when A6 is unavailable post-trip						50,000
Redundant Path from Fire Water Pump Discharge to LPCI Loops A and B Cross-Tie	Completely eliminate failures to inject fire water into LPCI loops A and B cross-tie	9	17	846,000	1,170,000	
59 - Provide redundant path from fire protection pump discharge to LPCI loops A and B cross-tie						1,960,000

- (a) SAMAs in bold are potentially cost-beneficial
- (b) Estimated benefits taken from a revised assessment provided in response to RAI 3c (Entergy 2006b). This assessment is based on: (1) a multiplier of 5 to account for potential risk reduction in both internal and external events, (2) revised core inventories to reflect expect fuel management practices at PNPS, and (3) use of Version 1.13.1 of the MACCS2 code.
- (c) Due to an inadvertent use of baseline benefits rather than reduced benefits in the ER, the values for this analysis case have been corrected (Entergy 2006b).
- (d) Estimated costs reflect revised values provided in response to RAI 6.b (Entergy 2006b)
- (e) Estimated costs reflect revised values provided in response to RAI 5.e (Entergy 2006b)
- (f) Estimated benefits reflect revised values provided in response to RAI 6.d (Entergy 2006c)

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1 **G.6 Cost-Benefit Comparison**

2
3 Entergy's cost-benefit analysis and the NRC staff's review are described in the following
4 sections.

5 6 **G.6.1 Entergy's Evaluation**

7
8 The methodology used by Entergy was based primarily on NRC's guidance for performing
9 cost-benefit analysis, i.e., NUREG/BR-0184, *Regulatory Analysis Technical Evaluation*
10 *Handbook* (NRC 1997a). The guidance involves determining the net value for each SAMA
11 according to the following formula:

$$12 \text{ Net Value} = (\text{APE} + \text{AOC} + \text{AOE} + \text{AOSC}) - \text{COE}$$

14 where,

- 15
16
17 APE = present value of averted public exposure (\$)
18 AOC = present value of averted offsite property damage costs (\$)
19 AOE = present value of averted occupational exposure costs (\$)
20 AOSC = present value of averted onsite costs (\$)
21 COE = cost of enhancement (\$).

22
23 If the net value of a SAMA is negative, the cost of implementing the SAMA is larger than the
24 benefit associated with the SAMA and it is not considered cost-beneficial. Entergy's derivation
25 of each of the associated costs is summarized below.

26
27 NUREG/BR-0058 has recently been revised to reflect the agency's policy on discount rates.
28 Revision 4 of NUREG/BR-0058 states that two sets of estimates should be developed, one at 3
29 percent and one at 7 percent (NRC 2004). Entergy provided both sets of estimates (Entergy
30 2006a).

31 32 Averted Public Exposure (APE) Costs

33
34 The APE costs were calculated using the following formula:

$$35 \text{ APE} = \text{Annual reduction in public exposure } (\Delta \text{person-rem/per year}) \\ 36 \text{ x monetary equivalent of unit dose } (\$2000 \text{ per person-rem}) \\ 37 \text{ x present value conversion factor } (10.76 \text{ based on a 20-year period with a} \\ 38 \text{ 7-percent discount rate}).$$

39
40

1 As stated in NUREG/BR-0184 (NRC 1997a), it is important to note that the monetary value of
2 the public health risk after discounting does not represent the expected reduction in public
3 health risk due to a single accident. Rather, it is the present value of a stream of potential
4 losses extending over the remaining lifetime (in this case, the renewal period) of the facility.
5 Thus, it reflects the expected annual loss due to a single accident, the possibility that such an
6 accident could occur at any time over the renewal period, and the effect of discounting these
7 potential future losses to present value. For the purposes of initial screening, which assumes
8 elimination of all severe accidents due to internal events, Entergy calculated an APE of
9 approximately \$293,000 for the 20-year license renewal period.

10 Averted Offsite Property Damage Costs (AOC)

11 The AOCs were calculated using the following formula:

$$\begin{aligned} & \text{AOC} = \text{Annual CDF reduction} \\ & \quad \times \text{offsite economic costs associated with a severe accident (on a per-event} \\ & \quad \text{basis)} \\ & \quad \times \text{present value conversion factor.} \end{aligned}$$

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20 For the purposes of initial screening, which assumes all severe accidents due to internal events
21 are eliminated, Entergy calculated an annual offsite economic risk of about \$45,900 based on
22 the Level 3 risk analysis. This results in a discounted value of approximately \$494,000 for the
23 20-year license renewal period.

24 Averted Occupational Exposure (AOE) Costs

25
26
27 The AOE costs were calculated using the following formula:

$$\begin{aligned} & \text{AOE} = \text{Annual CDF reduction} \\ & \quad \times \text{occupational exposure per core damage event} \\ & \quad \times \text{monetary equivalent of unit dose} \\ & \quad \times \text{present value conversion factor.} \end{aligned}$$

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33
34 Entergy derived the values for averted occupational exposure from information provided in
35 Section 5.7.3 of the regulatory analysis handbook (NRC 1997a). Best estimate values provided
36 for immediate occupational dose (3300 person-rem) and long-term occupational dose (20,000
37 person-rem over a 10-year cleanup period) were used. The present value of these doses was
38 calculated using the equations provided in the handbook in conjunction with a monetary
39 equivalent of unit dose of \$2000 per person-rem, a real discount rate of 7 percent, and a time

Appendix G

1 period of 20 years to represent the license renewal period. For the purposes of initial screening,
2 which assumes all severe accidents due to internal events are eliminated, Entergy calculated an
3 AOE of approximately \$2,400 for the 20-year license renewal period.
4

5 Averted Onsite Costs

6

7 Averted onsite costs (AOSC) include averted cleanup and decontamination costs and averted
8 power replacement costs. Repair and refurbishment costs are considered for recoverable
9 accidents only and not for severe accidents. Entergy derived the values for AOSC based on
10 information provided in Section 5.7.6 of NUREG/BR-0184, the regulatory analysis handbook
11 (NRC 1997a).
12

13 Entergy divided this cost element into two parts – the onsite cleanup and decontamination cost,
14 also commonly referred to as averted cleanup and decontamination costs, and the replacement
15 power cost.
16

17 Averted cleanup and decontamination costs (ACC) were calculated using the following formula:
18

$$\begin{aligned} 19 \quad \text{ACC} &= \text{Annual CDF reduction} \\ 20 \quad &\quad \times \text{ present value of cleanup costs per core damage event} \\ 21 \quad &\quad \times \text{ present value conversion factor.} \end{aligned}$$

22

23 The total cost of cleanup and decontamination subsequent to a severe accident is estimated in
24 the regulatory analysis handbook to be $\$1.5 \times 10^9$ (undiscounted). This value was converted to
25 present costs over a 10-year cleanup period and integrated over the term of the proposed
26 license extension. For the purposes of initial screening, which assumes all severe accidents
27 due to internal events are eliminated, Entergy calculated an ACC of approximately \$74,000 for
28 the 20-year license renewal period.
29

30 Long-term replacement power costs (RPC) were calculated using the following formula:
31

$$\begin{aligned} 32 \quad \text{RPC} &= \text{Annual CDF reduction} \\ 33 \quad &\quad \times \text{ present value of replacement power for a single event} \\ 34 \quad &\quad \times \text{ factor to account for remaining service years for which replacement power is} \\ 35 \quad &\quad \text{required} \\ 36 \quad &\quad \times \text{ reactor power scaling factor} \end{aligned}$$

37

38 For the purposes of initial screening, which assumes all severe accidents due to internal events
39 are eliminated, Entergy calculated an RPC of approximately \$51,000 for the 20-year license
40 renewal period.

1 Using the above equations, Entergy estimated the total present dollar value equivalent
2 associated with completely eliminating severe accidents from internal events at PNPS to be
3 about \$914,000. Use of a multiplier of 5 to account for external events increases the value to
4 \$4.5M and represents the dollar value associated with completely eliminating all internal and
5 external event severe accident risk at PNPS.

6 7 Entergy's Results

8
9 If the implementation costs for a candidate SAMA exceeded the calculated benefit, the SAMA
10 was considered not to be cost-beneficial. In the baseline analysis contained in the ER (using a
11 7 percent discount rate, and considering the combined impact of both external events and
12 uncertainties), Entergy identified five potentially cost-beneficial SAMAs. The potentially
13 cost-beneficial SAMAs are:

- 14 • SAMA 30 – install key-locked control switches to enable AC bus cross-ties and modify
15 procedures to enhance the reliability of the AC power system.
- 16 • SAMA 34 – modify plant procedures to use DC bus cross-ties to enhance the reliability
17 of the DC power system.
- 18 • SAMA 56 – install additional fuses in panel C7 to enable the DTV valve function during
19 loss of containment heat removal accident sequences.
- 20 • SAMA 57 – modify plant procedures to allow use of the diesel fire pump hydro turbine in
21 the event that EDG A fails or fuel oil transfer pump P-141A is unavailable.
- 22 • SAMA 58 – modify plant procedures to allow alternately feeding B1 loads via B3 when
23 A3 is available, and alternately feeding B2 loads via B4 when A4 is available.

24
25 Entergy performed additional analyses to evaluate the impact of alternative discount rates and
26 remaining plant life on the results of the SAMA assessment. No additional SAMA candidates
27 were determined to be potentially cost-beneficial (Entergy 2006a). In response to an RAI,
28 Entergy provided a revised assessment based on modified multipliers and a separate
29 accounting of uncertainties. The revised assessment resulted in identification of the same
30 potentially cost-beneficial SAMAs. However, in response to additional NRC staff inquiries
31 regarding estimated benefits for certain SAMAs and lower cost alternatives, Entergy identified
32 two additional potentially cost-beneficial SAMAs. The potentially cost-beneficial SAMAs, and
33 Entergy's plans for further evaluation of these SAMAs are discussed in more detail in Section
34 G.6.2.

G.6.2 Review of Entergy's Cost-Benefit Evaluation

The cost-benefit analysis performed by Entergy was based primarily on NUREG/BR-0184 (NRC 1997a) and was executed consistent with this guidance.

In the ER, Entergy evaluated the reduction in risk for each SAMA in the context of an upper bound analysis which combined the impact of seismic and fire external events with the impact of uncertainty. The impact of external events was considered by applying a multiplier of 3.51 to the estimated SAMA benefits in internal events [(seismic CDF of 1.61×10^{-5} per year + fire CDF of 6.37×10^{-6} per year) / (internal events CDF of 6.4×10^{-6} per year)]. The impact of uncertainties was considered by applying an additional multiplier of 1.62, which represents the ratio of the 95th percentile CDF to the mean CDF for internal events. Entergy bounded the combined impact of external events and uncertainties by applying a multiplier of 6 to the estimated SAMA benefits in internal events.

In an RAI, the NRC staff requested that the baseline evaluation be revised to include only the impact of internal and external events (without uncertainties), and that the impact of analysis uncertainties on the SAMA evaluation results be considered separately (NRC 2006a). The NRC staff also pointed out that the external events multiplier should be at least 4.51 (to account for internal events CDF plus external events CDF) rather than 3.51. In response to the RAI, Entergy revised the baseline benefit values by applying a multiplier of 5 to the estimated SAMA benefits in internal events to account for potential SAMA benefits in both internal and external events (Entergy 2006b). Additionally, Entergy revised the consequence analyses on which the benefit estimates are based to account for fuel enrichment and burnup expected during the period of extended operation, and use of a later version of the MACCS2 code.

As a result of the revised baseline analysis (using a multiplier of 5 and a 7 percent real discount rate), Entergy found that the same five SAMA candidates (mentioned above) remained potentially cost-beneficial. No additional SAMA candidates were found to be potentially cost-beneficial. When benefits were evaluated using a 3 percent discount rate, as recommended in NUREG/BR-0058, Revision 4 (NRC 2004), no additional SAMAs were determined to be potentially cost-beneficial. Entergy considered the impact that possible increases in benefits from analysis uncertainties would have on the results of the SAMA assessment. In the ER, Entergy presents the results of an uncertainty analysis of the internal events CDF which indicates that the 95th percentile value is a factor of 1.62 times the mean CDF. Entergy re-examined the Phase II SAMAs to determine if any would be potentially cost beneficial if the revised baseline benefits were increased by an additional factor of 1.6. No additional SAMAs were identified.

1 In the ER, Entergy noted that the SAMA analysis is conservative and does not estimate all of
2 the benefits or all of the costs of a SAMA. Therefore, Entergy has submitted the five potentially
3 cost-beneficial SAMAs for engineering project cost-benefit analysis.
4

5 The NRC staff questioned the ability of some of the candidate SAMAs identified in the ER to
6 accomplish their intended objectives (NRC 2006a). In response to the RAIs, Entergy addressed
7 each SAMA and provided revised or new evaluations as discussed below.
8

- 9 • Phase II SAMA 27, modification for improving DC bus reliability, is the only SAMA listed
10 in the ER that directly addresses improving DC system reliability. Loss of DC bus
11 initiators contribute almost 50 percent of the internal events CDF. The CDF reduction
12 from implementation of SAMA 27 was estimated to be less than 5 percent. The staff
13 asked the applicant to discuss the loss of DC initiators in more detail, and the potential
14 for other modifications to reduce this contribution to CDF. In response, Entergy provided
15 additional information regarding the dominant contributors to loss of DC sequences, and
16 the simplifications made in the original SAMA assessment, in view of the fact that PNPS
17 has had no occurrences of loss of a DC bus in its operating history. Entergy reevaluated
18 the benefits of SAMA 27 by postulating that it would completely eliminate the occurrence
19 of a loss of a 125 VDC bus B initiator. This resulted in a 24 percent reduction in CDF, a
20 16 percent reduction in population dose, and a benefit (including the impact of
21 uncertainties) of approximately \$1.3 million. However, Entergy estimated the cost of
22 implementing this SAMA to be almost \$2 million (Entergy 2006b). Therefore, SAMA 27
23 would not be cost-beneficial.
24

25 The NRC staff notes that SAMA 27 involves improving injection capability by adding a
26 capability for auto-transfer of AC bus control power to a standby DC power source upon
27 loss of the normal DC source. The associated modifications are substantial, and the
28 implementation costs are therefore significant. A lower cost alternative, involving
29 enhancing procedures to make use of DC bus cross-ties to improve DC power reliability,
30 was evaluated as SAMA 34 and found to be potentially cost-beneficial, as mentioned
31 above. In view of the large contribution to risk from DC power related events, additional
32 lower cost alternatives for improving DC power were also pursued, as discussed below.
33

- 34 • Phase II SAMA 53, control containment venting within a narrow pressure band, was
35 identified as a potential SAMA to further reduce the risk contribution from basic event
36 CIV-XHE-FO-DTV, operator fails to vent containment using the direct torus vent. The
37 NRC staff questioned both the risk reduction estimate provided by Entergy for this
38 SAMA, as well as the whether an alternative SAMA to create a passive vent system
39 might be cost-beneficial.
40

Appendix G

1 In the ER, Entergy estimated the benefit of controlling containment venting within a
2 narrow pressure band, by reducing the probability of operator failure to vent, by a factor
3 of 3. The NRC staff noted that the benefit of controlled venting occurs for sequences
4 involving successful venting, and that these sequences are not affected by reducing the
5 operator failure to vent. In response to an RAI, Entergy performed a revised evaluation
6 by crediting continued vessel injection from LPCI or Core Spray for those sequences in
7 which torus venting is successful and alternative injection systems fail after torus
8 venting. Since the available net positive suction head (NPSH) is likely to be less than
9 the required NPSH with the vent open, a failure probability of 0.9 was assigned for this
10 new success path. The PSA model change resulted in about a 3 percent reduction in
11 CDF, a 5 percent reduction in population dose, and a benefit (including the impact of
12 uncertainties) of approximately \$387,000. Entergy concluded that this SAMA is
13 potentially cost-beneficial for PNPS provided the existing torus vent path, valves, and
14 controls do not require hardware modification (Entergy 2006c).

15
16 The NRC staff also asked the applicant to provide an evaluation of the costs and
17 benefits of converting the vent system to a passive design. In response, Entergy
18 evaluated a new SAMA that would involve modifying the air operated valves and the
19 associated solenoid valves so that the valves fail open on loss of air and nitrogen or on
20 loss of power. Entergy estimated that this modification would result in a CDF and
21 population dose reduction of about 14 percent, and a benefit (including the impact of
22 uncertainties) of \$1.2 million. However, Entergy estimated the cost of implementing this
23 SAMA to be approximately \$3.1million (Entergy 2006b). Therefore, this new SAMA
24 would not be cost beneficial at PNPS.

- 25
26 • Phase II SAMAs 57 and 59, which are procedural and hardware modifications,
27 respectively, were identified as potential SAMAs to further reduce the risk contribution
28 from two basic events – FXT-XHE-FO-V4T2, operator fails to align fire water crosstie for
29 reactor pressure vessel via LPCI, and FST-XHE-FO-DWS, operator fails to align fire
30 water cross-tie for drywell spray. The NRC staff noted that these SAMAs may not
31 effectively address the basic events, which are operator errors. Therefore, the NRC staff
32 asked the applicant to identify and evaluate other SAMAs that might lower the
33 importance of these events. In response, Entergy evaluated a new SAMA that would
34 involve changing an existing removable spool piece to permanent piping and providing
35 the capability to open locked-closed manual valves remotely from the control room.
36 These modifications would increase the success probability of the actions to align fire
37 water to the LPCI injection path. Entergy estimated that this modification would result in
38 a CDF reduction of less than 3 percent, a population dose reduction of 4 percent and a
39 benefit (including the impact of uncertainties) of approximately \$310,000. Entergy

1 estimated the cost of implementing this SAMA to be almost \$3 million (Entergy 2006b).
2 Therefore, this new SAMA would not be cost beneficial at PNPS
3

4 The NRC staff noted that for certain SAMAs considered in the ER, there may be alternatives
5 that could achieve much of the risk reduction at a lower cost. The NRC staff asked the
6 applicant to evaluate several lower cost alternatives to the SAMAs considered in the ER,
7 including SAMAs that had been found to be potentially cost-beneficial at other BWR plants.
8 These alternatives included: (1) the use of a redundant diesel fire pump for core injection, (2)
9 the use of a portable generator to power the battery chargers, (3) provide cables from diesel
10 generators to directly power battery chargers, (4) use portable generator to provide alternate DC
11 feed to panels supplied only by DC bus, and several additional alternatives (NRC 2006a).
12 Entergy provided a further evaluation of these alternatives, as summarized below.
13

- 14 • Use of a redundant diesel fire pump for core injection (in lieu of a diverse injection
15 system considered in Phase II SAMA 45) - Based on a bounding analysis in which
16 failures of the diesel fire pump to start and run were set to zero, this alternative was
17 estimated to result in a CDF reduction of about 4 percent, a population dose reduction of
18 8 percent and a benefit (including the impact of uncertainties) of \$650,000. However,
19 Entergy estimated the cost of implementing this SAMA to be approximately \$5.5 million
20 (Entergy 2006b). Therefore, this new SAMA would not be cost beneficial at PNPS.
21
- 22 • Use of a portable generator to power the battery chargers - In response to the NRC
23 staff's inquiry regarding use of a portable generator, Entergy stated that an existing 400
24 kilowatt security diesel generator could be used to extend the life of both 125 VDC
25 batteries. To assess the benefit, the probability of non-recovery of offsite power for 14
26 hours was increased to 24 hours. This resulted in a benefit (with uncertainties) of
27 approximately \$212,000 (Entergy 2006b). Entergy estimated the cost of implementing
28 this SAMA to be \$75,000. Entergy concluded that this low-cost alternative is potentially
29 cost-beneficial for PNPS.
30
- 31 • Provide cables from diesel generators to directly power battery chargers, and use
32 portable generator to provide alternate DC feed to panels – Entergy indicated that these
33 SAMAs do not address the dominant DC-related failures for PNPS. Also, Phase II
34 SAMA 34 (which was identified as potentially cost-beneficial in the baseline analysis)
35 and the additional, potentially cost-beneficial, alternative discussed above adequately
36 address the issues regarding DC power reliability.
37
- 38 • Entergy indicated that the remaining low cost alternatives are either already addressed
39 by existing plant procedures or by a Phase II SAMA.
40

Appendix G

1 The NRC staff notes that all of the potentially cost-beneficial SAMAs identified in either
2 Entergy's baseline analysis or uncertainty analysis are included within the set of SAMAs that
3 Entergy plans to further evaluate. However, two additional potentially cost-beneficial SAMAs
4 were identified as a result of the NRC staff review: (1) SAMA 53, control containment venting
5 within a narrow pressure band and (2) a new SAMA, use the security diesel generator to extend
6 the life of the 125 VDC batteries. These SAMA should also be included in the set of SAMAs to
7 be further evaluated by Entergy.

8
9 The NRC staff concludes that, with the exception of the potentially cost-beneficial SAMAs
10 discussed above, the costs of the SAMAs evaluated would be higher than the associated
11 benefits.

12 13 **G.7 Conclusions**

14
15 Entergy compiled a list of 281 SAMAs based on a review of: the most significant basic events
16 from the plant-specific PSA, insights from the plant-specific IPE and IPEEE, Phase II SAMAs
17 from license renewal applications for other plants, and review of other NRC and industry
18 documentation. A qualitative screening removed SAMA candidates that (1) were not applicable
19 at PNPS due to design differences, (2) had already been implemented at PNPS, or (3) were
20 similar and could be combined with another SAMA. Based on this screening, 222 SAMAs were
21 eliminated leaving 59 candidate SAMAs for evaluation.

22
23 For the remaining SAMA candidates, a more detailed design and cost estimate was developed
24 as shown in Table G-4. The cost-benefit analyses showed that five of the SAMA candidates
25 were potentially cost-beneficial in the baseline analysis (Phase II SAMAs 30, 34, 56, 57, and
26 58). Entergy performed additional analyses to evaluate the impact of parameter choices and
27 uncertainties on the results of the SAMA assessment. As a result, no additional SAMAs were
28 identified as potentially cost-beneficial in the ER. Entergy has indicated that the potentially cost-
29 beneficial SAMAs have been submitted for engineering project cost-benefit analysis. The NRC
30 staff concluded that all of these SAMAs are potentially cost-beneficial. In addition, as a result of
31 the NRC staff review, Entergy concluded that two additional SAMAs are also potentially cost-
32 beneficial, i.e., control containment venting within a narrow pressure band, and use the security
33 diesel generator to extend the life of the 125 VDC batteries.

34
35 The NRC staff reviewed the Entergy analysis and concludes that the methods used and the
36 implementation of those methods was sound. The treatment of SAMA benefits and costs
37 support the general conclusion that the SAMA evaluations performed by Entergy are reasonable
38 and sufficient for the license renewal submittal. Although the treatment of SAMAs for external
39 events was somewhat limited, the likelihood of there being cost-beneficial enhancements in this

1 area was minimized by improvements that have been realized as a result of the IPEEE process,
2 and inclusion of a multiplier to account for external events.

3
4 The NRC staff concurs with Entergy's identification of areas in which risk can be further reduced
5 in a cost-beneficial manner through the implementation of the identified, potentially cost-
6 beneficial SAMAs. Given the potential for cost-beneficial risk reduction, the NRC staff agrees
7 that further evaluation of these SAMAs by Entergy is warranted. However, these SAMAs do not
8 relate to adequately managing the effects of aging during the period of extended operation.
9 Therefore, they need not be implemented as part of license renewal pursuant to Title 10 of the
10 *Code of Federal Regulations*, Part 54.

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11. ABSTRACT (200 words or less)

This draft supplemental environmental impact statement (SEIS) has been prepared in response to an application submitted by Entergy Nuclear Operations, Inc. (Entergy), a subsidiary of Entergy Corporation, to the NRC to renew the OL for Pilgrim Nuclear Power Station (PNPS) for an additional 20 years under 10CFR Part54. This draft SEIS includes the NRC staff's analysis that considers and weighs the environmental impacts of the proposed action, the environmental impacts of alternatives to the proposed action, and mitigation measures available for reducing or avoiding adverse impacts. It also includes the staff's preliminary recommendation regarding the proposed action.

The NRC staff's preliminary recommendation is that the Commission determine that the adverse environmental impacts of license renewal for PNPS are not so great that preserving the option of license renewal for energy-planning decisionmakers would be unreasonable. This recommendation is based on (1) the analysis and findings in the GEIS; (2) the Environmental Report submitted by Entergy; (3) consultations with Federal, State, and local agencies; (4) the staff's own independent review; and (5) the staff's consideration of public comments received during the scoping process.

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