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United States Nuclear Regulatory Commission
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NUREG-2168, Vol. 2

Environmental Impact Statement for an Early Site Permit (ESP) at the PSEG Site

Final Report

Chapters 6 to 12

U.S. Nuclear Regulatory Commission
Office of New Reactors
Washington, DC 20555-0001

Regulatory Branch
Philadelphia District
U.S. Army Corps of Engineers
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ABSTRACT

This environmental impact statement (EIS) has been prepared in response to an application submitted on May 25, 2010 to the U.S. Nuclear Regulatory Commission (NRC) by PSEG Power, LLC, and PSEG Nuclear, LLC (PSEG), for an early site permit (ESP). The proposed actions requested in the PSEG application are (1) the NRC issuance of an ESP for the PSEG Site located adjacent to the existing Hope Creek Generating Station and Salem Generating Station, Units 1 and 2, in Lower Alloways Creek Township, Salem County, New Jersey, and (2) U.S. Army Corps of Engineers (USACE) permit action on a Department of the Army permit application to perform certain construction activities on the site. The USACE is a cooperating agency with the NRC in preparing this EIS and participates collaboratively on the review team.

This EIS includes the review team's analysis that considers and weighs the environmental impacts of building and operating a new nuclear power plant at the proposed PSEG Site, at alternative sites and mitigation measures available for reducing or avoiding adverse impacts. The EIS also addresses Federally listed species, cultural resources, essential fish habitat issues, and plant cooling system design alternatives.

The EIS includes the evaluation of the proposed action's impacts on waters of the United States pursuant to Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Appropriation Act of 1899. The USACE will conduct a public interest review in accordance with the guidelines promulgated by the U.S. Environmental Protection Agency under authority of Section 404(b) of the Clean Water Act. The public interest review, which will be addressed in

the USACE permit decision document, will include an alternatives analysis to determine the least environmentally damaging practicable alternative.

After considering the environmental aspects of the proposed NRC action, the NRC staff's recommendation to the Commission is that the ESP be issued as requested.
This recommendation is based on (1) the application submitted by PSEG, including Revision 4 of the Environmental Report (ER), and the PSEG responses to requests for additional information from the NRC and USACE staffs; (2) consultation with Federal, State, Tribal, and local agencies; (3) the staff's independent review; (4) the staff's consideration of comments related to the environmental review that were received during the public scoping process and the public comment period following the publication of the draft EIS; and (5) the assessments summarized in this EIS, including the potential mitigation measures identified in the ER and this EIS. The USACE will issue its Record of Decision based, in part, on this EIS.

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CONTENTS

Page

ABSTRACT iii
FIGURES xiii
TABLES xvii
EXECUTIVE SUMMARY xxiii
ACRONYMS AND ABBREVIATIONS xxxv
1.0 INTRODUCTION 1-1
1.1 Background 1-1
1.1.1 Plant Parameter Envelope 1-2
1.1.2 Site Preparation and Preliminary Construction Activities 1-2
1.1.3 NRC ESP Application Review 1-3
1.1.4 USACE Permit Application Review 1-6
1.1.5 Preconstruction Activities 1-7
1.1.6 Cooperating Agencies 1-7
1.1.7 Concurrent NRC Reviews 1-9
1.2 The Proposed Federal Actions 1-9
1.3 The Purpose and Need for the Proposed Actions 1-10
1.3.1 NRC Proposed Action 1-10
1.3.2 The USACE Permit Action 1-11
1.4 Alternatives to the Proposed Actions 1-12
1.5 Compliance and Consultations 1-13
1.6 Report Contents 1-13
2.0 AFFECTED ENVIRONMENT 2-1
2.1 Site Location 2-1
2.2 Land Use 2-5
2.2.1 The Site and Vicinity 2-5
2.2.2 Offsite Areas 2-15
2.2.3 The Region 2-21
2.3 Water 2-24
2.3.1 Hydrology 2-24
2.3.2 Water Use 2-42
2.3.3 Water Quality 2-45
2.3.4 Water Monitoring 2-51
2.4 Ecology 2-52
2.4.1 Terrestrial and Wetland Ecology 2-52
2.4.2 Aquatic Ecology 2-83
2.5 Socioeconomics 2-117

2.5.1 Demographics 2-118
2.5.2 Community Characteristics 2-124
2.6 Environmental Justice 2-145
2.6.1 Methodology 2-146
2.6.2 Scoping and Outreach 2-155
2.6.3 Special Circumstances of the Minority and Low-Income Populations 2-155
2.6.4 Migrant Populations 2-156
2.6.5 Environmental Justice Summary 2-156
2.7 Historic and Cultural Resources 2-156
2.7.1 Cultural Background 2-159
2.7.2 Historic and Cultural Resources at the PSEG Site and Offsite Areas 2-161
2.7.3 Consultation 2-166
2.7.4 Post-Draft EIS Consultation Activities 2-167
2.8 Geology 2-170
2.9 Meteorology and Air Quality 2-172
2.9.1 Climate 2-173
2.9.2 Air Quality 2-176
2.9.3 Atmospheric Dispersion 2-178
2.9.4 Meteorological Monitoring 2-180
2.10 Nonradiological Health 2-185
2.10.1 Public and Occupational Health 2-186
2.10.2 Noise 2-187
2.10.3 Transportation 2-188
2.10.4 Electromagnetic Fields 2-189
2.11 Radiological Environment 2-190
2.12 Related Federal Projects and Consultation 2-192
3.0 SITE LAYOUT AND PLANT PARAMETER ENVELOPE 3-1
3.1 External Appearance and Site Layout 3-1
3.2 Plant Parameter Envelope 3-4
3.2.1 Plant Water Use 3-7
3.2.2 Proposed Plant Structures 3-11
3.3 Construction and Preconstruction Activities 3-18
3.3.1 Site Preparation 3-19
3.3.2 Power Block Construction 3-22
3.3.3 Construction Workforce 3-24
3.3.4 Summary of Resource Commitments During Construction and Preconstruction 3-24
3.4 Operational Activities 3-25
3.4.1 Description of Cooling System Operational Modes 3-25
3.4.2 Plant-Environmental Interfaces During Operation 3-25

3.4.3 Radioactive Waste Management Systems 3-27
3.4.4 Nonradioactive Waste Management Systems 3-28
4.0 CONSTRUCTION IMPACTS AT THE PROPOSED SITE 4-1
4.1 Land-Use Impacts 4-4
4.1.1 The Site and Vicinity 4-4
4.1.2 Offsite Areas 4-8
4.2 Water-Related Impacts 4-12
4.2.1 Hydrological Alterations 4-13
4.2.2 Water-Use Impacts 4-18
4.2.3 Water-Quality Impacts 4-21
4.2.4 Hydrological Monitoring 4-24
4.3 Ecological Impacts 4-24
4.3.1 Terrestrial and Wetland Impacts 4-25
4.3.2 Aquatic Impacts 4-44
4.4 Socioeconomic Impacts 4-54
4.4.1 Physical Impacts 4-55
4.4.2 Demography 4-60
4.4.3 Economic Impacts to the Community 4-64
4.4.4 Infrastructure and Community Service Impacts 4-69
4.4.5 Summary of Socioeconomic Impacts 4-79
4.5 Environmental Justice Impacts 4-79
4.5.1 Health Impacts 4-80
4.5.2 Physical and Environmental Impacts 4-80
4.5.3 Socioeconomic Impacts 4-82
4.5.4 Subsistence and Special Conditions 4-82
4.5.5 Migrant Labor 4-83
4.5.6 Summary of Environmental Justice Impacts 4-83
4.6 Historic and Cultural Resources 4-83
4.7 Meteorological and Air-Quality Impacts 4-86
4.7.1 Construction and Preconstruction Activities 4-86
4.7.2 Traffic (Emissions) 4-88
4.7.3 Summary 4-89
4.8 Nonradiological Health Impacts 4-89
4.8.1 Public and Occupational Health 4-90
4.8.2 Noise Impacts 4-94
4.8.3 Impacts of Transporting Construction Materials and Construction Personnel to the PSEG Site 4-95
4.8.4 Summary of Nonradiological Health Impacts 4-97
4.9 Radiation Health Impacts 4-97

4.9.1 Direct Radiation Exposures 4-97
4.9.2 Radiation Exposures from Gaseous Effluents 4-98
4.9.3 Radiation Exposures from Liquid Effluents...4-99
4.9.4 Total Dose to Site-Preparation Workers 4-99
4.9.5 Summary of Radiological Health Impacts...4-100
4.10 Nonradioactive Waste Impacts...4-100
4.10.1 Impacts to Land 4-100
4.10.2 Impacts to Water 4-101
4.10.3 Impacts to Air..4-101
4.10.4 Summary of Impacts...4-102
4.11 Measures and Controls to Limit Adverse Impacts During Construction Activities 4-102
4.12 Summary of Preconstruction and Construction Impacts 4-106
5.0 OPERATIONAL IMPACTS AT THE PROPOSED SITE 5-1
5.1 Land-Use Impacts 5-1
5.1.1 The Site and Vicinity..5-1
5.1.2 Offsite Areas..5-3
5.2 Water-Related Impacts...5-4
5.2.1 Hydrological Alterations...5-5
5.2.2 Water-Use Impacts...5-6
5.2.3 Water-Quality Impacts..5-10
5.2.4 Water Monitoring 5-16
5.3 Ecological Impacts 5-17
5.3.1 Terrestrial and Wetland Impacts Related to Operations............................5-17
5.3.2 Aquatic Impacts Related to Operations 5-30
5.4 Socioeconomic Impacts 5-42
5.4.1 Physical Impacts..5-43
5.4.2 Demography 5-48
5.4.3 Economic Impacts to the Community 5-50
5.4.4 Infrastructure and Community Service Impacts..5-55
5.4.5 Summary of Socioeconomics 5-61
5.5 Environmental Justice 5-62
5.5.1 Health Impacts...5-62
5.5.2 Physical and Environmental Impacts..5-63
5.5.3 Socioeconomic Impacts...5-65
5.5.4 Subsistence and Special Conditions 5-65
5.5.5 Migrant Labor 5-66
5.5.6 Summary of Environmental Justice Impacts 5-66
5.6 Historic and Cultural Resources..5-66

5.7 Meteorology and Air Quality Impacts 5-67
5.7.1 Air-Quality Impacts 5-68
5.7.2 Cooling System Impacts 5-71
5.7.3 Transmission Line Impacts 5-75
5.7.4 Summary 5-76
5.8 Nonradiological Health Impacts 5-76
5.8.1 Etiological Agents 5-76
5.8.2 Noise 5-78
5.8.3 Acute Effects of Electromagnetic Fields 5-79
5.8.4 Chronic Effects of Electromagnetic Fields 5-79
5.8.5 Occupational Health 5-80
5.8.6 Impacts of Transporting Operations Personnel to the PSEG Site 5-81
5.8.7 Summary of Nonradiological Health Impacts 5-82
5.9 Radiological Impacts of Normal Operations 5-82
5.9.1 Exposure Pathways 5-82
5.9.2 Radiation Doses to Members of the Public 5-86
5.9.3 Impacts to Members of the Public 5-88
5.9.4 Occupational Doses to Workers 5-91
5.9.5 Impacts to Biota Other than Humans 5-91
5.9.6 Radiological Monitoring 5-93
5.10 Nonradiological Waste Impacts 5-94
5.10.1 Impacts to Land 5-94
5.10.2 Impacts to Water 5-95
5.10.3 Impacts to Air 5-95
5.10.4 Mixed Waste Impacts 5-96
5.10.5 Summary of Waste Impacts 5-96
5.11 Environmental Impacts of Postulated Accidents 5-97
5.11.1 Design Basis Accidents 5-101
5.11.2 Severe Accidents 5-106
5.11.3 Severe Accident Mitigation Alternatives 5-118
5.11.4 Summary of Postulated Accident Impacts 5-118
5.12 Measures and Controls to Limit Adverse Impacts During Operation 5-118
5.13 Summary of Operational Impacts 5-123
6.0 FUEL CYCLE, TRANSPORTATION, AND DECOMMISSIONING 6-1
6.1 Fuel-Cycle Impacts and Solid-Waste Management 6-1
6.1.1 Land Use 6-8
6.1.2 Water Use 6-9
6.1.3 Fossil Fuel Impacts 6-9
6.1.4 Chemical Effluents 6-10

6.1.5 Radiological Effluents 6-11
6.1.6 Radiological Wastes 6-13
6.1.7 Occupational Dose 6-17
6.1.8 Transportation 6-17
6.1.9 Summary 6-17
6.2 Transportation Impacts 6-17
6.2.1 Transportation of Unirradiated Fuel 6-20
6.2.2 Transportation of Spent Fuel 6-28
6.2.3 Transportation of Radioactive Waste 6-40
6.2.4 Conclusions for Transportation 6-43
6.3 Decommissioning Impacts 6-44
7.0 CUMULATIVE IMPACTS 7-1
7.1 Land Use 7-6
7.2 Water Use and Quality 7-9
7.2.1 Water-Use Impacts 7-10
7.2.2 Water-Quality Impacts 7-14
7.3 Ecology 7-18
7.3.1 Terrestrial and Wetlands Resources 7-18
7.3.2 Aquatic Ecosystem 7-25
7.4 Socioeconomics and Environmental Justice 7-30
7.4.1 Socioeconomics 7-30
7.4.2 Environmental Justice 7-33
7.5 Historic and Cultural Resources 7-34
7.6 Air Quality 7-36
7.6.1 Criteria Pollutants 7-36
7.6.2 Greenhouse Gas Emissions 7-37
7.6.3 Summary 7-39
7.7 Nonradiological Health 7-40
7.8 Radiological Impacts of Normal Operation 7-42
7.9 Nonradiological Waste Systems 7-43
7.10 Postulated Accidents 7-45
7.11 Fuel Cycle, Transportation, and Decommissioning 7-46
7.11.1 Fuel Cycle 7-46
7.11.2 Transportation of Radioactive Material 7-47
7.11.3 Decommissioning 7-48
7.11.4 Summary of Cumulative Fuel Cycle, Transportation, and Decommissioning Impacts 7-48
7.12 Conclusions 7-48
8.0 NEED FOR POWER 8-1
8.1 Description of Power System 8-3

8.1.1 Rationale for Choosing New Jersey as the Market Area 8-3
8.1.2 Structure of Power Markets Serving New Jersey 8-4
8.1.3 Electric System Reliability in New Jersey 8-7
8.1.4 Forecasting Model Methodology and Sufficiency Attributes 8-10
8.2 Power Demand 8-12
8.2.1 Factors Affecting Power Growth and Demand 8-12
8.2.2 Historic and Forecast Electricity Demand 8-15
8.3 Power Supply 8-17
8.4 Assessment of Need for Power 8-20
8.5 Conclusion 8-20
9.0 ENVIRONMENTAL IMPACTS OF ALTERNATIVES 9-1
9.1 No-Action Alternative 9-3
9.2 Energy Alternatives 9-3
9.2.1 Alternatives Not Requiring New Generation Capacity 9-4
9.2.2 Alternatives Requiring New Generation Capacity 9-8
9.2.3 Feasible Discrete New Generating Alternatives 9-20
9.2.4 Combination of Alternatives 9-36
9.2.5 Summary Comparison of Alternatives 9-42
9.3 Alternative Sites 9-44
9.3.1 Alternative Site-Selection Process 9-45
9.3.2 Site 4-1 9-56
9.3.3 Site 7-1 9-106
9.3.4 Site 7-2 9-147
9.3.5 Site 7-3 9-186
9.3.6 Comparison of the Impacts of the Proposed Action and Alternative Sites 9-227
9.4 System Design Alternatives 9-232
9.4.1 Heat Dissipation Systems 9-232
9.4.2 Circulating Water System Alternatives 9-234
9.4.3 Summary 9-240
10.0 CONCLUSIONS AND RECOMMENDATIONS 10-1
10.1 Impacts of the Proposed Action 10-3
10.2 Unavoidable Adverse Environmental Impacts 10-4
10.2.1 Unavoidable Adverse Impacts during Construction and Preconstruction 10-4
10.2.2 Unavoidable Adverse Impacts during Operation 10-12
10.3 Relationship Between Short-Term Uses and Long-Term Productivity of the Human Environment 10-18
10.4 Irreversible and Irretrievable Commitments of Resources 10-18
10.4.1 Irreversible Commitments of Resources 10-19

10.4.2 Irretrievable Commitments of Resources 10-20
10.5 Alternatives to the Proposed Action 10-21
10.6 Benefit-Cost Balance....... 10-22
10.6.1 Benefits....... 10-23
10.6.2 Costs 10-27
10.6.3 Summary of Benefits and Costs 10-32
10.7 Staff Conclusions and Recommendations 10-33
11.0 REFERENCES....... 11-1
12.0 INDEX 12-1
APPENDIX A CONTRIBUTORS TO THE ENVIRONMENTAL IMPACT STATEMENT A-1
APPENDIX B ORGANIZATIONS CONTACTED B-1
APPENDIX C CHRONOLOGY OF NRC AND USACE STAFF ENVIRONMENTAL REVIEW CORRESPONDENCE RELATED TO THE PSEG APPLICATION FOR AN EARLY SITE PERMIT (ESP) AT THE PSEG SITE C-1
APPENDIX D SCOPING COMMENTS AND RESPONSES D-1
APPENDIX E DRAFT ENVIRONMENTAL IMPACT STATEMENT COMMENTS AND RESPONSES....... E-1
APPENDIX F KEY CONSULTATION CORRESPONDENCE F-1
APPENDIX G SUPPORTING INFORMATION AND DATA: POPULATION PROJECTIONS AND RADIOLOGICAL DOSE ASSESSMENT....... G-1
APPENDIX H LIST OF AUTHORIZATIONS, PERMITS, AND CERTIFICATIONS H-1
APPENDIX I PSEG SITE CHARACTERISTICS AND PLANT PARAMETER ENVELOPE VALUES....... I-1
APPENDIX J PSEG REPRESENTATIONS AND ASSUMPTIONS J-1
APPENDIX K GREENHOUSE GAS FOOTPRINT ESTIMATES FOR A REFERENCE 1,000-MW(E) LIGHT WATER REACTOR (LWR) K-1

FIGURES

Figure		Page
ES-1	PSEG Site Location and Vicinity	xxv
ES 2	Map Showing the Locations of Alternative Sites	xxxi
2-1	PSEG Site Location Vicinity and Region	2-2
2-2	PSEG Site Utilization Plan	2-3
2-3	Aerial View of the Existing PSEG Property	2-4
2-4	PSEG Site and Near Offsite Land Use	2-7
2-5	NJDEP 2002 Land Use and Land Cover Within the PSEG Site	2-8
2-6	USACE Jurisdictional Determination Block 26, Lots 2, 4, 4.01, 5, and 5.01, Lower Alloways Creek Township	2-11
2-7	Land Use Within the Vicinity of the PSEG Site	2-13
2-8	Farmland Resources in the Vicinity of the PSEG Site	2-16
2-9	Major Transportation Features in the PSEG Site Region	2-17
2-10	Existing PSEG Transmission Corridors	2-19
2-11	Land Management Areas along the Proposed Causeway Route	2-22
2-12	Land Use in the PSEG Site Region	2-23
2-13	The Delaware River Watershed	2-26
2-14	Streams on and near the PSEG Site Identified Using the High-Resolution USGS National Hydrography Dataset	2-27
2-15	Annual Discharge at the Trenton USGS Streamflow Gage	2-32
2-16	Characteristics of the Monthly Discharge During Water Years 1913–2011 at the Trenton USGS Streamflow Gage	2-33
2-17	Cross-Section Through the Southern New Jersey Coastal Plain Aquifer System	2-37
2-18	Hydrogeologic Units at the PSEG Site from ER 2.3-23	2-39
2-19	Surface-Water-Quality Sampling Locations on and Near the PSEG Site	2-46
2-20	Chloride Data for the HCGS and SGS Groundwater Production Wells for the Period 2003–2013	2-51
2-21	Surface Waters and Desilt Basins On and Near the PSEG Site Providing Habitat for Aquatic Resources	2-84
2-22	Delaware Bay and River Sampling Zones: Zones 1, 2, and 3 Lower Bay; Zones 4, 5, and 6 Middle Bay; Zones 7 and 8 Upper Bay; Zones 9 through 14 Delaware River	2-95
2-23	Local Road Network in the Vicinity of the PSEG Site	2-133
2-24	Aggregate of Minorities Block Groups Within 50 Mi of the PSEG Site	2-150
2-25	Hispanic Ethnicity Block Groups Within 50 Mi of the PSEG Site	2-151
2-26	Black Minority Block Groups Within 50 Mi of the PSEG Site	2-153
2-27	Low-Income Household Block Groups Within 50 Mi of the PSEG Site	2-154
2-28	The USACE Permit Area and NRC Direct Area of Potential Effect for Section 106 review	2-158
2-29	Underwater Portion of the USACE Permit Area	2-159
2-30	View of Abel and Mary Nicholson House NHL where the existing NDCT was not visible	2-168

2-31 View of Abel and Mary Nicholson House NHL showing existing cooling tower 2-168
2-32 Stratigraphic Section of the PSEG Site Modified from Site Safety Aanalysis Report 2.5.1-34 2-171
2-33 View of SGS and HCGS Looking West-Northwest from the Existing PSEG Meteorological Tower Unit 2-182
2-34 Existing PSEG Meteorological Tower and Meteorological Building with Backup Meteorological Tower in Foreground 2-183
2-35 Close-up View of 33-ft Instrument Boom 2-184
3-1 Existing Salem Generating Station and Hope Creek Generating Station Site 3-2
3-2 Plant Water Use 3-9
3-3 Photo Simulation Showing the Existing Hope Creek Generating Station Cooling Tower, the Existing Hope Creek-Red Lion Transmission Line, the Two Potential New Cooling Towers, a Potential New Transmission Line, and the Potential New Causeway as Viewed from the Money Island Estuary Platform 3-17
4-1 Land Use/Land Cover Impacted by Preconstruction and Construction at the PSEG Site 4-6
4-2 Acoustic Criteria Isopleths for In-Water and Nearshore Pile-Driving Activities 4-49
5-1 Evaluation of Groundwater Drawdown from Onsite Pumping 5-9
5-2 Predicted PSEG Thermal Plume in Relation to the Approximate Locations of the HCGS HDA and the SGS Plume Boundary under Flood Tide Conditions 5-13
5-3 LMDCT Salt Deposition Rates 5-19
5-4 Simulations of the Appearance of New Nuclear Power Plant Facilities at the PSEG Site from Augustine Beach Access and Collins Beach Road, New Castle County, Delaware 5-46
5-5 Simulations of the Appearance of New Nuclear Power Plant Facilities at the PSEG Site and the Proposed Causeway from the Hancock's Bridge Community and the Money Island Estuary Platform in Salem County, New Jersey 5-47
5-6 Exposure Pathways to Humans 5-84
5-7 Exposure Pathways to Biota Other than Humans 5-85
6-1 The Uranium Fuel Cycle: No-Recycle Option 6-6
6-2 Illustration of Truck Stop Model 6-32
8-1 PJM Interconnection, LLC, Service Area 8-5
8-2 New Jersey Electric Utility Service Areas 8-6
8-3 Map of the Reliability*First* Region 8-8
8-4 DOE-Designated Critical Congestion Area and Congestion Area of Concern in the Eastern Interconnection 8-9
8-5 Actual and Forecast Summer Peak Demand in the PJM RTO 2006–2012 8-11
8-6 Historic and Projected Electricity Demand in New Jersey 1998–2023 8-16
8-7 Generation Resources by Fuel Type, 2007–2012 8-18
9-1 Map Showing the Locations of PSEG Alternative Sites 9-49
9-2 County Preserved Farmland at Alternative Site 4-1 9-62
9-3 Deed of Conservation Restriction Parcel at Alternative Site 4-1 9-63
9-4 Wildlife Sanctuaries, Refuges, and Preserves Within the 6-mi Vicinity of Alternative Site 4-1 9-77
9-5 Aggregate of Minorities Block Groups Within 50 Mi of Site 4-1 9-97

9-6 Low-Income Block Groups Within 50 Mi of Site 4-1 9-98
9-7 County Preserved Farmland at Alternative Site 7-1 9-111
9-8 Wildlife Sanctuaries, Refuges, and Preserves Within the 6-mi Vicinity of Alternative Site 7-1 9-123
9-9 Wildlife Sanctuaries, Refuges, and Preserves within the 6-mi Vicinity of Alternative Site 7-2 9-163
9-10 Deed of Conservation Restriction Parcels at Site 7-3 9-191
9-11 Wildlife Sanctuaries, Refuges, and Preserves within the 6-mi Vicinity of Site 7-3 ..9-203

TABLES

Table **Page**

ES-1 Cumulative Impacts on Environmental Resources, Including the Impacts of a New Nuclear Power Plant at the PSEG Site ... xxvii
ES-2 Comparison of Environmental Impacts of Energy Alternatives ... xxx
ES-3 Comparison of Environmental Impacts at Alternative Sites ... xxxii
2-1 NJDEP 2002 Land Use and Land Cover Within the Proposed PSEG Site ... 2-9
2-2 Land Use in the Vicinity and Region of the PSEG Site ... 2-14
2-3 Land Use in the Existing PSEG Transmission Line Corridors and in the Existing PSEG Access Road Right-of-Way ... 2-20
2-4 Parameters Measured Daily at U.S. Geological Survey Stream Gages in the Delaware River near the PSEG Site ... 2-28
2-5 Annual Discharge in the Delaware River at Trenton, New Jersey ... 2-31
2-6 Reservoirs in the Delaware River Basin with Storages Exceeding 10,000 ac-ft ... 2-33
2-7 Approximate Top Elevation and Thickness for Hydrogeologic Units at the Northern Portion of the PSEG Site ... 2-40
2-8 Threatened, Endangered, and Special Concern Species Potentially Occurring in the Vicinity of the PSEG Site ... 2-63
2-9 Macroinvertebrates Sampled in Desilt Basins, Onsite Marsh Creeks, Offsite Large Marsh Creeks, and Nearshore Delaware River Estuary in the Vicinity of the PSEG Site in 2009 ... 2-86
2-10 Fish Species Sampled in Desilt Basins and Marsh Creeks in the Vicinity of the PSEG Site in 2009 and Between 2003 and 2010 ... 2-87
2-11 Fish Species and Blue Crab Abundance from Bottom and Pelagic Trawl and Seining Sampling in the Delaware River Estuary and Near the PSEG Site Between 2003 and 2010 ... 2-92
2-12 Federally and State-Listed Species in the Vicinity of the PSEG Site and Existing Transmission Corridors ... 2-113
2-13 Recent Population and Growth Rates of Counties in the Economic Impact Area ... 2-119
2-14 Population of Counties, Townships and Municipalities Within 10 mi of PSEG ... 2-119
2-15 Historical and Projected Populations in the Economic Impact Area and the States of Delaware and New Jersey, 1970–2040 ... 2-121
2-16 Percentage Age and Gender Distribution in the Economic Impact Area ... 2-122
2-17 Household Income Distribution Within the Economic Impact Area in 2011 Inflation-Adjusted Dollars ... 2-122
2-18 Racial and Ethnic Distribution Within the Economic Impact Area ... 2-123
2-19 Estimates of the Transient and Migrant Worker Populations in the Economic Impact Area ... 2-123
2-20 2011 Annual Average Labor Force, Employment, and Unemployment in Counties of the Impact Area and in the States of New Jersey and Delaware ... 2-125
2-21 Annual Unemployment Rates for Counties of the Economic Impact Area and the States of New Jersey and Delaware, 2002 to 2011 ... 2-125
2-22 Total Employment by Industry Type in the Economic Impact Area ... 2-127

2-23 HCGS and SGS Employee Distribution by State and County as of 2008 2-128
2-24 Residential Locations of Outage Workers for the Largest Recent Outage at the HCGS/SGS Site 2-129
2-25 Per Capita Income for Counties of the Impact Area and the States of New Jersey and Delaware, 2002 to 2011 2-129
2-26 Tax Rates for Counties in Economic Impact Area and States 2-130
2-27 Operation-Related Payroll and Purchases for Materials and Services for HCGS and SGS 2-131
2-28 Annual Average Daily Traffic Counts on Selected Roads Near the PSEG Site 2-134
2-29 Business and General Aviation Airports Serving the Economic Impact Area 2-135
2-30 Housing Data for Counties in the Economic Impact Area 2-137
2-31 Major Water Supply Systems in New Jersey Counties of the Economic Impact Area 2-139
2-32 Public Wastewater Treatment Systems in the Economic Impact Area 2-141
2-33 Local Law Enforcement Personnel in Counties of the Economic Impact Area 2-143
2-34 Public School Enrollment, Teachers, and Student-to-Teacher Ratios in the Economic Impact Area and State 2-145
2-35 Statewide Percent Minority Populations and Associated 20 Percentage Point Threshold Criteria for the 50-mi Region 2-148
2-36 Distribution of Census Block Groups Exceeding Environmental Justice Thresholds in the Economic Impact Area 2-152
2-37 Historic Properties within the 4.9-mi Area of Potential Effect that are Visible from the PSEG Site 2-165
2-38 Mean Seasonal and Annual Morning and Afternoon Mixing Heights and Wind Speeds at the PSEG Site 2-178
2-39 Atmospheric Dispersion Factors for Proposed Units 1 and 2 Design Basis Accident Calculations 2-179
2-40 Maximum Annual Average Atmospheric Dispersion and Deposition Factors for Evaluation of Normal Effluents for Receptors of Interest 2-180
2-41 Existing PSEG Meteorological Instrumentation Performance Specifications 2-185
3-1 Plant Water Use 3-8
3-2 Assumed Schedule for Preconstruction and Construction at the PSEG Site 3-19
3-3 Summary of Resource Commitments Associated with Preconstruction and Construction at the PSEG Site 3-24
3-4 Annual Estimated Pollutant Emissions from Cooling Towers, Auxiliary Boilers, Diesel Generators, and Gas Turbines at a New Nuclear Power Plant at the PSEG Site 3-27
3-5 Blowdown Constituents and Concentrations in Liquid Effluent Discharge 3-29
4-1 Land-Use Changes from Preconstruction and Construction Activities on the PSEG Site 4-5
4-2 Offsite Land-Use Changes from Building the Proposed Causeway 4-9
4-3 Estimated Acoustic Area of Effect for Fish from Pile-Driving Activities 4-47
4-4 Estimated Construction Workforce Requirements by Construction Month 4-61
4-5 Projected Construction Labor Availability and Onsite Labor Requirement 4-63
4-6 Estimated Population Increase in the Economic Impact Area During the Peak Building Period 4-64

4-7 Estimated Annual Purchases of Services and Materials During the Building Period 4-65
4-8 Expected Distribution of Newly Created Workers in the Economic Impact Area at Peak Employment 4-67
4-9 Estimated Increase in Income Tax Revenue Associated with Workforce 4-67
4-10 Estimated Sales Tax Revenue on Purchases During Building Period 4-69
4-11 Level of Service Ranges 4-70
4-12 Traffic Impact Analysis Assumptions 4-71
4-13 Impacts on Roadways around PSEG Site during Peak Building 4-72
4-14 Estimated Housing Impacts in the Economic Impact Area 4-74
4-15 Estimated Water Supply Impacts in the Economic Impact Area 4-75
4-16 Estimated Wastewater Supply Impacts in the Economic Impact Area 4-76
4-17 Estimated Number of School-Aged Children Associated with In-Migrating Workforce Associated with Building at the PSEG Site 4-78
4-18 Typical Noise and Emissions from Construction Equipment and Light Vehicles Used in Major Construction Projects 4-92
4-19 Projected Total Nonfatal Occupational Illnesses and Injuries to Construction Force Using 2009 Rates for Various Groups 4-93
4-20 Nonradiological Impacts of Transporting Construction Workers to and from the PSEG Site 4-96
4-21 Measures and Controls to Limit Adverse Impacts when Building a New Nuclear Power Plant at the PSEG Site 4-103
4-22 Summary of Impacts from Building a New Nuclear Power Plant at the PSEG Site 4-107
5-1 Maximum Predicted Salt Deposition Rate 5-18
5-2 Ambient Noise Levels at HCGS and SGS in February 2009 5-20
5-3 Impingement Rate for Important, Most Abundant, and Total Finfish Species and Blue Crab Impinged at SGS and HCGS 5-32
5-4 Estimated Population Increase in the Economic Impact Area During Operations 5-49
5-5 Estimated Annual Purchases of Services and Materials During Operations 5-51
5-6 Expected Distribution of Newly Created Workers in the Economic Impact Area During Operations 5-52
5-7 Estimated Increase in Income Tax Revenue Associated with Workforce 5-53
5-8 Estimated Sales Tax Revenue on Purchases During Operations 5-54
5-9 Estimated Housing Impacts in the Economic Impact Area 5-57
5-10 Estimated Water Supply Impacts in the Economic Impact Area 5-59
5-11 Estimated Wastewater Supply Impacts in the Economic Impact Area 5-59
5-12 Estimated Number of School-Aged Children Associated with In-Migrating Workforce Associated with Operations at the PSEG Site 5-61
5-13 Annual Estimated Emissions from Cooling Towers, Auxiliary Boilers, Diesel Generators, and Gas Turbines at the PSEG Site 5-69
5-14 Nonradiological Impacts of Transporting Operations Personnel to and from the PSEG Site 5-82
5-15 Doses to the MEI for Liquid Effluent Releases from PSEG 5-86
5-16 Doses to the MEI from the Gaseous Effluent Pathway for a New Nuclear Power Plant 5-87

5-17 Comparison of MEI Dose Estimates from Liquid and Gaseous Effluents of the PSEG Site to Design Objectives 5-89
5-18 Comparison of Doses for the PSEG Site to 40 CFR Part 190 5-90
5-19 Biota Other Than Human Doses from Liquid and Gaseous Effluents 5-92
5-20 Comparison of Biota Dose Rate from a New Nuclear Power Plant at the PSEG Site to IAEA Guidelines for Biota Protection 5-93
5-21 Atmospheric Dispersion Factors for PSEG Site Design Basis Accident Calculations 5-103
5-22 Design Basis Accident Doses for the US-APWR 5-103
5-23 Design Basis Accident Doses for the U.S. EPR 5-104
5-24 Design Basis Accident Doses for the AP1000 Reactor 5-104
5-25 Design Basis Accident Doses for ABWR 5-105
5-26 Environmental Risks from a US-APWR Severe Accident at the PSEG Site 5-109
5-27 Environmental Risks from an AP1000 Reactor Severe Accident at the PSEG Site 5-110
5-28 Environmental Risks from a U.S. EPR Severe Accident at the PSEG Site 5-111
5-29 Environmental Risks from an ABWR Severe Accident at the PSEG Site 5-112
5-30 Comparison of Environmental Risks for a New Nuclear Power Plant at the PSEG Site with Risks for Current-Generation Reactors at Five Sites Evaluated in NUREG–1150 5-113
5-31 Comparison of Environmental Risks from Severe Accidents for a US-APWR, an AP1000, a U.S. EPR, and an ABWR at the PSEG Site with Risks for Current Plants from Operating License Renewal Reviews 5-113
5-32 Measures and Controls to Limit Adverse Impacts During Operation of a New Nuclear Power Plant at the PSEG Site 5-119
5-33 Summary of Operational Impacts for a New Nuclear Power Plant at the PSEG Site 5-124
6-1 Uranium Fuel Cycle Environmental Data as Provided in S–3 of 10 CFR 51.51(b) 6-2
6-2 Comparison of Annual Average Dose Received by an Individual from All Sources 6-13
6-3 Number of Truck Shipments of Unirradiated Fuel for the Reference LWR and ABWR, AP1000, U.S. EPR, and US-APWR Reactors at the PSEG Site, Normalized to the Reference LWR 6-21
6-4 RADTRAN 5.6 Input Parameters for Reference LWR Fresh Fuel Shipments 6-22
6-5 Radiological Impacts Under Normal Conditions of Transporting Unirradiated Fuel to the PSEG Site or Alternative Sites for a Single Reactor, Normalized to Reference LWR 6-24
6-6 Nonradiological Impacts of Transporting Unirradiated Fuel to the PSEG Site and Alternative Sites with a Single Reactor, Normalized to Reference LWR 6-28
6-7 Transportation Route Information for Shipments from the PSEG Site and Alternative Sites to the Yucca Mountain Spent Fuel Disposal Facility 6-31
6-8 RADTRAN 5.6 Normal Exposure Parameters 6-31
6-9 Normal Radiation Doses to Transport Workers and the Public from Shipping Spent Fuel from the PSEG Site and Alternative Sites to the Proposed HLW Repository at Yucca Mountain, Normalized to Reference LWR 6-33

6-10 Radionuclide Inventories Used in Transportation Accident Risk Calculations for the US-APWR, U.S. EPR, ABWR, and AP1000 Reactors....................................6-36
6-11 Annual Spent Fuel Transportation Accident Impacts for a Single Reactor at the PSEG Site and Alternative Sites, Normalized to Reference LWR Reactor...............6-39
6-12 Nonradiological Impacts of Transporting Spent Fuel from the PSEG Site and Alternative Sites to Yucca Mountain for a Single Reactor, Normalized to Reference LWR....................................6-40
6-13 Summary of Radioactive Waste Shipments from the PSEG Site and Alternative Sites for a Single Reactor, Normalized to Reference LWR.....................................6-42
6-14 Nonradiological Impacts of Radioactive Waste Shipments from the PSEG Site and Alternative Sites with a Single Reactor, Normalized to Reference LWR 6-42
7-1 Projects and Other Actions Considered in the Cumulative Impacts Analysis for the PSEG Site....................................7-2
7-2 PSEG Estimates of Land-Use Impacts Associated with a Potential Offsite Transmission Line ROW....................................7-8
7-3 Comparison of Annual Carbon Dioxide Emissions 7-38
7-4 Cumulative Impacts on Environmental Resources, Including the Impacts of a New Nuclear Power Plant at the PSEG Site 7-49
8-1 Historical and Projected Average Annual Growth Rate of New Jersey's Population, 1995 to 2025 8-13
8-2 Energy Use by Customer Class, New Jersey, 2013 8-13
8-3 Electricity Demand in New Jersey for 2014–2023 8-16
8-4 Total Electricity Needed in New Jersey in 2023....................................8-17
8-5 New Jersey Electricity Supply by Fuel 8-18
8-6 New Jersey Capacity 2023 8-20
8-7 Need for Power in New Jersey in 2023....................................8-20
9-1 Summary of Environmental Impacts of Coal-Fired Power Generation at the PSEG Site 9-28
9-2 Summary of Environmental Impacts of Natural-Gas-Fired Power Generation 9-35
9-3 Summary of Environmental Impacts of a Combination of Power Sources................9-40
9-4 Summary of Environmental Impacts of Constructing and Operating New Nuclear, Coal-Fired, and Natural-Gas-Fired Power-Generating Units and a Combination of Alternatives 9-43
9-5 Comparison of Carbon Dioxide Emissions for Energy Alternatives 9-43
9-6 Rankings of the Candidate Sites Based on Total Numerical Scores 9-51
9-7 Weighted Numerical Scores for the Candidate Sites Based on Three Categories of Site Characteristics....................................9-51
9-8 Projects and Other Actions Considered in the Cumulative Impacts Analysis for Site 4-1....................................9-58
9-9 Delaware River Reduction in Flow and Assessed Impact Levels 9-68
9-10 State and Federal Threatened, Endangered, and Rare Species Recorded in the Site 4-1 Area 9-75
9-11 Federally and State-Listed Aquatic Species in Hunterdon County, New Jersey, Near the Proposed Location of Water Intake and Discharge Structures 9-83
9-12 Estimated Population Increase in the Alternative 4-1 Site Economic Impact Area....................................9-89

9-13 Housing Units at the Alternative 4-1 Site in Hunterdon and Bucks Counties 9-93
9-14 Estimated Number of School-Aged Children Associated with the In-Migrating Workforce Associated with Building and Operations at Site 4-1 9-94
9-15 Projects and Other Actions Considered in the Cumulative Impacts Analysis for Site 7-1 9-107
9-16 State and Federal Threatened, Endangered, and Rare Species Recorded in the Site 7-1 Area 9-122
9-17 Federally and State-Listed Aquatic Species in the Delaware River Estuary Near Site 7-1 9-130
9-18 Projects and Other Actions Considered in the Cumulative Impacts Analysis for Site 7-2 9-148
9-19 State and Federal Threatened, Endangered, and Rare Species Recorded in the Site 7-2 Area 9-162
9-20 Federally and State-Listed Aquatic Species in the Delaware River Estuary Near Site 7-2 9-170
9-21 Projects and Other Actions Considered in the Cumulative Impacts Analysis for Site 7-3 9-187
9-22 State and Federal Threatened, Endangered, and Rare Species Recorded in the Site 7-3 Area 9-202
9-23 Federally and State-Listed Aquatic Species in the Delaware River Estuary Near Site 7-3 9-210
9-24 Comparison of Cumulative Impacts at the Proposed PSEG Site and Four Alternative Sites 9-229
10-1 Unavoidable Adverse Environmental Impacts During Construction and Preconstruction 10-5
10-2 Unavoidable Adverse Environmental Impacts from Operations............................. 10-13
10-3 Benefits of Building and Operating a New Nuclear Power Plant at the PSEG Site 10-24
10-4 Internal and External Costs of Building and Operations at the PSEG Site 10-27

EXECUTIVE SUMMARY

This environmental impact statement (EIS) presents the results of a U.S. Nuclear Regulatory Commission (NRC) environmental review of an application for an early site permit (ESP) at a proposed site in Salem County, New Jersey. In support of its proposed action of issuing a Department of the Army permit, the U.S. Army Corps of Engineers (USACE) participated in the preparation of the EIS as a cooperating agency and as a collaborative member of the review team, which consisted of the NRC staff, its contractor staff, and the USACE staff.

BACKGROUND

On May 25, 2010, PSEG Power, LLC, and PSEG Nuclear, LLC (PSEG) submitted an application to the NRC for an ESP at the PSEG Site located adjacent to the existing Hope Creek Generating Station (HCGS) and Salem Generating Station (SGS) in Lower Alloways Creek Township, Salem County, New Jersey. On June 5, 2015, PSEG submitted a fourth revised version of its application, which also included an Environmental Report (ER).

Upon acceptance of PSEG's initial application, the NRC review team began the environmental review process as described in Title 10 of the *Code of Federal Regulations* (CFR) Part 52 by publishing in the *Federal Register* on October 15, 2010, a Notice of Intent to prepare an EIS and conduct scoping. As part of the environmental review, the review team did the following:

- considered comments received during the 60-day scoping process that began on October 15, 2010, and conducted related public scoping meetings on November 4, 2010 in Carneys Point, New Jersey;
- conducted site audits from April 17, 2012 through April 19, 2012 and from May 7, 2012 through May 11, 2012;
- conducted public meetings on the draft EIS on October 1, 2014 in Carneys Point, New Jersey and on October 23, 2014 in Middletown, Delaware;
- considered comments received during the 105-day comment period for the draft EIS, which began on August 22, 2014;
- reviewed PSEG's ER and developed requests for additional information using guidance from NUREG–1555, *Standard Review Plans for Environmental Reviews for Nuclear Power Plants: Environmental Standard Review Plan*; and
- consulted with Native American tribes and Federal and State agencies such as the U.S. Fish and Wildlife Service, the National Marine Fisheries Service, the Advisory Council on Historic Preservation, the New Jersey Department of Environmental Protection, the New Jersey State Historic Preservation Office, and the State of Delaware Office of Historical and Cultural Affairs.

PROPOSED ACTION

The proposed actions related to the PSEG application are (1) the NRC issuance of an ESP for the PSEG Site and (2) the USACE issuance of a Department of the Army permit pursuant to Section 404 of the Federal Water Pollution Control Act (Clean Water Act [CWA]) and Section 10 of the Rivers and Harbors Appropriation Act of 1899, as amended, to perform certain dredge and fill activities on the site.

PURPOSE AND NEED FOR ACTION

The purpose and need for the NRC proposed action—issuance of the ESP—is to provide for early resolution of site safety and environmental issues, which provides stability in the licensing process. Although no reactor will be built at the PSEG Site under this action (the ESP), to resolve environmental issues the staff assumed in this EIS that one or two reactors with the parameters specified in the plant parameter envelope (PPE) would be built and operated. Any new nuclear plant would provide for additional electrical generating capacity to meet the need for up to 2,200 MW(e) of baseload power in the State of New Jersey by 2021.

The objective of the PSEG-requested USACE action is to obtain a Department of the Army individual permit to perform regulated dredge and fill activities that would affect wetlands and other waters of the United States. The basic purpose of obtaining the Department of the Army individual permit is for PSEG to conduct work associated with building a power plant to generate electricity for additional baseload capacity.

PUBLIC INVOLVEMENT

A 60-day scoping period was held from October 15, 2010 through December 14, 2010, and on November 4, 2010, the NRC held public scoping meetings in Carneys Point, New Jersey during which interested parties were invited to provide comments on the applicant's ER. The review team received many oral comments during the public meetings and 12 written statements, 7 letters, and 1 e-mail during the scoping period on topics including surface-water hydrology, ecology, socioeconomics, historic and cultural resources, air quality, uranium fuel cycle, energy alternatives, and benefit-cost balance.

In addition, during the 105-day comment period on the draft EIS, the review team held public meetings in Carneys Point, New Jersey on October 1, 2014 and in Middletown, Delaware on October 23, 2014. A combined total of approximately 75 people attended the public meetings in New Jersey, and approximately 140 people attended the public meetings in Delaware. A number of attendees at each meeting provided oral comments.

AFFECTED ENVIRONMENT

The PSEG Site is located on the southern part of Artificial Island adjacent to the existing HCGS and SGS Units 1 and 2, in Lower Alloways Creek Township, Salem County, New Jersey. The PSEG Site is on the eastern bank of the Delaware River about 18 mi south of Wilmington, Delaware, and 30 mi southwest of Philadelphia, Pennsylvania. The site is about 7 mi east of Middletown, Delaware; 7.5 mi southwest of Salem, New Jersey; and 9 mi south of Pennsville,

New Jersey. Figure ES-1 depicts the location of the PSEG Site in relation to nearby counties and cities within the context of the 50-mi region and the 6-mi vicinity.

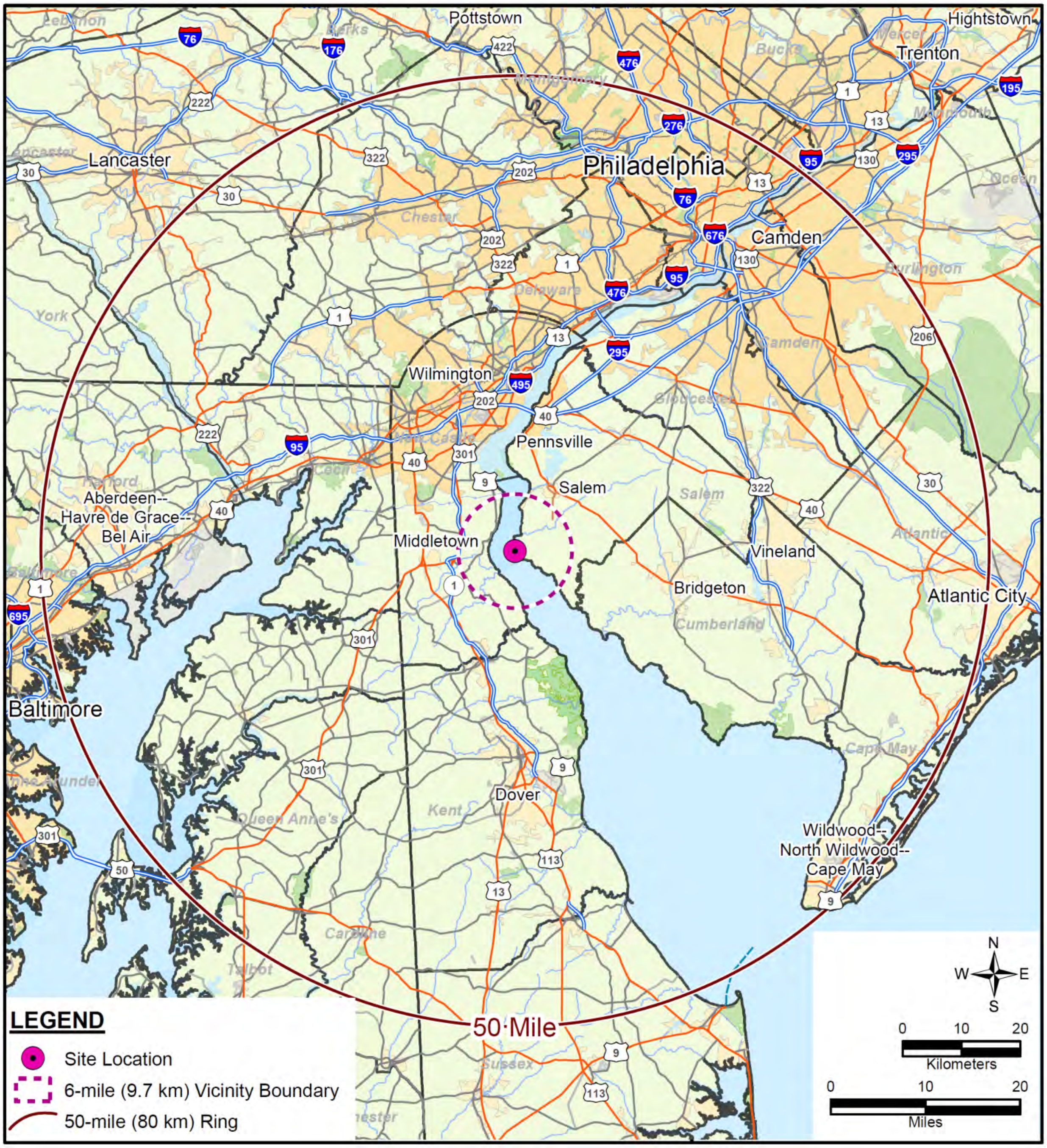

Figure ES-1. PSEG Site Location and Vicinity

Cooling water for any new nuclear units constructed at the PSEG Site would be obtained from the Delaware River. These units would use either mechanical or natural draft cooling towers to transfer waste heat to the atmosphere. A portion of the water obtained from the Delaware River would be returned to the environment via a discharge structure located in the Delaware River on

the western side of Artificial Island. The remaining portion of the water would be released to the atmosphere via evaporative cooling.

EVALUATION OF ENVIRONMENTAL IMPACTS

When evaluating the environmental impacts associated with nuclear power plant construction) and operations, the NRC's authority is limited to construction activities related to radiological health and safety or common defense and security; that is, under 10 CFR 51.4, the NRC-authorized activities are related to safety-related structures, systems, or components and may include pile driving; subsurface preparation; placement of backfill, concrete, or permanent retaining walls within an excavation; installation of foundations; or in-place assembly, erection, fabrication, or testing. In this EIS, the NRC review team evaluates the potential environmental impacts of the construction and operation of a new nuclear power plant at the PSEG Site for the following resource areas:

- land use,
- air quality,
- aquatic ecology,
- terrestrial ecology,
- surface water and groundwater,
- waste (radiological and nonradiological),
- human health (radiological and nonradiological),
- socioeconomics and environmental justice, and
- historic and cultural resources.

This EIS also evaluates impacts associated with accidents, the fuel cycle, decommissioning, and transportation of radioactive materials.

The impacts are designated as SMALL, MODERATE, or LARGE. The incremental impacts related to the construction and operations activities requiring the NRC authorization are described and characterized, as are the cumulative impacts resulting from the proposed action when the effects are added to, or interact with, other past, present, and reasonably foreseeable future effects on the same resources.

> **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.

Table ES-1 provides a summary of the cumulative impacts for the PSEG Site. The review team found that the cumulative environmental impacts would be SMALL for several resource categories, including demography, nonradiological health, radiological health, severe accidents, waste, fuel cycle, decommissioning, and transportation.

Table ES-1. Cumulative Impacts on Environmental Resources, Including the Impacts of a New Nuclear Power Plant at the PSEG Site

Resource Category	Impact Level
Land Use	MODERATE
Water-Related	
—Surface-Water Use	MODERATE
—Groundwater Use	MODERATE
—Surface-Water Quality	MODERATE
—Groundwater Quality	MODERATE
Ecology	
—Terrestrial Ecosystems	MODERATE
—Aquatic Ecosystems	MODERATE to LARGE
Socioeconomic	
—Physical Impacts	SMALL to MODERATE
—Demography	SMALL
—Taxes and Economic Impacts	SMALL (beneficial for the region) to LARGE (beneficial for Salem County)
—Infrastructure and Community Services	SMALL to MODERATE
Environmental Justice	None[(a)]
Historic and Cultural Resources	MODERATE
Air Quality	SMALL to MODERATE
Nonradiological Health	SMALL
Radiological Health	SMALL
Waste Management	SMALL
Severe Accidents	SMALL
Fuel Cycle, Transportation, and Decommissioning	SMALL

(a) The entry “None” for Environmental Justice does not mean there are no adverse impacts to minority or low-income populations from the proposed action. Rather, “None” means that, while there may be adverse impacts, those impacts do not affect minority or low-income populations in any disproportionate manner, relative to the general population.

The cumulative socioeconomic impacts for physical impacts, infrastructure and community services, and air quality would be SMALL to MODERATE. The review team found that the cumulative environmental impacts on land use, surface-water use and quality, groundwater use and quality, terrestrial and wetland ecosystems, and historic and cultural resources would be MODERATE. However, the contributions of impacts from the NRC-authorized activities would be SMALL for all of the above-listed resource areas, except for land-use impacts; physical impacts, infrastructure and community services impacts, and historic and cultural resources. The new cooling towers would contribute to MODERATE cumulative physical impacts associated with aesthetics in certain locations, and traffic impacts during the peak periods for building a new nuclear plant would contribute to MODERATE cumulative impacts for infrastructure and community services.

Incremental impacts associated with the development of the causeway and the transmission lines would be the principal contributors to the MODERATE cumulative impacts for land use and for historic and cultural resources. Extensive past and present use of surface water from the Delaware River would be the primary driver for the MODERATE impacts for surface-water use and quality. Similarly, extensive past and present groundwater withdrawals from the local aquifer system would contribute to the MODERATE cumulative impacts to groundwater resources.

Cumulative terrestrial and wetland ecosystem impacts would be MODERATE because of the loss of habitat from development of the causeway and the transmission line corridors. The significant history of the degradation of the Delaware Bay and Delaware River Estuary has had a noticeable and sometimes destabilizing effect on many aquatic species and communities. Building and operating any new nuclear plant at the PSEG Site, in conjunction with the operations of the existing HCGS and SGS nuclear units, would contribute to MODERATE to LARGE cumulative impacts to aquatic ecosystems.

The cumulative impacts to taxes and the economy would be beneficial and would range from SMALL for the State of New Jersey and the region to LARGE for Salem County.

There are few minority or low-income populations near the PSEG Site and the review team identified no pathways for disproportionately high and adverse impacts on minority or low-income populations.

The cumulative impacts on air quality would range from SMALL for criteria pollutants to MODERATE for greenhouse gases, based on both their emissions and associated concentrations in the atmosphere.

NEED FOR POWER AND ALTERNATIVES

The review team assessed the need for the power that would be produced by the proposed project and determined that if the plant were to be built on schedule (i.e., by 2021), there would be a demonstrated need for the capacity of the largest proposed reactor design in the PPE, such that the benefits of the proposed project (i.e., the power it would provide) would be realized.

The review team also considered the environmental impacts associated with alternatives to issuing an ESP for the PSEG Site. These alternatives included a no-action alternative (i.e., not issuing the ESP), as well as alternative energy sources, siting locations, and system designs.

The **no-action alternative** would result in the ESP not being granted or the USACE not issuing its permit. Upon such a denial, construction and operation of a new nuclear plant at the PSEG Site in accordance with the 10 CFR 52 (10 CFR 52-TN251) process referencing an approved ESP would not occur, and the predicted environmental impacts would not take place. If other generating sources were built to meet the need for power, either at another site or using a different energy source, the environmental impacts associated with those other sources would eventually occur. The review team also assessed the need for the power that would be produced by the proposed project and determined that if the plant were to be built on schedule

(by 2021), there would be a demonstrated need for the capacity of the largest proposed reactor design in the PPE, such that the benefits of the proposed project (the power it would provide) would be realized.

Based on the review team's review of **energy alternatives**, the review team eliminated several energy sources (e.g., wind, solar, and biomass) from full consideration because those technologies are not currently capable of meeting the baseload electricity need. The review team concluded that, from an environmental perspective, none of the viable baseload alternatives (i.e., natural gas, coal, or a combination of alternatives) is clearly environmentally preferable to building new baseload nuclear power generating units at the PSEG Site. Table ES-2 provides a comparative summary of the environmental impacts of the viable energy alternatives.

The review team compared the cumulative effects of the proposed action at the PSEG Site against those at the **alternative sites**. The following four alternatives sites were selected for review (see Figure ES-2):

- Site 4-1 in Hunterdon County, New Jersey;
- Site 7-1 in Salem County, New Jersey;
- Site 7-2 in Salem County, New Jersey; and
- Site 7-3 in Cumberland County, New Jersey.

Table ES-3 provides a comparative summary of the cumulative impacts for the alternative sites. Although there are differences and distinctions between the cumulative environmental impacts of building and operating a new nuclear power plant at the PSEG Site or at one of the alternative sites, the review team concludes that these differences are not sufficient to determine that any of the alternative sites would be environmentally preferable to the PSEG Site for building and operating a new nuclear power plant. In such a case, the PSEG Site prevails because none of the alternative sites are clearly environmentally preferable.

The review team considered various alternative systems designs, including alternative heat-dissipation systems and multiple alternative intake, discharge, and water-supply systems. The review team identified no alternatives for the PSEG Site that would be environmentally preferable to the systems designs used as the basis for analysis in this EIS. However, if at some time in the future PSEG requests authorization from the NRC (e.g., a combined license) to build and operate a new nuclear power plant, the review team will need to compare the specific heat dissipation design chosen to the other designs that were included in the PPE (Section 9.4.1 provides more detail on this matter).

Table ES-2. Comparison of Environmental Impacts of Energy Alternatives

Resource Areas	PSEG Site (Nuclear)	Energy Alternatives[a]		
		Coal	Natural Gas	Combination
Land Use	SMALL to MODERATE	MODERATE	MODERATE	MODERATE
Surface Water	SMALL	SMALL	SMALL	SMALL
Groundwater	SMALL	SMALL	SMALL	SMALL
Terrestrial Ecosystems	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE
Aquatic Ecosystems	SMALL	SMALL	SMALL	SMALL
Socioeconomics	LARGE (beneficial) to MODERATE (adverse)	LARGE (beneficial) to MODERATE (adverse)	MODERATE (beneficial) to SMALL (adverse)	MODERATE (beneficial) to MODERATE (adverse)
Environmental Justice	None[b]	None[b]	None[b]	None[b]
Historic and Cultural	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE
Air Quality	SMALL	MODERATE	SMALL to MODERATE	SMALL to MODERATE
Human Health	SMALL	SMALL	SMALL	SMALL
Waste Management	SMALL	MODERATE	SMALL	SMALL

(a) Impacts taken from Table 9-4 (see Section 9.2.5) in the EIS. The conclusions for the energy alternatives are compared to those for the NRC-authorized activities at the PSEG Site as reflected in Chapters 4 and 5, as well as in Section 6.1. Note that cumulative impacts are not included in the comparison of energy alternatives.

(b) The entry “None” for Environmental Justice does not mean there are no adverse impacts to minority or low-income populations from the proposed action. Rather, “None” means that, while there may be adverse impacts, those impacts do not affect minority or low-income populations in any disproportionate manner, relative to the general population.

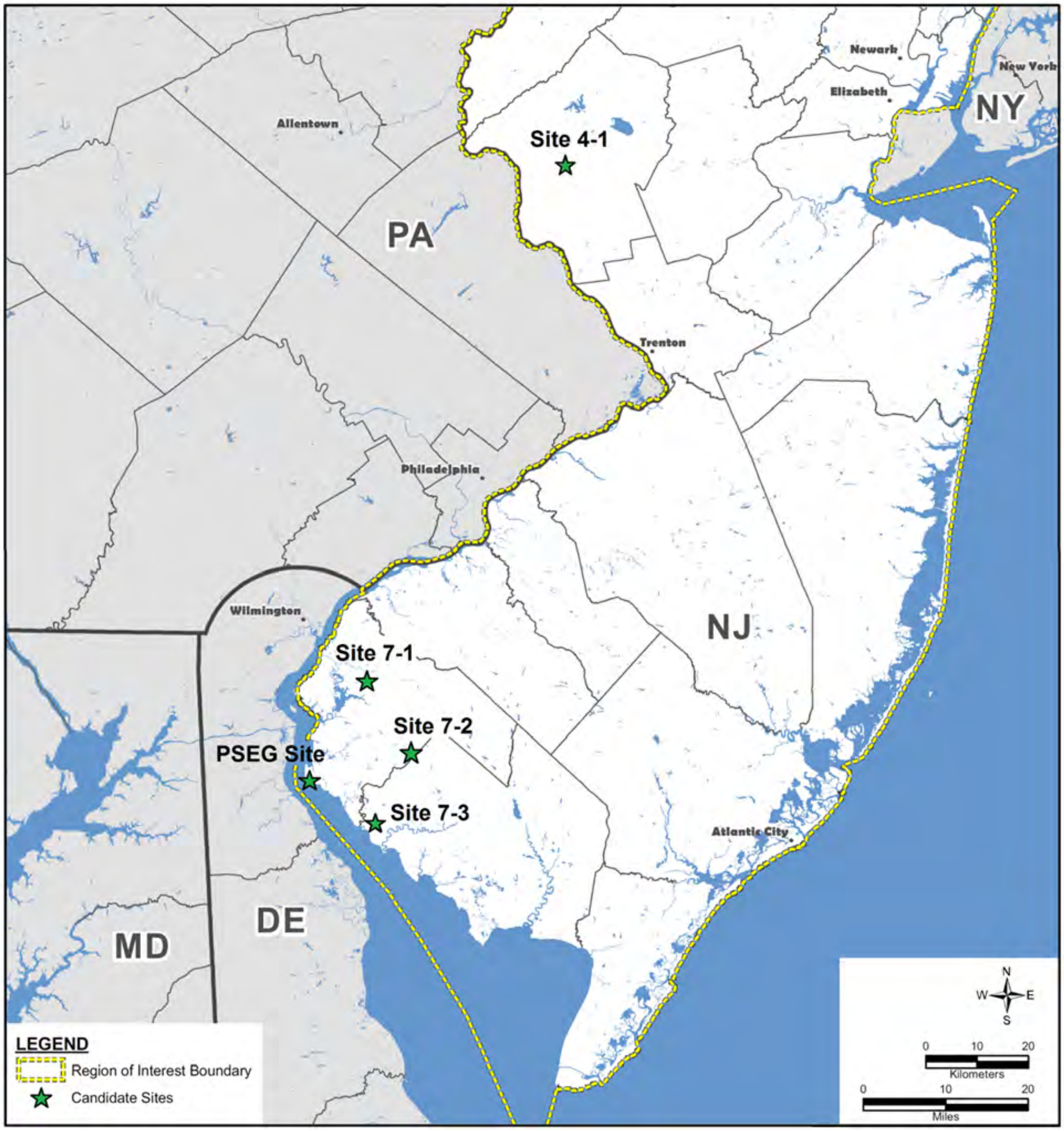

Figure ES-2. Map Showing the Locations of Alternative Sites (note that the PSEG Site is also identified as Site 7-4)

Table ES-3. Comparison of Environmental Impacts at Alternative Sites

Resource Areas	PSEG Site[a] (Site 7-4)	Alternative Sites[b]			
		Site 4-1	Site 7-1	Site 7-2	Site 7-3
Land Use	MODERATE	MODERATE	MODERATE	MODERATE	MODERATE
Surface Water	MODERATE	MODERATE	MODERATE	MODERATE	MODERATE
Groundwater	MODERATE	SMALL	MODERATE	MODERATE	MODERATE
Terrestrial Ecosystems	MODERATE	MODERATE	MODERATE	MODERATE	MODERATE
Aquatic Ecosystems	MODERATE to LARGE	MODERATE	MODERATE to LARGE	MODERATE to LARGE	MODERATE to LARGE
Socioeconomics	LARGE (beneficial) to MODERATE (adverse)	LARGE (beneficial) to LARGE (adverse)	LARGE (beneficial) to LARGE (adverse)	LARGE (beneficial) to LARGE (adverse)	LARGE (beneficial) to LARGE (adverse)
Environmental Justice	None[c]	None[c]	Potential[c]	None[c]	None[c]
Historic and Cultural	MODERATE	LARGE	MODERATE	MODERATE	MODERATE
Air Quality	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE
Human Health	SMALL	SMALL	SMALL	SMALL	SMALL
Waste Management	SMALL	SMALL	SMALL	SMALL	SMALL

(a) Cumulative impact determinations taken from Table 7-4 in the EIS (see Section 7.12).
(b) Cumulative impact determinations taken from Table 9-24 in the EIS (see Section 9.3.6).
(c) The entry "None" for Environmental Justice does not mean there are no adverse impacts to minority or low-income populations from the proposed action. Rather, "None" means that, while there may be adverse impacts, those impacts do not affect minority or low-income populations in any disproportionate manner, relative to the general population. Similarly, the entry "Potential" means that the review team has determined the presence of pathways by which a minority or low-income population could be affected disproportionately.

BENEFITS AND COSTS

The review team compiled and compared the pertinent analytical conclusions reached in this EIS. All of the expected impacts from building and operating a new nuclear power plant at the PSEG Site were gathered and aggregated into two final categories: (1) the expected environmental costs and (2) the expected benefits to be derived from approval of the proposed action. Although the analysis in Section 10.6 of this EIS is conceptually similar to a purely economic benefit-cost analysis, which determines the net present dollar value of a given project, the intent of that section is to identify potential societal benefits of the proposed activities and compare them to the potential internal (i.e., private) and external (i.e., societal) costs of the proposed activities. In general, the purpose is to inform the ESP process by gathering and reviewing information that demonstrates the likelihood that the benefits of the proposed activities outweigh the aggregate costs.

On the basis of the assessments in this EIS, the building and operation of a new nuclear power plant at the PSEG Site, with mitigation measures identified by the review team, would accrue benefits (e.g., the electricity produced) that most likely would outweigh the economic, environmental, and social costs. For the NRC-proposed action (i.e., the issuance of the ESP), the accrued future benefits would also outweigh the costs of preconstruction, construction, and operation of a new nuclear power plant at the PSEG Site.

RECOMMENDATION

The NRC staff's recommendation to the Commission related to the environmental aspects of the proposed action is that the ESP should be issued as proposed.

This recommendation is based on the following:

- the application, including the ER and its revisions, submitted by PSEG;
- consultation with Federal, State, Tribal, and local agencies;
- consideration of public comments received during scoping and the public comment period following the publication of the draft EIS; and
- the review team's independent review and assessment as detailed in this EIS.

In making its recommendation, the NRC staff determined that none of the alternative sites is environmentally preferable (and therefore, also not obviously superior) to the PSEG Site. The NRC staff also determined that none of the energy or cooling-system alternatives assessed is environmentally preferable to the proposed action.

The NRC staff's determination is independent of the USACE's determination of whether the PSEG Site is the least environmentally damaging practicable alternative pursuant to CWA Section 404(b)(1) Guidelines. The USACE will conclude its analysis of both offsite and onsite alternatives in its Record of Decision.

ACRONYMS AND ABBREVIATIONS

°C	degree(s) Celsius
°F	degree(s) Fahrenheit
µg	microgram(s)
µm	micrometer(s)
µS/cm	microsievert(s) per centimeter
χ/Q	atmospheric dispersion factor(s)
7Q10	7-day, 10-year low flow (i.e., the lowest flow for 7 consecutive days, expected to occur once per decade)
ABWR	Advanced Boiling Water Reactor
ac	acre(s)
ac-ft	acre-feet
acfm	actual cubic feet per minute
ACHP	Advisory Council on Historic Preservation
ACS	American Community Survey
ACW	Alloway Creek Watershed Wetland Restoration
AD	Anno Domini
ADAMS	Agencywide Documents Access and Management System
AE	Atlantic City Electric
ALARA	as low as reasonably achievable
A.M.E.	African Methodist Episcopal
ANL	Argonne National Laboratory
ANS	American Nuclear Society
AP1000	Advanced Passive 1000 (pressurized water) reactor
APE	area of potential effect
AQCR	Air Quality Control Region
ARRA	American Recovery and Reinvestment Act
ASCE/SEI	American Society of Civil Engineers/Structural Engineering Institute
ASMFC	Atlantic States Marine Fisheries Commission
ASSRT	Atlantic Sturgeon Status Review Team
ATWS	anticipated transient without scram
BA	biological assessment
BACT	Best Available Control Technology
bbl	barrel(s)
BBS	North American Breeding Bird Survey
BC	Before Christ
BEA	Bureau of Economic Analysis
BEIR	Biological Effects of Ionizing Radiation

BGEPA	Bald and Golden Eagle Protection Act
BGS	basic generation service
BLS	Bureau of Labor Statistics (U.S. Department of Labor)
BMP	best management practice
BNL	Brookhaven National Laboratory
BRAC	Base Realignment and Closure
BTS	Bureau of Technical Services
Btu	British thermal unit(s)
BUD	beneficial use determination
BWA	Bureau of Water Allocation
BWR	boiling water reactor
C&D	Chesapeake and Delaware
CAA	Clean Air Act
CAES	compressed air energy storage
CAFRA	Coastal Area Facility Review Act
CAIR	Clean Air Interstate Rule
CCR	coal combustion residual
CCS	carbon capture and sequestration
CCW	component cooling water
CDC	Centers for Disease Control and Prevention
CDF	Confined Disposal Facility
CEDE	committed effective dose equivalent
CEQ	Council on Environmental Quality
CFR	*Code of Federal Regulations*
cfs	cubic feet per second
CH_4	methane
Ci	curie(s)
cm	centimeter(s)
CMP	Coastal Management Program
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	CO_2 equivalent
COL	combined construction permit and operating license or combined license
COLA	combined license application
CORMIX	Cornell Mixing Zone Expert System
CP	construction permit
CR	County Route
CSAPR	Cross-State Air Pollution Rule
CSP	concentrating solar power
CWA	Clean Water Act (aka Federal Water Pollution Control Act)

CWIS	circulating water intake structure
CWS	circulating water system
CZM	coastal zone management
CZMA	Coastal Zone Management Act
d	day
D/Q	deposition factor(s)
DA	Department of the Army
DAM	Day-Ahead Market
dB	decibel(s)
dBA	decibel(s) on the A-weighted scale
DBA	design basis accident
DBF	design basis flood
DC	direct current
DBT	dry-bulb temperature
DCD	Design Certification/Control Document
DCR	Deed of Conservation Restriction
DDT	Dichlorodiphenyltrichloroethane
DE	Delaware
DEIS	draft environmental impact statement
DFW	Division of Fish & Wildlife
DNL	day-night average sound levels
DNREC	Delaware Department of Natural Resources and Environmental Control
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
DPCC	Discharge Prevention, Containment, and Countermeasure
DPS	distinct population segment
DR	demand response
DRBC	Delaware River Basin Commission
DRN	Delaware Riverkeeper Network
DSM	demand-side management
DWDS	demineralized water distribution system
DWS	drinking water standard
EA	environmental assessment
EAB	exclusion area boundary
ECOS	Environmental Conservation Online System (FWS)
EDC	electric delivery company
EDG	emergency diesel generator
EE	energy efficiency

EEP	Estuary Enhancement Program
EFH	essential fish habitat
EIA	Energy Information Administration
EIF	equivalent impact factor
EIS	environmental impact statement
ELF	extremely low frequency
EMAAC	Eastern Mid-Atlantic Area Council
EMF	electromagnetic field
EMS	emergency medical services
EO	Executive Order
EPA	U.S. Environmental Protection Agency
EPR	Evolutionary Power Reactor
ER	Environmental Report
ESA	Endangered Species Act of 1973, as amended
ESF	engineered safety feature
ESMP	Environmental Surveillance and Monitoring Program
ESP	early site permit
ESPA	early site permit application
ESRP	Environmental Standard Review Plan (NUREG–1555)
ESWS	essential service water system
FEMA	U.S. Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
FHWA	Federal Highway Administration
FMP	fishery management plan
FP	fission product
fpm	feet per minute
fps	feet per second
FPS	fire protection system
FR	*Federal Register*
FRN	*Federal Register* Notice
FSAR	Final Safety Analysis Report
ft	foot or feet
ft^2	square foot or feet
ft^3	cubic foot or feet
FWCA	Fish and Wildlife Coordination Act
FWS	U.S. Fish and Wildlife Service
g	gram(s)
gal	gallon(s)
GBq	gigabecquerel

GCRP	U.S. Global Change Research Program
GDP	gross domestic product
GEIS	*Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (NUREG–1437)
GEIS-DECOM	GEIS-Decommissioning of Nuclear Facilities (NUREG–0586)
GHG	greenhouse gas
GI-LLI	gastrointestinal lining of lower intestine
GIS	geographic information system
GMP	gross metropolitan product
gpd	gallon(s) per day
gpm	gallon(s) per minute
GSR	geologic survey report
GWh	gigawatt-hour(s)
GWPP	groundwater protection program
Gy	Gray(s)
H1H	high-first-high
H2H	high-second-high
ha	hectare(s)
HAP	hazardous air pollutant
HAPC	Habitat Area of Particular Concern
HCGS	Hope Creek Generating Station
HDA	heat dissipation area
HLW	high-level waste
HPO	historic preservation office
hr	hour(s)
Hz	hertz
I	U.S. Interstate (highway)
IAEA	International Atomic Energy Agency
ICRP	International Commission on Radiological Protection
IGCC	integrated gasification combined cycle
in.	inch(es)
in. Hg	inch(es) of mercury
IPCC	Intergovernmental Panel on Climate Change
IRM	installed reserve margin
ISFSI	independent spent fuel storage installation
JCPL	Jersey Central Power & Light
kg	kilogram(s)

kHz	kilohertz
km	kilometer(s)
km/hr	kilometer(s) per hour
km^2	square kilometer(s)
kV	kilovolt(s)
kW(e)	kilowatt(s) (electrical)
kWh	kilowatt-hour(s)
L	liter(s)
LAER	lowest achievable emission rate
lb	pound(s)
Ldn	day-night average sound level
LEDPA	least environmentally damaging practicable alternative
Leq	equivalent continuous sound level
LFG	landfill gas
LLC	Limited Liability Company
LLW	low-level waste
LMDCT	linear mechanical draft cooling tower
LMP	locational marginal price
LOCA	loss of coolant accident
LOI	letter of interpretation
LOLE	loss of load expectation
LOS	level of service
LPZ	low population zone
LST	local standard time
LULC	land use and land cover
LWA	Limited Work Authorization
LWCF	Land and Water Conservation Fund
LWR	light water reactor
m	meter(s)
m/s	meter(s) per second
m^2	square meter(s)
m^3	cubic meter(s)
m^3/s	cubic meter(s) per second
MACCS2	Melcor Accident Consequence Code System Version 1.12
MAPP	Mid-Atlantic Power Pathway
MCCI	molten corium-to-concrete interaction
MCWB	mean coincident wet-bulb temperature
MDCT	mechanical draft cooling tower
MEI	maximally exposed individual

MERP	Marsh Ecology Research Program
mg	milligram(s)
Mgd	million gallon(s) per day
mGy	milligray(s)
mi	mile(s)
mi^2	square mile(s)
min	minute(s)
mL	milliliter(s)
MLW	mean low water
MM	million
mm	millimeter(s)
mo	month(s)
MOU	Memorandum of Understanding
MOX	mixed oxides
mph	mile(s) per hour
mrad	millirad(s)
mrem	millirem(s)
MSA	Magnuson-Stevens Fishery Conservation and Management Act
MSA	Metropolitan Statistical Area
MSDS	material safety data sheets
MSL	mean sea level
mSv	millisievert(s)
MSW	municipal solid waste
MT	metric ton(nes)
MTU	metric ton(nes) uranium
MUA	municipal utilities authority
MW	megawatt(s)
MW(e)	megawatt(s) (electrical)
MW(t)	megawatt(s) (thermal)
MWd	megawatt-day(s)
MWd/MTU	megawatt-day(s) per metric ton of uranium
MWh	megawatt-hour(s)
NA	not applicable
N_2O	nitrous oxide
NAAQS	National Ambient Air Quality Standard
NAVD	North American Vertical Datum (sea level reference point used in surveying)
NAVD88	North American Vertical Datum of 1988
NCA	Noise Control Act
NCI	National Cancer Institute

NCP	non-coincident peak
NCRP	National Council on Radiation Protection and Measurements
NDCT	natural draft cooling tower
NEFMC	New England Fishery Management Council
NEI	Nuclear Electric Institute
NEPA	National Environmental Policy Act of 1969, as amended
NEPT	Neptune Regional Transmission System
NERC	North American Electric Reliability Corporation
NESC	National Electric Safety Code
NGCC	natural gas combined cycle
NGVD29	National Geodetic Vertical Datum of 1929
NHD	National Hydrology Dataset
NHL	National Historic Landmark
NHPA	National Historic Preservation Act
NIEHS	National Institute of Environmental Health Sciences
NJ	New Jersey
NJAC	New Jersey Administrative Code
NJBNE	New Jersey Bureau of Nuclear Engineering
NJBPU	New Jersey Board of Public Utilities
NJDEP	New Jersey Department of Environmental Protection
NJDOT	New Jersey Department of Transportation
NJEMP	New Jersey Energy Master Plan
NJGS	New Jersey Geological Survey
NJLWD	New Jersey Department of Labor and Workforce Development
NJPDES	New Jersey Pollutant Discharge Elimination System
NJSA	New Jersey Statutes Annotated
NJSM	New Jersey State Museum
NMFS	National Marine Fisheries Service
NO_2	nitrogen dioxide
NOAA	National Oceanic and Atmospheric Administration
NO_x	oxides of nitrogen
NPDES	National Pollutant Discharge Elimination System
NPS	National Park Service
NRC	U.S. Nuclear Regulatory Commission
NRCS	Natural Resource Conservation Service
NREL	National Renewable Energy Laboratory
NRHP	National Register of Historic Places
NSF	National Science Foundation
NSLP	Northeast Supply Link Project
NSPS	new source performance standard
NSR	New Source Review

NTU	nephelometric turbidity unit(s)
NUREG	U.S. Nuclear Regulatory Commission technical document
NWI	National Wetland Inventory
NWR	National Wildlife Refuge
NWS	National Weather Service
NY-NJ-CT	New York–Northern New Jersey–Long Island (nonattainment area)
NYB	New York Bight
O_3	ozone
ODCM	Offsite Dose Calculation Manual
ODST	Office of Dredging and Sediment Technology
OL	operating license
OPA	Office of Planning Advocacy
OPSI	Organization of PJM States, Inc.
ORNL	Oak Ridge National Laboratory
OSHA	Occupational Safety and Health Administration
PA-NJ-DE	Philadelphia–Wilmington (nonattainment area)
PA-NJ-MD-DE	Philadelphia–Wilmington–Atlantic City (nonattainment area)
PAM	primary amebic meningoencephalitis
para.	paragraph
Pb	lead
PCB	polychlorinated biphenyl
PECO	PECO Energy
pH	measure of acidity or basicity in solution
PHI	Pepco Holdings Inc.
PIR	public interest review
PIRF	public interest review factor
PJM	PJM Interconnection, LLC
PM	particulate matter
PM_{10}	particulate matter with a mean aerodynamic diameter of 10 μm or less
$PM_{2.5}$	particulate matter with a mean aerodynamic diameter of 2.5 μm or less
PNNL	Pacific Northwest National Laboratory
ppb	part(s) per billion
PPE	plant parameter envelope
ppm	part(s) per million
ppt	part(s) per thousand
PRA	probabilistic risk assessment
PRM	Potomac-Raritan-Magothy (aquifer)
PSD	Prevention of Significant Deterioration
PSE&G	Public Service Electric and Gas Company

PSEG	PSEG Power, LLC, and PSEG Nuclear, LLC
psi	pound(s) per square inch
psu	practical salinity unit
PSWS	potable and sanitary water system
PTE	potential to emit
PV	photovoltaic
PWR	pressurized water reactor
rad	radiation absorbed dose
RAI	Request for Additional Information
RCRA	Resource Conservation and Recovery Act of 1976, as amended
REC	renewable energy credit(s)
RECO	Rockland Electric Company
rem	Roentgen equivalent man (a unit of radiation dose)
REMP	radiological environmental monitoring program
RERR	Radioactive Effluent Release Report
RFC	Reliability*First* Corporation
RFI	request for information
RG	Regulatory Guide
RGPP	Radiological Groundwater Protection Program
RKM	River Kilometer
RM	River Mile
ROD	Record of Decision
ROI	region of interest
ROW	right-of-way
RPM	reliability pricing model
RPS	Renewable Portfolio Standard
RSA	relevant service area
RSICC	Radiation Safety Information Computational Center
RTEP	Regional Transmission Expansion Plan
RTM	real-time market
RTO	regional transmission organization
RTP	rated thermal power
RV	recreational vehicle
RWS	raw water service
Ryr	reactor-year(s)
s	second(s)
SA	sanitation authority or sewerage authority
SACTI	Seasonal and Annual Cooling Tower Impact (prediction code)
SAFSTOR	Safe Storage

SAMA	severe accident mitigation alternative
SAV	submerged aquatic vegetation
SBO	station blackout (in reference to a diesel generator)
scf	standard cubic feet
SCR	selective catalytic reduction
SE	southeast
SECA	Solid State Energy Conversion Alliance
SEIA	Socioeconomic Impact Area
SEIS	Supplemental Environmental Impact Statement
SEL_{cum}	cumulative sound exposure level
SER	safety evaluation report
SESC Act	Soil Erosion and Sediment Control Act
SGS	Salem Generating Station, Units 1 and 2
SGTR	steam generator tube rupture
SHPO	State Historic Preservation Office
SIL	significant impact level
SMC	South Macro-Corridor
SMR	small modular reactor
SO_2	sulfur dioxide
SO_x	oxides of sulfur
SOARCA	State-of-the-Art Reactor Consequence Analysis
SPCC	spill prevention, control, and countermeasures
SPCCP	spill prevention, control, and countermeasure plan
SPL_{peak}	sound pressure level (peak)
SPL_{rms}	sound pressure level (root mean square)
SRERP	Susquehanna-Roseland Electric Reliability Project
SSAR	Site Safety Analysis Report
SSC	structure, system, or component
STP	sewage treatment plant
Sv	sievert
SWIS	service water intake system
SWPPP	stormwater pollution prevention plan
SWS	service water system
T	ton(s)
T&E	threatened and endangered
TDS	total dissolved solids
TEDE	total effective dose equivalent
THPO	Tribal Historic Preservation Office
TIA	traffic impact analysis
TLD	thermoluminescent dosimeter

TPS	third party supplier
tpy	ton(s) per year
TRAGIS	Transportation Routing Analysis Geographic Information System
^{235}U	uranium-235
UA	utilities authority
UHS	ultimate heat sink
UMTRI	University of Michigan Transportation Research Institute
U.S.	United States
U.S. EPR	U.S. Evolutionary Power Reactor
US-APWR	U.S. Advanced Pressurized Water Reactor
USACE	U.S. Army Corps of Engineers
USC	United States Code
USCB	U.S. Census Bureau
USCG	U.S. Coast Guard
USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service
USGS	U.S. Geological Survey
V	volt
VOC	volatile organic compound
WBT	wet-bulb temperature
WHO	World Health Organization
WMA	Wildlife Management Area
WMC	West Macro-Corridor
WRA	Water Resources Association of Delaware River Basin
yd	yard(s)
yd^3	cubic yard(s)
yr	year(s)
yr^{-1}	per year

6.0 FUEL CYCLE, TRANSPORTATION, AND DECOMMISSIONING

This chapter addresses environmental impacts from (1) uranium fuel-cycle and solid-waste management (Section 6.1), (2) transportation of radioactive material (Section 6.2), and (3) decommissioning of a new nuclear power plant at the PSEG Site in Salem County, New Jersey (Section 6.3). In its evaluation of uranium fuel-cycle impacts from a new plant at the PSEG Power, LLC, and PSEG Nuclear, LLC (PSEG), Site, at this early site permit (ESP) stage, PSEG has developed a plant parameter envelope (PPE) based on parameters derived from one Advanced Boiling Water Reactor (ABWR), one U.S. Evolutionary Power Reactor (U.S. EPR), one U.S. Advanced Pressurized Water Reactor (US-APWR), or two Advanced Passive 1000 (AP1000) reactors. Of these alternatives, the two Westinghouse AP1000 reactors provide the bounding case for the evaluation of fuel-cycle, transportation, and decommissioning impacts. The assessment of fuel-cycle impacts is based on values in Table S–3 in Title 10 of the *Code of Federal Regulations* (CFR) Part 51.51(b) (10 CFR Part 51-TN250), which in turn assumes an 80 percent annual capacity factor referenced to a 1,000-MW(e) light water reactor (LWR), resulting in 800 MW of electrical output. For a bounding analysis in this part of the environmental review, PSEG assumed a 96.3 percent capacity factor for each of two 1,200-MW(e) AP1000 reactors with a net electrical power output of 1,150 MW(e) each and scaled the impact values from Table S–3 by an appropriate factor (PSEG 2012-TN1720). The results reported here apply to the impacts from two AP1000 units, each with the capacity factor of 96.3 percent assumed by PSEG (PSEG 2015-TN4280; PSEG 2014-TN3564).

6.1 Fuel-Cycle Impacts and Solid-Waste Management

This section discusses the environmental impacts from the uranium fuel-cycle and solid-waste management for the AP1000 reactor design. The environmental impacts of this design are evaluated against specific criteria for LWR designs in 10 CFR 51.51 (TN250).

The regulations in 10 CFR 51.51(a) (TN250) state that

> "Under §51.50 every environmental report (ER) prepared for the construction permit stage or early site permit stage or combined license stage of a light-water-cooled nuclear power reactor, and submitted on or after September 4, 1979, shall take Table S–3, Table of Uranium Fuel Cycle Environmental Data, as the basis for evaluating the contribution of the environmental effects of uranium mining and milling, the production of uranium hexafluoride, isotopic enrichment, fuel fabrication, reprocessing of irradiated fuel, transportation of radioactive materials and management of low level wastes and high level wastes related to uranium fuel cycle activities to the environmental costs of licensing the nuclear power reactor. Table S–3 shall be included in the environmental report and may be supplemented by a discussion of the environmental significance of the data set forth in the table as weighed in the analysis for the proposed facility."

The new nuclear power plant evaluated for the PSEG Site is based on light-water-cooled reactors that use uranium dioxide fuel; therefore, Table S–3 (10 CFR 51.51(b) [TN250]) can be used to assess the environmental impacts of the uranium fuel cycle. Table S–3 values are

normalized for a reference 1,000 megawatt (electrical) (MW(e)) LWR at an 80 percent capacity factor. The 10 CFR 51.51(a) (TN250) Table S–3 values are reproduced in Table 6-1.

Table 6-1. Uranium Fuel Cycle Environmental Data as Provided in Table S–3 of 10 CFR 51.51(b)[(a)]

Environmental Considerations	Total	Maximum Effect per Annual Fuel Requirement or Reference Reactor Year of Model 1,000-MW(e) LWR
Natural Resource Use		
Land (acres):		
Temporarily committed[(b)]	100	
Undisturbed area	79	
Disturbed area	22	Equivalent to a 100-MW(e) coal-fired power plant
Permanently committed	13	
Overburden moved (millions of metric tons [MT])	2.8	Equivalent to a 95-MW(e) coal-fired power plant
Water (millions of gallons):		
Discharged to air	160	= 2 percent of model 1,000-MW(e) LWR with cooling tower
Discharged to water bodies	11,090	
Discharged to ground	127	
Total	11,377	<4 percent of model 1,000-MW(e) with once-through cooling
Fossil fuel:		
Electrical energy (thousands of MW-hr)	323	<5 percent of model 1,000-MW(e) LWR output
Equivalent coal (thousands of MT)	118	Equivalent to the consumption of a 45-MW(e) coal-fired power plant
Fossil fuel:		
Electrical energy (thousands of MW-hr)	323	<5 percent of model 1,000-MW(e) LWR output
Equivalent coal (thousands of MT)	118	Equivalent to the consumption of a 45-MW(e) coal-fired power plant
Natural gas (millions of standard cubic feet)	135	<0.4 percent of model 1,000-MW(e) energy output
Effluents—Chemical (MT)		
Gases (including entrainment):[(c)]		
SO_x	4,400	
NO_x[(d)]	1,190	Equivalent to emissions from 45-MW(e) coal-fired plant for a year
Hydrocarbons	14	
CO	29.6	
Particulates	1,154	

Table 6-1. (continued)

Environmental Considerations	Total	Maximum Effect per Annual Fuel Requirement or Reference Reactor Year of Model 1,000-MW(e) LWR
Other gases:		
F	0.67	Principally from uranium hexafluoride (UF_6) production, enrichment, and reprocessing. The concentration is within the range of state standard-below level that has effects on human health
HCl	0.014	
Liquids:		
SO_4^-	9.9	From enrichment, fuel-fabrication, and reprocessing steps. Components that constitute a potential for adverse environmental effect are present in dilute concentrations and receive additional dilution by receiving bodies of water to levels below permissible standards. The constituents that require dilution and the flow of dilution water are NH_3—600 cfs, NO_3—20 cfs, Fluoride—70 cfs
NO_3^-	25.8	
Fluoride	12.9	
Ca^{++}	5.4	
Cl^-	8.5	
Na^+	12.1	
NH_3	10	
Fe	0.4	
Tailings solutions (thousands of MT)	240	From mills only–no significant effluents to environment
Solids	91,000	Principally from mills–no significant effluents to environment
Effluents–Radiological (curies)		
Gases (including entrainment):		
Rn-222		Presently under reconsideration by the Commission
Ra-226	0.02	
Th-230	0.02	
Uranium	0.034	
Tritium (thousands)	18.1	
C-14	24	
Kr-85 (thousands)	400	
Ru-106	0.14	Principally from fuel reprocessing plants
I-129	1.3	
I-131	0.83	
Tc-99		Presently under consideration by the Commission
Fission products and transuranics	0.203	
Liquids:		
Uranium and daughters	2.1	Principally from milling–included tailings liquor and returned to ground–no effluents; therefore, no effect on environment
Ra-226	0.0034	From UF_6 production

Table 6-1. (continued)

Environmental Considerations	Total	Maximum Effect per Annual Fuel Requirement or Reference Reactor Year of Model 1,000-MW(e) LWR
Th-230	0.0015	
Th-234	0.01	From fuel-fabrication plants–concentration 10 percent of 10 CFR Part 20 (TN283) for total processing 26 annual fuel requirements for model LWR
Fission and activation products	5.9×10^{-6}	
Solids (buried on the site):		
Other than high level (shallow)	11,300	9,100 Ci comes from low-level reactor wastes and 1,500 Ci comes from reactor decontamination and decommissioning—buried at land burial facilities. 600 Ci comes from mills—included in tailings returned to ground. Approximately 60 Ci comes from conversion and spent fuel storage. No significant effluent to the environment
TRU and HLW (deep)	1.1×10^{7}	Buried at Federal Repository
Effluents—thermal (billions of British thermal units)	4,063	<5 percent of model 1,000-MW(e) LWR
Transportation (person-rem):		
Exposure of workers and general public	2.5	
Occupational exposure (person-rem)	22.6	From reprocessing and waste management

(a) In some cases where no entry appears, it is clear from the background documents that the matter was addressed and that, in effect, the table should be read as if a specific zero entry had been made. However, there are other areas that are not addressed at all in the table. Table S–3 does not include health effects from the effluents described in the table, or estimates of releases of radon-222 from the uranium fuel cycle, or estimates of technetium-99 released from waste-management or reprocessing activities. These issues may be the subject of litigation in the individual licensing proceedings.

Data supporting this table are given in the *Environmental Survey of the Uranium Fuel Cycle*, WASH-1248 (AEC 1974-TN23); the *Environmental Survey of the Reprocessing and Waste Management Portion of the LWR Fuel Cycle*, NUREG–0116 (Supp. 1 to WASH-1248) (NRC 1976-TN292); the *Public Comments and Task Force Responses Regarding the Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle*, NUREG–0216 (Supp. 2 to WASH-1248) (NRC 1977-TN1255); and in the record of the final rulemaking pertaining to Uranium Fuel Cycle Impacts from Spent Fuel Reprocessing and Radioactive Waste Management, Docket RM-50-3. The contributions from reprocessing, waste management, and transportation of wastes are maximized for either of the two fuel cycles (i.e., uranium-only and no-recycle). The contribution from transportation excludes transportation of cold fuel to a reactor and of irradiated fuel and radioactive wastes from a reactor, which are considered in Table S–4 of 10 CFR 51.20(g). The contributions from the other steps of the fuel cycle are given in columns A-E of Table S–3A of WASH-1248.

(b) The contributions to temporarily committed land from reprocessing are not prorated over 30 yr, because the complete temporary impact accrues regardless of whether the plant services 1 reactor for 1 yr or 57 reactors for 30 yr.

(c) Estimated effluents based upon combustion of equivalent coal for power generation.

(d) 1.2 percent from natural-gas use and process.

Source: Adapted from Table S–3 in 10 CFR 51.51(b) (TN250). Some minor changes have been made to format and wording but not to the data as it appears in Table S–3.

Specific categories of environmental considerations are included in Table S–3 (see Table 6-1). These categories relate to land use, water consumption and thermal effluents, radioactive releases, burial of transuranic high-level waste (HLW) and low-level waste (LLW), and radiation doses from transportation and occupational exposures. In developing Table S–3, the staff considered two fuel-cycle options that differed in the treatment of irradiated (spent) fuel removed from a reactor. The no-recycle option treats all spent fuel as waste to be disposed at a Federal waste repository, whereas the uranium-only recycle option involves reprocessing spent fuel to recover unused uranium and to return it for use in new fuel. Neither cycle involves the recovery of plutonium. The contributions in Table S–3 resulting from reprocessing, waste management, and transportation of wastes are maximized for both of the two fuel cycles (i.e., uranium-only and no-recycle); that is, the identified environmental impacts are based on the cycle that results in the greater impact. The uranium fuel cycle is defined as the total of the operations and processes associated with provision, use, and ultimate disposition of fuel for nuclear power reactors.

The Nuclear Nonproliferation Act of 1978 (22 USC 3201 et seq. -TN737) significantly affected the disposition of spent nuclear fuel by deferring indefinitely the commercial reprocessing and recycling of spent fuel produced in the U.S. commercial nuclear power program. While the ban on the reprocessing of spent fuel was lifted in October 1981 by the Reagan administration, economic circumstances changed, reserves of uranium ore increased, and the stagnation of the nuclear power industry in the United States provided little incentive for industry to resume reprocessing. During the 109th Congress, the Energy Policy Act of 2005 (42 USC 15801 et seq. -TN738) was enacted. It authorized the U.S. Department of Energy (DOE) to conduct an advanced fuel-recycling technology research and development program to evaluate proliferation-resistant fuel-recycling and transmutation technologies that minimize environmental or public health and safety impacts. Consequently, while Federal policy does not prohibit reprocessing, additional government and commercial efforts would be necessary before commercial reprocessing and recycling of spent fuel produced in the U.S. commercial nuclear power plants could commence.

The no-recycle option is presented schematically in Figure 6-1. Natural uranium is mined in either open-pit or underground mines or by an in situ leach-solution mining process. In situ leach mining, presently the primary form of uranium mining in the United States, involves injecting a lixiviant solution into the uranium ore body to dissolve uranium and then pumping the solution to the surface for further processing. The ore or in situ leach solution is transferred to mills where it is processed to produce “yellowcake” (U_3O_8). A conversion facility prepares the U_3O_8 by converting it to UF_6, which is then processed by an enrichment facility to increase the percentage of the more fissile uranium-235 isotope and decrease the percentage of the nonfissile uranium-238 isotope. At a fuel-fabrication facility, the enriched uranium, which is approximately 5 percent uranium-235, is then converted to uranium dioxide (UO_2). The UO_2 is pelletized, sintered, and inserted into tubes to form fuel assemblies, which are placed in a reactor to produce power. When the content of the uranium-235 reaches a point where the nuclear reactor has become inefficient with respect to neutron economy, the fuel assemblies are withdrawn from the reactor as spent fuel. After onsite storage for sufficient time to allow for short-lived fission-product decay and to reduce the heat-generation rate, the fuel assemblies would be transferred to a waste repository for internment. Disposal of spent fuel elements in a repository constitutes the final step in the no-recycle option.

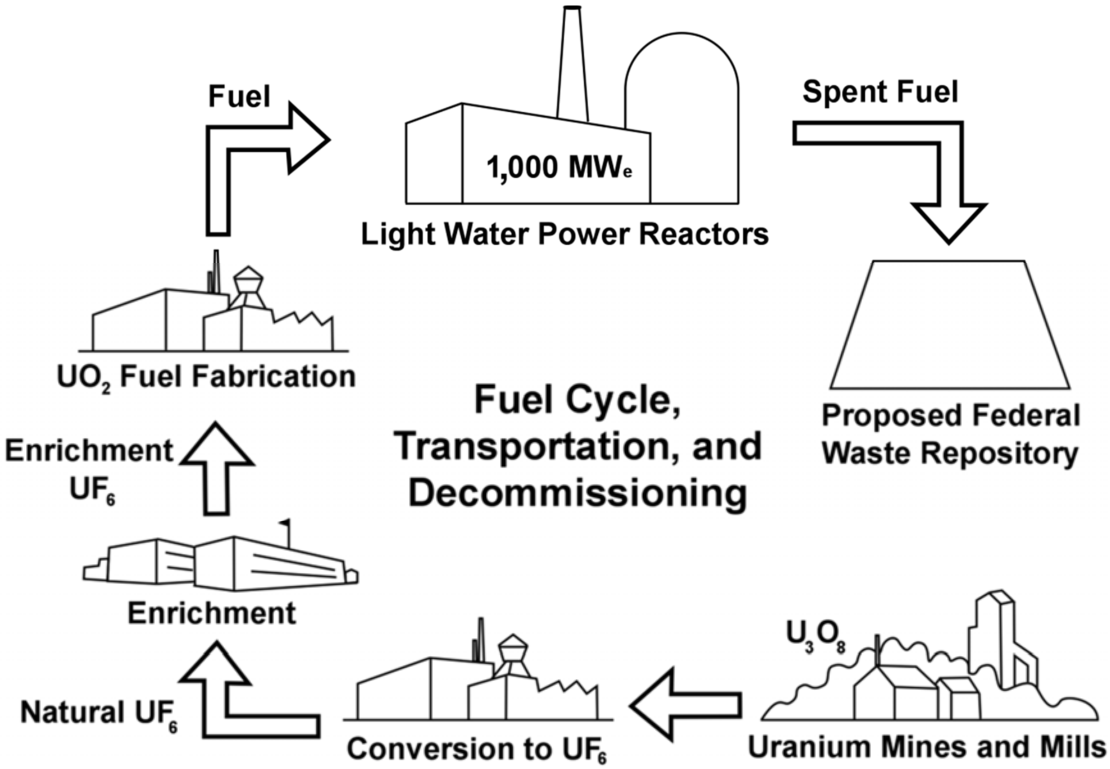

Figure 6-1. The Uranium Fuel Cycle: No-Recycle Option (Source: Derived from NRC 1999-TN289)

The following assessment of the environmental impacts of the fuel cycle as related to the operation of the proposed project is based on the values given in Table S–3 (Table 6-1) and the staff's analysis of the radiological impact from radon-222 and technetium-99. In NUREG–1437, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS) (NRC 1996-TN288; NRC 1999-TN289; NRC 2013-TN2654),[(1)] the staff provides a detailed analysis of the environmental impacts from the uranium fuel cycle. Although NUREG–1437 is specific to the impacts related to license renewal, the information is relevant to this review because the advanced LWR design considered here uses the same type of fuel as considered in the staff's evaluation in NUREG–1437. The staff's analyses in NUREG–1437 (NRC 2013-TN2654) are summarized and set forth here.

Each AP1000 reactor unit is rated at 3,400 MW(t) (Westinghouse 2008-TN496). Considering the bounding case of two AP1000 reactors located on the PSEG Site (PSEG 2012-TN1720), the power rating for a new nuclear power plant at the PSEG Site would be 6,800 MW(t). For this analysis, the net electric power output of each AP1000 reactor unit is presumed to be 1,150 MW(e). At a capacity factor of 96.3 percent (PSEG 2012-TN1720), each AP1000 unit produces an average of 1,107 MW(e). For two AP1000 units, this corresponds to 2,215 MW(e).

(1) NUREG–1437 was originally issued in 1996. Addendum 1 to NUREG–1437 was issued in 1999. NUREG–1437, Revision 1, was issued in June 2013. The version of NUREG–1437 cited, whether 1996 or 2013, is the one where the technical information is discussed. In some cases, the technical information is discussed in both documents. For those instances, NUREG–1437, Revision 1, is cited.

The fuel-cycle impacts in Table S–3 are based on a reference 1,000-MW(e) LWR operating at an annual capacity factor of 80 percent for a net electric output of 800 MW(e). As explained above, the total net electric output for two AP1000 reactors at the PSEG Site is 2,215 MW(e), which is about 2.77 times (i.e., 2,215 MW(e) divided by 800 MW(e) yields 2.77) the output value in Table S–3 (see Table 6-1). For added conservatism in its review and evaluation of the environmental impacts of the nuclear fuel cycle, the staff multiplied the values in Table S–3 by a factor of 3, rather than a factor of 2.77, providing additional assurance that this analysis bounds the options considered in the PSEG PPE. Scaling up by a factor of 3 is referred to as using the 1,000-MW(e) LWR-scaled model.

Recent changes in the uranium fuel cycle may have some bearing on environmental impacts; however, as discussed below, the staff is confident that the contemporary normalized uranium fuel-cycle impacts are below those identified in Table S–3. This assertion is true in light of the following recent uranium fuel-cycle trends in the United States.

- Increasing use of in situ leach uranium mining, which does not produce mine tailings and would lower the release of radon gas. A detailed discussion of this subject is provided in Section 6.1.5.
- Transitioning of U.S. uranium enrichment technology from gaseous diffusion to gas centrifugation. The latter process uses only a small fraction of the electrical energy per separation unit compared to gaseous diffusion. (U.S. gaseous-diffusion plants relied on electricity derived mainly from the burning of coal.)
- Current LWRs use nuclear fuel more efficiently due to higher fuel burnup. Therefore, less uranium fuel per year of reactor operation is required than in the past to generate the same amount of electricity.
- Fewer spent fuel assemblies per reactor-year are discharged; hence, the waste storage/repository impact is lessened.

The values in Table S–3 were calculated from industry averages for the performance of each type of facility or operation within the fuel cycle. Recognizing that this approach meant that there would be a range of reasonable values for each estimate, the staff followed the policy of choosing the assumptions or factors to be applied so that the calculated values would not be underestimated. This approach was intended to make sure that the actual environmental impacts would be less than the quantities shown in Table S–3 for all LWR nuclear power plants within the widest range of operating conditions. The staff recognizes that many of the fuel-cycle parameters and interactions vary in small ways from the estimates in Table S–3; the staff concludes that these variations would have no impacts on the Table S–3 calculations. For example, to determine the quantity of fuel required for a year's operation of a nuclear power plant in Table S–3, the staff defined the model reactor as a 1,000-MW(e) LWR operating at 80 percent capacity with a 12-month fuel-reloading cycle and an average fuel burnup of 33,000 MWd/MTU. This is a "reference reactor-year" (NRC 2013-TN2654).

If approved, the combined license (COL) for a new nuclear power plant at the PSEG Site would allow 40 years of operation. In NUREG–1437, the sum of the initial fuel loading plus all of the reloads for the lifetime of the reactor was divided by a 60-year lifetime (40-year initial license term and 20-year license renewal term) to obtain an average annual fuel requirement. This

approach was followed in NUREG–1437 (NRC 1996-TN288; NRC 1999-TN289) and carried forward into NUREG–1437, Revision 1 (NRC 2013-TN2654), for both boiling water reactors and pressurized water reactors; the higher annual requirement, 35 metric tons (MT) of uranium made into fuel for a boiling water reactor, was chosen in NUREG–1437, Revision 1, as the basis for the reference reactor-year (NRC 2013-TN2654). The average annual fuel requirement presented in NUREG–1437, Revision 1, would only be increased by 2 percent if a 40-year lifetime was evaluated. However, a number of fuel-management improvements have been adopted by nuclear power plants to achieve higher performance and to reduce fuel and separative-work (enrichment) requirements. Since the time when Table S–3 was promulgated, these improvements have reduced the annual fuel requirement, which means the Table S–3 assumptions remain bounding as applied to the proposed new nuclear power plant. Another change supporting the bounding nature of the Table S–3 assumptions with respect to the impacts of a new nuclear power plant at the PSEG Site is the elimination of the U.S. restrictions on the importation of foreign uranium. Until recently, the economic conditions of the uranium market favored use of foreign uranium at the expense of the domestic uranium industry. In the 1980s, the economic conditions of the uranium market resulted in the closing of most U.S. uranium mines and mills, substantially reducing the environmental impacts in the United States from uranium-mining activities. More recently, there is renewed interest in uranium recovery in the United States. Between 2007 and 2014, the NRC received 10 license applications for uranium recovery facilities (NRC 2014-TN4054). All but two of these applications were for facilities using the in situ recovery process, which does not produce mill tailings that would have released radon to the environment. Factoring in changes to the fuel cycle suggests that the environmental impacts of mining and tail millings could drop to levels below those given in Table S–3; however, Table S–3 estimates remain bounding as applied to the proposed new nuclear power plant.

In sum, these reasons highlight why Table S–3 is likely to overestimate impacts from a new nuclear power plant at the PSEG Site, and therefore the information in Table S–3 remains adequate for use in the bounding approach used in this analysis. Section 4.12.1.1 of NUREG–1437, Revision 1 (NRC 2013-TN2654), and Section 6.2 of NUREG–1437 (NRC 1996-TN288) discuss in greater detail the sensitivity to changes in the uranium fuel cycle since issuance of Table S–3 on the environmental impacts.

6.1.1 Land Use

The total annual land requirement for the fuel cycle supporting the 1,000-MW(e) LWR-scaled model is about 339 ac. Approximately 39 ac are permanently committed land, and 300 ac are temporarily committed. A “temporary” land commitment is a commitment for the life of the specific fuel-cycle plant (e.g., a mill, enrichment plant, or succeeding plants). After the decommissioning of the nuclear units, such land can be released for unrestricted use. “Permanent” commitments represent land that may not be released for use after plant shutdown and decommissioning because decommissioning activities do not result in the removal of sufficient radioactive material to meet the limits in 10 CFR Part 20 (TN283), Subpart E, for release of that area for unrestricted use. Of the 300 ac of temporarily committed land, 66 ac are assumed to be disturbed (NRC 1996-TN288). In comparison, a coal-fired power plant using the same megawatt electric output as the LWR-scaled model and using strip-mined coal requires the disturbance of about 600 ac/year for fuel alone. The staff concludes that the impacts on land use to support the 1,000-MW(e) LWR-scaled model would be minor.

6.1.2 Water Use

The principal water use for the fuel cycle supporting a 1,000-MW(e) LWR-scaled model is that required to remove waste heat from the power stations supplying electrical energy to the enrichment step of this cycle. Scaling from Table S–3, of the total annual water use of 3.41×10^{10} gal, about 3.33×10^{10} gal are required for the removal of waste heat, assuming that a new unit uses once-through cooling. Also, scaling from Table S–3, other water uses involve the discharge to air (e.g., evaporation losses in process cooling) of about 4.80×10^{8} gal/year and discharge to the ground (e.g., mine drainage) of about 3.81×10^{8} gal/year.

On a thermal-effluent basis, annual discharges from the nuclear fuel cycle are about 4 percent of the 1,000-MW(e) LWR-scaled model using once-through cooling. The consumptive water use of 4.80×10^{8} gal/year is about 2 percent of the 1,000-MW(e) LWR-scaled model using cooling towers. The maximum consumptive water use (assuming that all plants supplying electrical energy to the nuclear fuel cycle use cooling towers) would be about 6 percent of the 1,000-MW(e) LWR-scaled model using cooling towers. Under this condition, thermal effluents would be negligible. The staff concludes that the impacts on water use for these combinations of thermal loadings and water consumption would be minor.

6.1.3 Fossil Fuel Impacts

As indicated in Appendix K, the largest source of greenhouse gas (GHG) emissions associated with nuclear power is from the fuel cycle, not operation of the plant. The largest source of GHGs in the fuel cycle is production of electric energy and process heat from combustion of fossil fuel in conventional power plants. This energy is used to power components of the fuel cycle such as enrichment.

Table S–3 in 10 CFR 51.51 (TN250) presents data for evaluating the environmental effects of a reference 1,000-MW(e) light-water-cooled nuclear power reactor resulting from the uranium fuel cycle. Table S–3 does not provide an estimate of GHG emissions associated with the uranium fuel cycle but does state that 323,000 MWh is the assumed annual electric energy use associated with the uranium fuel cycle for the reference 1,000-MW(e) nuclear power plant and this 323,000 MWh of annual electric energy is assumed to be generated by a 45-MW(e) coal-fired power plant burning 118,000 MT of coal. Table S–3 also assumes approximately 135,000,000 standard cubic feet (scf) of natural gas is also required per year to generate process heat for certain portions of the uranium fuel cycle.

In Appendix K of this environmental impact statement (EIS), the NRC staff used the fossil fuel usage assumptions presented in Table S–3 to estimate that the GHG footprint of the fuel cycle to support a reference 1,000-MW(e) LWR with an 80 percent capacity factor for a 40-year operational period is on the order of 10,100,000 MT of carbon dioxide (CO_2) equivalent (CO_2e). Scaling this footprint to the power level and capacity factor of the two proposed AP1000 reactor units using the scaling factor of 3 discussed earlier, the review team estimates the GHG footprint for 40 years of fuel-cycle emissions to be approximately 3.0×10^{7} MT of CO_2e. This rate of GHG production equals 750,000 MT of CO_2e per year, less than 1 percent of New Jersey's annual CO_2 emission rate and 0.01 percent of the total U.S. annual CO_2 emission rate of 6.7 billion MT of CO_2e (EPA 2013-TN2815).

The largest use of electricity in the fuel cycle comes from the enrichment process. The development of Table S–3 assumed that the gaseous-diffusion process is used to enrich uranium. The gaseous-diffusion technology is no longer used for uranium enrichment. The last gaseous-diffusion enrichment facility in the U.S. ceased operations recently (USEC 2013-TN2765). Current enrichment facilities use gas-centrifuge technologies, and recent applications for new uranium enrichment facilities are based on gas-centrifuge and laser-separation technologies. The same amount of enrichment from gas-centrifuge and laser-separation facilities uses less electricity and therefore results in lower amounts of air emissions (e.g., CO_2) than a gaseous-diffusion facility. In addition, U.S. electric utilities have begun to switch from coal to cheaper, cleaner-burning natural gas (DOE/EIA 1995-TN2996); the Table S–3 assumption that a 45-MW(e) coal-fired plant is used to generate the 323,000 MWh of annual electric energy for the uranium fuel cycle also results in conservative air emission estimates. Therefore, the NRC staff concludes that the values for electricity use and air emissions in Table S–3 continue to be appropriately bounding values.

On this basis, the NRC staff concludes that the fossil fuel impacts, including GHG emissions, from the direct and indirect consumption of electric energy for fuel-cycle operations would be minor.

6.1.4 Chemical Effluents

The quantities of gaseous and particulate chemical effluents produced in fuel-cycle processes are given in Table S–3 (Table 6-1) for the reference 1,000-MW(e) LWR. According to WASH-1248 (AEC 1974-TN23), the quantities result from the generation of electricity for fuel-cycle operations. The principal effluents are sulfur oxides, nitrogen oxides, and particulates. Table 6-1 states that the fuel cycle for the reference 1,000-MW(e) LWR requires 323,000 MWh of electricity. The fuel cycle for the 1,000-MW(e) LWR-scaled model would therefore require 969,000 MWh of electricity, or less than 0.024 percent of the 4.1 billion MWh of electricity generated in the United States in 2012 (DOE/EIA 2013-TN2540). Therefore, the gaseous and particulate chemical effluents from fuel-cycle processes to support the operation of the 1,000-MW(e) LWR-scaled model would add less than 0.024 percent to the national gaseous and particulate chemical effluents for electricity generation.

Liquid chemical effluents produced in fuel-cycle processes are related to fuel enrichment and fabrication and may be released to receiving waters. These effluents are usually present in dilute concentrations such that only small amounts of dilution water are required to reach levels of concentration that are within established standards. Table S–3 (Table 6-1) specifies the amount of dilution water required for specific constituents. In addition, all liquid discharges into the navigable waters of the United States from facilities associated with the fuel-cycle operations would be subject to requirements and limitations set by appropriate Federal, State, Tribal, and local agencies.

Tailings solutions and solids are generated during the milling process, but as Table S–3 indicates, effluents are not released in quantities sufficient to have a significant impact on the environment.

Based on the above analysis, the NRC staff concludes that the impacts of these chemical effluents (i.e., gaseous, particulate, and liquid) would be minor.

6.1.5 Radiological Effluents

Radioactive effluents estimated to be released to the environment from waste-management activities and certain other phases of the fuel-cycle process are listed in Table S–3 (Table 6-1). NUREG–1437 (NRC 2013-TN2654) provides the 100-year environmental dose commitment to the U.S. population from fuel-cycle activities for 1 year of operation of the reference 1,000-MW(e) LWR using the radioactive effluents in Table 6-1. Excluding reactor releases and dose commitments because of exposure to radon-222 and technetium-99, the total overall whole body gaseous dose commitment and whole body liquid dose commitment from the fuel cycle were calculated to be approximately 400 person-rem and 200 person-rem, respectively. Scaling these dose commitments by a factor of about 3 for the 1,000-MW(e) LWR-scaled model results in whole body dose commitment estimates of 1,200 person-rem for gaseous releases and 600 person-rem for liquid releases. Therefore, for both pathways, the estimated 100-year environmental dose commitment to the U.S. population would be approximately 1,800-person-rem for the 1,000-MW(e) LWR-scaled model.

Currently, the radiological impacts associated with radon-222 and technetium-99 releases are not addressed in Table S–3. Principal radon releases occur during mining and milling operations and as emissions from mill tailings, whereas principal technetium-99 releases occur from gaseous-diffusion enrichment facilities. PSEG provided an assessment of radon-222 and technetium-99 in its ER (PSEG 2015-TN4280). PSEG's evaluation relied on the information discussed in NUREG–1437 (NRC 1996-TN288).

In Section 6.2 of NUREG–1437 (NRC 1996-TN288), the staff estimated the radon-222 releases from mining and milling operations and from mill tailings for each year of operation of the reference 1,000-MW(e) LWR. The estimated release of radon-222 for the 1,000-MW(e) LWR-scaled model is approximately 15,600 Ci. Of this total, about 78 percent would be from mining, 15 percent from milling operations, and 7 percent from inactive tailings before stabilization. For radon releases from stabilized tailings, the staff assumed that the LWR-scaled model would result in an emission of 3 Ci/reactor-year (i.e., about 3 times the NUREG–1437 (NRC 1996-TN288) estimate for the reference reactor-year). The major risks from radon-222 are from exposure to the bone and the lung, although there is a small risk from exposure to the whole body. The organ-specific dose-weighting factors from 10 CFR Part 20 (TN283) were applied to the bone and lung doses to estimate the 100-year dose commitment from radon-222 to the whole body. The estimated 100-year environmental dose commitment from mining, milling, and tailings before stabilization for each site year (assuming the 1,000-MW(e) LWR-scaled model) would be approximately 2,800 person-rem to the whole body. From stabilized tailings piles, the estimated 100-year environmental dose commitment would be approximately 54 person-rem to the whole body. Additional insights regarding Federal policy/resource perspectives concerning institutional controls comparisons with routine radon-222 exposure and risk and long-term releases from stabilized tailing piles are discussed in NUREG–1437 (NRC 1996-TN288).

The staff also considered the potential health effects associated with the releases of technetium-99 (NRC 2013-TN2654). The estimated releases of technetium-99 for the reference reactor-year for the 1,000-MW(e) LWR-scaled model are 0.021 Ci from chemical processing of recycled UF_6 before it enters the isotope-enrichment cascade and 0.015 Ci into the groundwater from an HLW repository. The major risks from technetium-99 are from exposure of the gastrointestinal tract and kidney, although there is a small risk from exposure to the whole body. The organ-specific dose-weighting factors from 10 CFR Part 20 (TN283) were applied to the gastrointestinal tract and kidney doses, and the total-body 100-year dose commitment from technetium-99 to the whole body was estimated to be 300 person-rem for the 1,000-MW(e) LWR-scaled model.

Radiation protection experts 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 relationship is used to describe the relationship between radiation dose and detriments such as cancer induction. *Health Risks from Exposure to Low Levels of Ionizing Radiation: BEIR VII—Phase 2*, a recent report by the National Research Council (National Research Council 2006-TN296), uses the linear, no-threshold dose response model as a basis for estimating the risks from low doses. This approach is accepted by the NRC as a conservative method for estimating health risks from radiation exposure, recognizing that the model may overestimate those risks. Based on this method, the staff estimated the risk to the public from radiation exposure using the nominal probability coefficient for total detriment. This coefficient has the value of 570 fatal cancers, nonfatal cancers, and severe hereditary effects per 1,000,000 person-rem (10,000 person-Sv), equal to 0.00057 effect per person-rem. The coefficient is taken from Publication 103 of the International Commission on Radiological Protection (ICRP 2007-TN422).

The nominal probability coefficient was multiplied by the sum of the estimated whole body population doses from gaseous effluents, liquid effluents, radon-222, and technetium-99 discussed above (approximately 5,000 person-rem/year) to calculate that the U.S. population would incur a total of approximately 2.8 fatal cancers, nonfatal cancers, and severe hereditary effects annually.

Radon-222 releases from tailings are indistinguishable from background radiation levels at a few kilometers from the tailings pile (at less than 0.6 mi in some cases) (NRC 1996-TN288; NRC 1999-TN289). The public dose limit in the U.S. Environmental Protection Agency (EPA) regulation, 40 CFR Part 190 (TN739), is 25 mrem/year to the whole body from the entire fuel cycle, but most NRC licensees have airborne effluents resulting in doses of less than 1 mrem/year (61 FR 65120-TN294).

In addition, at the request of the U.S. Congress, the National Cancer Institute conducted a study and published *Cancer in Populations Living Near Nuclear Facilities* in 1990 (Jablon et al. 1990-TN1257). This report included an evaluation of health statistics around all nuclear power plants as well as several other nuclear fuel-cycle facilities in operation in the United States in 1981 and found “no evidence that an excess occurrence of cancer has resulted from living near nuclear facilities” (Jablon et al. 1990-TN1257). The contribution to the annual average dose received by an individual from fuel-cycle-related radiation and other sources as reported in a publication of the National Council on Radiation Protection and Measurements (NCRP 2009-TN420) is listed

in Table 6-2. The contribution from the nuclear fuel cycle to an individual's annual average radiation dose is extremely small (about 0.1 mrem/year) compared to the annual average background radiation dose (about 311 mrem/year).

Based on the analyses presented above, the staff concludes that the environmental impacts of radioactive effluents from the fuel cycle, including gaseous and liquid releases, are minor.

Table 6-2. Comparison of Annual Average Dose Received by an Individual from All Sources

	Source	Dose (mrem/yr)[(a)]	Percent of Total
Ubiquitous background	Radon & Thoron	228	37
	Space	33	5
	Terrestrial	21	3
	Internal (body)	29	5
	Total background sources	**311**	**50**
Medical	Computed tomography	147	24
	Medical x-ray	76	12
	Nuclear medicine	77	12
	Total medical sources	**300**	**48**
Consumer	Construction materials, smoking, air travel, mining, agriculture, fossil fuel combustion	13	2
Other	Occupational	0.5[(b)]	0.1
	Nuclear fuel cycle	0.05[(c)]	0.01
Total		**624**	**100**

(a) NCRP Report 160 table expressed doses in mSv/yr (1 mSv/yr equals 100 mrem/yr).
(b) Occupational dose is regulated separately from public dose and is provided here for informational purposes.
(c) Estimated using 153 person-Sv/yr from Table 6.1 of NCRP 160 and a 2006 U.S. population of 300 million.

Source: NCRP 2009-TN420.

6.1.6 Radiological Wastes

The estimated quantities of buried radioactive waste material (LLW, HLW, and transuranic wastes) generated by the reference 1,000-MW(e) LWR are specified in Table S–3 (Table 6-1). For LLW disposal at land burial facilities, the Commission notes in Table S–3 that there would be no significant radioactive releases to the environment. The PSEG Site is in the State of New Jersey, which is part of the Atlantic Interstate Low-Level Waste Management Compact and thus has continuing access to the LLW disposal facility at Barnwell, South Carolina, as long as it remains open. Class A LLW generated by the PSEG Site could also be shipped to the Energy Solutions disposal facility near Clive, Utah, as some Class A LLW generators within the State of New Jersey have done (DOE 2013-TN3120).

The Barnwell facility is expected to be closed in 2038 to LLW generated in New Jersey (CNS 2010-TN2682). At that time, PSEG could enter into an agreement with another licensed facility that would accept LLW from the new nuclear power plant at the PSEG Site. Alternatively, PSEG could implement measures to reduce the generation of Class B and C wastes, extending the capacity of the onsite solid-waste storage system. PSEG could also construct additional temporary storage facilities on the site. PSEG could also enter into an agreement with a third-party contractor to process, store, own, and ultimately dispose of LLW

from the new nuclear capacity at the PSEG Site. The Waste Control Specialists, LLC, site in Andrews County, Texas, is licensed to accept Class A, B, and C LLW from the Texas Compact (Texas and Vermont). Waste Control Specialists, LLC, may accept Class A, B, and C LLW from outside the Texas Compact for disposal subject to established criteria, conditions, and approval processes (Tex. Admin Code 31-675.23-TN731). Because PSEG would likely have to choose one or a combination of these options, the staff considered the environmental impacts of each of these options.

Table S–3 addresses the environmental impacts if PSEG enters into an agreement with a licensed facility for disposal of LLW, and Table S–4 addresses the environmental impacts from transportation of LLW as discussed in Section 6.2. The use of third-party contractors was not explicitly addressed in Tables S–3 and S–4; however, such third-party contractors are already licensed by the NRC or Agreement States and currently operate in the United States. Experience from the operation of these facilities shows that the additional environmental impacts are not significant compared to the impacts described in Tables S–3 and S–4.

Measures to reduce the generation of Class B and C wastes, such as reducing the service run length of resin beds, could increase the volume of LLW but would not increase the total activity (in curies) of radioactive material in the waste. The volume of waste would still be bounded by or very similar to the estimates in Table S–3, and the environmental impacts would not be significantly different.

In most circumstances, the NRC's regulations (10 CFR Part 50-TN249) allow licensees operating nuclear power plants to construct and operate additional onsite LLW storage facilities without seeking approval from the NRC. Licensees are required to evaluate the safety and environmental impacts before constructing the facility and to make those evaluations available to NRC inspectors. A number of nuclear power plant licensees have constructed and operate such facilities in the United States. Typically, these additional facilities are constructed near the power block inside the security fence on land that has already been disturbed during initial plant construction. Therefore, the impacts on environmental resources (e.g., land use and aquatic and terrestrial biota) would be minimal. All of the NRC (10 CFR Part 20-TN283) and EPA (40 CFR Part 190-TN739) dose limitations would apply for both public and occupational radiation exposure. The radiological environmental monitoring programs around nuclear power plants that operate such facilities show that the increase in radiation dose at the site boundary is not significant; the radiation doses continue to be below 25 mrem/year, the dose limit of 40 CFR Part 190 (TN739). The NRC staff concludes that doses to members of the public within the NRC and EPA regulations are a minimal impact. Therefore, the impacts from radiation would be minor.

In addition, the NRC staff assessed the impacts of onsite LLW storage at currently operating nuclear power plants and concluded that the radiation doses to offsite individuals from interim LLW storage are insignificant (NRC 2013-TN2654). The types and amounts of LLW generated by the new capacity at the PSEG Site would be very similar to those generated by currently operating nuclear power plants, and the construction and operation of these interim LLW storage facilities would be very similar to the construction and operation of the currently operating facilities. Additionally, in NUREG–1437 (NRC 2013-TN2654), the NRC staff concluded that there should be no significant issues or environmental impacts associated with

interim storage of LLW generated by nuclear power plants. Interim storage facilities would be used until these wastes could be safely shipped to licensed disposal facilities.

Current national policy, as found, for example, in the Nuclear Waste Policy Act (42 USC 10101 et seq. -TN740), mandates that HLW and transuranic waste are to be buried at deep geologic repositories. No release to the environment is expected to be associated with deep geologic disposal because it has been assumed that all of the gaseous and volatile radionuclides contained in the spent fuel are released to the atmosphere before the disposal of the waste. In NUREG–0116 (NRC 1976-TN292), which provides background and context for the Table S–3 values established by the Commission, the NRC staff indicates that these HLWs and transuranic wastes will be buried and will not be released to the environment.

As part of the Table S–3 rulemaking, the NRC staff evaluated, along with more conservative assumptions, this zero-release assumption associated with waste burial in a repository, and the NRC reached an overall generic determination that fuel-cycle impacts would not be significant. In 1983, the Supreme Court affirmed the NRC's position that the zero-release assumption was reasonable in the context of the Table S–3 rulemaking to address generically the impacts of the uranium fuel cycle in individual reactor-licensing proceedings (Baltimore Gas and Electric Co. v. Natural Resources Defense Council, Inc. 1983-TN1054).

Environmental impacts from onsite spent fuel storage during the licensed life of the plant have been studied extensively and are well understood. In the context of operating license (OL) renewal, the staff (NRC 2013-TN2654) provides descriptions of the storage of spent fuel during the licensed lifetime of reactor operations. Radiological impacts are well within regulatory limits; thus, radiological impacts of onsite storage during operations will be minimal. Nonradiological environmental impacts have been shown to be not significant (NRC1989-TN3714). Thus, the NRC staff has determined that disturbance to resource areas (e.g., terrestrial and aquatic ecology, historic and cultural resources, and land-use resources) that may be associated with potential additional onsite operational storage would not alter the conclusions presented in Chapters 5 and 7 of this EIS. However, the U.S. Army Corps of Engineers may require additional mitigation measures for any disturbance to wetland resources. The overall conclusion for onsite storage of spent fuel during the licensed lifetime of reactor operations is that the environmental impacts will be minor.

On August 26, 2014, the Commission issued a revised rule at 10 CFR 51.23 (TN250) and associated *Generic Environmental Impact Statement for Continued Storage of Spent Nuclear Fuel*, NUREG–2157 (NRC 2014-TN4117). The revised rule adopts the generic impact determinations made in NUREG–2157 and codifies the NRC's generic determinations regarding the environmental impacts of continued storage of spent nuclear fuel beyond a reactor's OL (i.e., those impacts that could occur as a result of the storage of spent nuclear fuel at at-reactor or away-from-reactor sites after a reactor's licensed life for operation and until a permanent repository becomes available).

In CLI-14-08 (NRC 2014-TN4303), the Commission held that the revised 10 CFR 51.23 (TN250) and associated NUREG–2157 cure the deficiencies identified by the court in *New York v. NRC* (2012-TN2397), 681 F.3d 471 (D.C. Cir. 2012) and stated that the rule satisfies the NRC's National Environmental Policy Act (NEPA, 42 USC 4321 et seq. –TN661) obligations with

respect to continued storage for actions such as the EIS application for a new nuclear power plant at the PSEG Site. As directed by 10 CFR 51.23(b) (TN250), the impacts assessed in NUREG–2157 (NRC 2014-TN4117) are deemed incorporated into this EIS.

The staff's evaluation of the potential environmental impacts of continued storage of spent fuel presented in NUREG–2157 (NRC 2014-TN4117) identifies an impact level, or a range of impacts, for each resource area for a range of site conditions and timeframes. The timeframes analyzed in NUREG–2157 include the short-term timeframe (i.e., 60 years beyond the licensed life of a reactor), the long-term timeframe (i.e., an additional 100 years after the short-term timeframe), and an indefinite timeframe (see Section 1.8.2 of NUREG–2157 [NRC 2014-TN4117]).

The analysis in Section 4.20 of NUREG–2157 (NRC 2014-TN4117) concludes that the potential impacts of spent fuel storage at the reactor site in both a spent fuel pool and in an at-reactor independent spent fuel storage installation would be SMALL during the short-term timeframe. However, for the longer timeframes for at-reactor storage, and for all timeframes for away-from-reactor storage, Sections 4.20 and 5.20 of NUREG–2157 provide a range of potential impacts in some resource areas. These ranges reflect uncertainties that are inherent in analyzing environmental impacts to some resource areas over long timeframes. Those uncertainties exist, however, regardless of whether the impacts are analyzed generically or site-specifically.

Appendix B of NUREG–2157 (NRC 2014-TN4117) provides an assessment of the technical feasibility of a deep geologic repository and continued safe storage of spent fuel. That assessment concluded that a deep geologic repository is technically feasible and that a reasonable timeframe for its development is about 25 to 35 years. The assessment in NUREG–2157 noted that DOE's goal is to have sited, constructed, and commenced operations of a repository by 2048 (NRC 2014-TN4117). If the current proposed action is approved and no renewals are granted in the future, the short-term timeframe will end 60 years after the end of the licensed period. The licensed period plus the short-term timeframe is more than twice as long as the time estimated to develop a deep geologic repository.

The most likely impacts of the continued storage of spent fuel are those considered for at-reactor storage in the short-term timeframe. In the unlikely event that fuel remains on the site into the long-term and indefinite timeframes, the ranges in NUREG–2157 reflect factors that lead to uncertainties regarding the potential impacts over these very long periods of time (NRC 2014-TN4117). Based on the analysis and impact determination in NUREG–2157 (NRC 2014-TN4117), and taking into account the impacts that the NRC can predict with certainty, which are SMALL; the uncertainty reflected by the ranges in the long-term and indefinite timeframes; and the relative likelihood of the timeframes, the staff finds that the impacts for at-reactor storage at a new nuclear power plant at the PSEG Site are likely to be minor.

Spent fuel could also be moved to an away-from-reactor storage facility. However, there is uncertainty whether an away-from-reactor storage facility would be constructed, uncertainty regarding where it might be located, and uncertainty regarding the impacts in short-term, long-term, and indefinite timeframes . As a result, these impacts provide limited insights to the decision maker in the overall picture of the environmental impacts from the proposed action and do not change the staff's overall conclusion regarding the environmental impacts of radiological wastes from the fuel cycle, which includes the impacts associated with spent fuel storage.

The NRC staff concludes, based on Table S–3 and the above conclusions regarding storage and disposal of LLW and spent fuel, that the environmental impacts from radioactive waste storage and disposal associated with the operation of a new nuclear power plant at the PSEG Site would be SMALL.

6.1.7 Occupational Dose

The annual occupational dose attributable to all phases of the fuel cycle for the 1,000-MW(e) LWR-scaled model is about 1,800 person-rem. This is based on the NUREG–1437 occupational dose estimate of 600 person-rem attributable to all phases of the fuel cycle for the model 1,000-MW(e) LWR (NRC 1996-TN288; NRC 1999-TN289). The NRC staff concludes that the environmental impact from this occupational dose is minor because the dose to any individual worker would be maintained within the limits of 10 CFR Part 20 (TN283), which is 5 rem/year.

6.1.8 Transportation

The transportation dose to workers and the public related to the uranium fuel cycle totals about 2.5 person-rem annually for the reference 1,000-MW(e) LWR, according to Table S–3 (Table 6-1). This corresponds to a dose of 7.5 person-rem for the 1,000-MW(e) LWR-scaled model at the PSEG Site. For purposes of comparison, the estimated collective dose from natural background radiation to the current population within 50 mi of the PSEG Site with a 2010 population of 5,460,955 is about 831,200 person-rem/year (PSEG 2015-TN4280). Based on this comparison, the NRC staff concludes that environmental impacts of transportation would be minor.

6.1.9 Summary

The staff evaluated the environmental impacts of the uranium fuel cycle, as given in Table S–3 of 10 CFR 51.51(b) (TN250) (see Table 6-1), considered the effects of radon-222 and technetium-99, and appropriately scaled the impacts for the 1,000-MW(e) LWR-scaled model. The NRC staff also evaluated the environmental impacts of GHG emissions from the uranium fuel cycle and appropriately scaled the impacts for the 1,000-MW(e) LWR-scaled model. Based on this evaluation, the staff concludes that the impacts of the uranium fuel cycle would be SMALL.

6.2 Transportation Impacts

This section addresses both the radiological and nonradiological environmental impacts from normal operating and accident conditions resulting from (1) shipment of unirradiated fuel to the PSEG Site and alternative sites (Section 6.2.1), (2) shipment of spent fuel to a monitored retrievable storage facility or a permanent repository (Section 6.2.2), and (3) shipment of LLW and mixed waste to offsite disposal facilities (Section 6.2.3). For the purposes of these analyses, the NRC staff considered the proposed Yucca Mountain, Nevada, repository site as a surrogate destination for a monitored retrievable storage facility or permanent repository. The impacts evaluated in this section for a new nuclear power plant at the PSEG Site are appropriate to characterize the alternative sites discussed in Section 9.3 of this EIS. In addition to the proposed PSEG Site, the alternative sites evaluated in this EIS include one site in Hunterdon County, New

Jersey, two sites in Salem County, New Jersey, and one site in Cumberland County, New Jersey. There is no meaningful differentiation among the proposed and the alternative sites regarding the radiological and nonradiological environmental impacts from normal operating and accident conditions; thus, these conditions are not discussed further in Chapter 9.

The NRC performed a generic analysis of the environmental effects of the transportation of fuel and waste to and from LWRs in the *Environmental Survey of Transportation of Radioactive Materials To and From Nuclear Power Plants*, WASH-1238 (AEC 1972-TN22) and in a supplement to WASH-1238, NUREG–75/038 (NRC 1975-TN216), and found the impact to be small. These documents provided the basis for Table S–4 in 10 CFR 51.52 (TN250) that summarizes the environmental impacts of transportation of fuel and waste to and from one LWR of 3,000 to 5,000 MW(t) (1,000 to 1,500 MW(e)). Impacts are provided for normal conditions of transport and accidents in transport for a reference 1,100-MW(e) LWR.(1) Dose to transportation workers during normal transportation operations was estimated to result in a collective dose of 4 person-rem per reference reactor-year. The combined dose to the public along the route and the dose to onlookers were estimated to result in a collective dose of 3 person-rem per reference reactor-year.

Environmental risks of radiological effects during accident conditions, as stated in Table S–4, are small. Nonradiological impacts from postulated accidents were estimated as one fatal injury in 100 reference reactor-years and one nonfatal injury in 10 reference reactor-years. Subsequent reviews of transportation impacts in NUREG–0170 (NRC 1977-TN417) and NUREG/CR–6672 (Sprung et al. 2000-TN222) conclude that impacts were bounded by Table S–4 in 10 CFR 51.52 (TN250). In accordance with 10 CFR 51.52(a) (TN250), a full description and a detailed analysis of transportation impacts are not required when licensing an LWR (i.e., impacts are assumed to be bounded by Table S–4) if the reactor meets the following criteria:

- the reactor has a core thermal power level that does not exceed 3,800 MW(t);
- fuel is in the form of sintered uranium oxide pellets having a uranium-235 enrichment not exceeding 4 percent by weight; and pellets are encapsulated in Zircaloy-clad fuel rods;(2)
- the average level of irradiation of the fuel from the reactor does not exceed 33,000 MWd/MTU, and no irradiated fuel assembly is shipped until at least 90 days after it is discharged from the reactor;

(1) The transportation impacts associated with the PSEG Site were normalized for a reference 1,100-MW(e) LWR at an 80 percent capacity factor for comparisons to Table S–4. Note that the basis for Table S–4 is a 1,100 MW(e) LWR at an 80 percent capacity factor (AEC 1972-TN22; NRC 1975-TN216). The basis for Table S–3 in 10 CFR 51.51(b) (TN250) that was discussed in Section 6.1 of this EIS is a 1,000-MW(e) LWR with an 80 percent capacity factor (NRC 1976-TN292). However, because fuel cycle and transportation impacts are evaluated separately, this difference does not affect the results and conclusions in this EIS.

(2) 10 CFR 51.52(a)(2) (TN250) specifies the use of Zircaloy as the fuel rod cladding material. The NRC has also specified in 10 CFR 50.46 (TN249) that ZIRLO is an acceptable fuel rod cladding material, and that with regard to the potential environmental impacts associated with the transportation of M5 clad fuel assemblies, the M5 cladding had no impact on previous assessments determined in accordance with 10 CFR 51.52 (65 FR 794-TN2657).

- with the exception of irradiated fuel, all radioactive waste shipped from the reactor is packaged and in solid form;
- unirradiated fuel is shipped to the reactor by truck; irradiated (spent) fuel is shipped from the reactor by truck, railcar, or barge; and radioactive waste, other than irradiated fuel, is shipped from the reactor by truck or railcar.

The environmental impacts of the transportation of fuel and radioactive wastes to and from nuclear power facilities are resolved generically in 10 CFR 51.52 (TN250), provided that the specific conditions in the rule (see above) are met. The NRC may consider requests for licensed plants to operate at conditions above those in the facility's licensing basis; for example, higher burnups (above 33,000 MWd/MTU), enrichments (above 4 weight percent uranium-235), or thermal power levels (above 3,800 MW(t)). Departures from the conditions itemized in 10 CFR 51.52(a) (TN250) are to be supported by a full description and detailed analysis of the environmental effects, as specified in 10 CFR 51.52(b) (TN250). Departures found to be acceptable for licensed facilities cannot serve as the basis for initial licensing of new reactors.

In its application, PSEG did not identify a specific reactor design. Rather, it used bounding parameters from four reactor designs. These designs are LWRs and include the ABWR (4,300 MW(t)/unit), the AP1000 (3,400 MW(t)/unit), U.S. EPR (4,590 MW(t)/unit), and the US-APWR (4,451 MW(t)/unit). For the ABWR, U.S. EPR, and US-APWR, one unit is proposed; for the AP1000, two units are proposed. None of the proposed LWR designs meets all the conditions in 10 CFR 51.52(a) (TN250); therefore, a full description and detailed analysis are required for each LWR design. This conclusion is based on the following:

- the U.S. EPR, ABWR, and US-APWR designs exceed the 3,800-MW(t) core thermal power level;
- the ABWR, AP1000, U.S. EPR, and US-APWR designs require fuel that exceeds the U-235 enrichment of 4 percent; and
- the ABWR, AP1000, U.S. EPR, and US-APWR designs are expected to exceed the average irradiation level of 33,000 MWd/MTU.

In its ER and request for additional information (RAI) responses (PSEG 2015-TN4280; PSEG 2012-TN2465), PSEG provided a full description and detailed analyses of transportation impacts for the proposed PSEG Site. In these analyses, the radiological impacts of transporting fuel and waste to and from the proposed PSEG Site were calculated using the RADTRAN 5.6 computer code (Weiner et al. 2008-TN302). RADTRAN 5.6 was used in this EIS and is the most commonly used transportation impact analysis software in the nuclear industry. However, the ER does not present the transportation impacts for the alternative sites evaluated in this EIS. In addition, the ER analyzes but does not present detailed incident-free radiological transportation impacts for unirradiated fuel and irradiated fuel based on normalizing the number of shipments to the 880 MW(e) (net) WASH-1238 reactor. Therefore, to address these subjects, the NRC staff conducted additional transportation analyses to verify the analyses performed by the applicant in the ER, using the normalized number of shipments, collective doses per shipment, radiological risks per shipment, and alternative site scaling factors estimated by the applicant (PSEG 2015-TN4280; PSEG 2012-TN2465; PSEG 2013-TN2463).

Comments on previous new reactor EISs also were considered when developing the scope of this EIS. Based on these comments, this EIS includes an explicit analysis of the nonradiological impacts of transporting unirradiated fuel, spent fuel, and radioactive waste to and from the PSEG Site and alternative sites. Nonradiological impacts of transporting construction workers and materials (see Section 4.8.3) and operations workers (Section 5.8.6) are addressed elsewhere in this EIS. Publicly available information about traffic accident, injury, and fatality rates was used to estimate nonradiological impacts. In addition, the radiological impacts on maximally exposed individuals (MEIs) are evaluated.

6.2.1 Transportation of Unirradiated Fuel

The NRC staff performed an independent evaluation of the environmental impacts of transporting unirradiated (i.e., fresh) fuel to the PSEG Site and alternative sites. Radiological impacts of normal conditions and transportation accidents as well as nonradiological impacts are discussed in this section. Radiological impacts on populations and MEIs are presented. PSEG assumed in its ER and RAI responses (PSEG 2015-TN4280; PSEG 2012-TN2465) that the unirradiated fuel would be shipped from Richland, Washington; in addition, the NRC staff's analysis assumed a "representative" route from the fuel-fabrication facility to the PSEG Site and alternative sites. This means that there are no substantive differences between the impacts calculated, for the purposes of Chapter 9, for the PSEG Site and the four alternative sites. The site-specific differences are minor because the differences in dose estimates as a result of differences in shipping distances among the potential fuel-fabrication plant to the PSEG Site and alternative sites are small.

6.2.1.1 Normal Conditions

Normal conditions, sometimes referred to as "incident-free" transportation, are transportation activities during which shipments reach their destination without releasing any radioactive material to the environment. Impacts from these shipments would be from the low levels of radiation that penetrate the unirradiated fuel shipping containers. Radiation exposures at some level would occur to the following individuals: (1) persons residing along the transportation corridors between the fuel-fabrication facility and the PSEG or alternative sites; (2) persons in vehicles traveling on the same route as an unirradiated fuel shipment; (3) persons at vehicle stops for refueling, rest, and vehicle inspections; and (4) transportation crew workers.

Truck Shipments

Table 6-3 provides an estimate of the number of truck shipments of unirradiated fuel for the ABWR, AP1000, U.S. EPR, and US-APWR reactor designs compared to those of the reference 1,100-MW(e) reactor specified in WASH-1238 (AEC 1972-TN22) operating at 80 percent capacity (880 MW(e)). After normalization, the NRC staff verified that the number of truck shipments of unirradiated fuel to the PSEG Site or alternative sites would be fewer than the number of truck shipments of unirradiated fuel estimated for the reference LWR in WASH-1238. The results are consistent with the estimates provided in PSEG's ER and RAI responses (PSEG 2015-TN4280; PSEG 2012-TN2465).

Table 6-3. Number of Truck Shipments of Unirradiated Fuel for the Reference LWR and ABWR, AP1000, U.S. EPR, and US-APWR Reactors at the PSEG Site, Normalized to the Reference LWR (880 MW(e) net)

Reactor Type	Number of Shipments per Reactor: Initial Core	Annual Reload	Total[(a)]	Unit Electric Generation, MW(e)[(b)]	Capacity Factor[(b)]	Normalized Shipments per 880 MW(e) (net)[(c,d)]	Normalized Average Annual Shipments
Reference LWR (WASH-1238)	18	6	252	1,100	0.8	252	6.3
ABWR	37	6.1	281	1,500	0.963	171	4.3
AP1000	23	3.8	175	1,150	0.963	139	3.5
U.S. EPR	45	7.5	345	1,600	0.963	197	4.9
US-APWR	32	5.3	244	1,600	0.963	139	3.5

(a) Total shipments of unirradiated fuel over a 40-yr plant lifetime including the initial core load.
(b) Unit capacities and capacity factors were taken from WASH-1238 (AEC 1972-TN22) for the reference LWR.
(c) Shipments for the ABWR, AP1000, U.S. EPR, and the US-APWR were based on the annual reload data from PSEG 2015-TN4280 and an initial core equivalent to 6 years of annual shipments (PSEG 2012-TN1720).
(d) Normalized to net electric output for WASH-1238 reference LWR (i.e., 1,100-MW(e) plant at 80 percent or net electrical output of 880 MW(e)).

Shipping Mode and Weight Limits

In 10 CFR 51.52 (TN250), a condition is identified that states all unirradiated fuel is shipped to the reactor by truck. PSEG specifies that unirradiated fuel would be shipped to the proposed reactor site by truck. 10 CFR 51.52 (TN250) Table S–4, includes a condition that the truck shipments not exceed 73,000 lb as governed by Federal or State gross vehicle weight restrictions. PSEG states in its ER that the unirradiated fuel shipments to the PSEG Site and alternative sites would comply with applicable weight restrictions (PSEG 2015-TN4280; PSEG 2012-TN2465).

Radiological Doses to Transport Workers and the Public

10 CFR 51.52 (TN250), Table S–4, includes conditions related to radiological dose to transport workers and members of the public along transport routes. These doses are a function of many variables, including the radiation dose rate emitted from the unirradiated fuel shipments, the number of exposed individuals and their locations relative to the shipment, the time in transit (including travel and stop times), and the number of shipments to which the individuals are exposed. For this EIS, the radiological dose impacts of the transportation of unirradiated fuel were independently calculated by the NRC staff for the worker and the public using the RADTRAN 5.6 computer code (Weiner et al. 2008-TN302).

One of the key assumptions in WASH-1238 (AEC 1972-TN22) for the reference LWR unirradiated fuel shipments is that the radiation dose rate at 3.3 ft from the transport vehicle is about 0.1 mrem/hour. This assumption also was used in the NRC staff's analysis of the ABWR, AP1000, U.S. EPR, and US-APWR reactor unirradiated fuel shipments. This assumption is reasonable because the reactor fuel materials would be low-dose-rate uranium radionuclides and would be packaged similarly to those described in WASH-1238 (i.e., inside a metal

container that provides little radiation shielding). The numbers of shipments per year were obtained by dividing the normalized shipments in Table 6-3 by 40 years of reactor operation. Other key input parameters used in the radiation dose analysis for unirradiated fuel are shown in Table 6-4.

Table 6-4. RADTRAN 5.6 Input Parameters for Reference LWR Fresh Fuel Shipments

Parameter	RADTRAN 5.6 Input Value	Source
Shipping distance, km	3,200	AEC 1972-TN22 [(a)]
Travel fraction—Rural	0.90	Rural, suburban, and urban travel fractions are taken from NRC 1977-TN417.
Travel fraction—Suburban	0.05	
Travel fraction—Urban	0.05	
Population density—Rural, persons/km^2	10	Rural, suburban, and urban population densities are taken from DOE 2002-TN418.
Population density—Suburban, persons/km^2	349	
Population density—Urban, persons/km^2	2,260	
Vehicle speed—km/hr	88.49	Conservative in-transit speed of 55 mph assumed; predominantly interstate highways used.
Traffic count—Rural, vehicles/hr	530	Rural, suburban, and urban traffic counts are taken from DOE 2002-TN418.
Traffic count—Suburban, vehicles/hr	760	
Traffic count—Urban, vehicles/hr	2,400	
Dose rate at 1 m from vehicle, mrem/hr	0.1	AEC 1972-TN22.
Packaging length, m	7.3	Approximate length of two LWR fuel element packages placed on end (DOE 1997-TN1238).
Number of truck crew	2	AEC 1972-TN22; NRC 1977-TN417; DOE 2002-TN418.
Stop time, hr/trip	4	Based on one 30-minute stop per 4-hr driving time.
Population density at stops, persons/km^2	[(b)]	

(a) AEC 1972-TN22 provides a range of shipping distances between 40 km (25 mi) and 4,800 km (3,000 mi) for unirradiated fuel shipments. A 3,200-km (2,000-mi) "representative" shipping distance was assumed here.
(b) See Table 6-8 for truck stop parameters.

The RADTRAN 5.6 results for this "generic" unirradiated fuel shipment are as follows:

- worker dose: 1.7×10^{-3} person-rem/shipment,
- general public dose (onlookers/persons at stops and sharing the highway): 2.9×10^{-3} person-rem/shipment, and
- general public dose (along route/persons living near a highway or truck stop): 4.1×10^{-5} person-rem/shipment.

To estimate the annual doses to the public and workers from the average annual shipments of unirradiated fuel for the ABWR, AP1000, U.S. EPR, and US-APWR reactors, PSEG assumed in its ER and RAI responses (PSEG 2015-TN4280; PSEG 2012-TN2465) that the unirradiated fuel would be shipped from Richland, Washington. Table 6-5 presents the annual radiological impacts on workers, public onlookers (persons at stops and sharing the road), and members of the public along the route (i.e., residents within 0.5 mi of the highway) for transporting

unirradiated fuel from Richland, Washington, to the PSEG Site and alternative sites for a single ABWR, AP1000, U.S. EPR, and US-APWR reactor.

The cumulative annual dose estimates in Table 6-5 were normalized to 1,100 MW(e) (880 MW(e) net electrical output). The NRC staff performed an independent review and determined that all dose estimates are bounded by the Table S–4 conditions of 4 person-rem/year to transportation workers, 3 person-rem/year to onlookers, and 3 person-rem/year to members of the public along the route.

Radiation protection experts 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 relationship is used to describe the relationship between radiation dose and detriments such as cancer induction. A recent report by the National Research Council (National Research Council 2006-TN296), the BEIR VII report, uses the linear, no-threshold dose response model as a basis for estimating the risks from low doses. This approach is accepted by the NRC as a conservative method for estimating health risks from radiation exposure, recognizing that the model may overestimate those risks. Based on this method, the NRC staff estimated the risk to the public from radiation exposure using the nominal probability coefficient for total detriment. This coefficient has the value of 570 fatal cancers, nonfatal cancers, and severe hereditary effects per 1,000,000 person-rem (10,000 person-Sv), equal to 0.00057 effects per person-rem. The coefficient is taken from ICRP Publication 103 (ICRP 2007-TN422).

Both the NCRP and ICRP suggest that when the collective effective dose is smaller than the reciprocal of the relevant risk detriment (in other words, less than 1/0.00057, which is less than 1,754 person-rem), the risk assessment should note that the most likely number of excess health effects is zero (NCRP 1995-TN728; ICRP 2007-TN422). The largest annual collective dose estimate for transporting unirradiated fuel to the PSEG Site and alternative sites was less than 2×10^{-2} person-rem, which is less than the 1,754 person-rem value that ICRP and NCRP suggest would most likely result in zero excess health effects.

To place these impacts in perspective, the average U.S. resident receives about 311 mrem/year effective dose equivalent from natural background radiation (i.e., exposures from cosmic radiation; naturally occurring radioactive materials, such as radon; and global fallout from testing of nuclear explosive devices) (NCRP 2009-TN420). Using this average effective dose, the collective population dose from natural background radiation to the population along the generic representative route would be about 2.2×10^5 person-rem. Therefore, the radiation doses from transporting unirradiated fuel to the PSEG Site and alternative sites are minimal compared to the collective population dose to the same population from exposure to natural sources of radiation.

Table 6-5. Radiological Impacts Under Normal Conditions of Transporting Unirradiated Fuel to the PSEG Site or Alternative Sites for a Single Reactor, Normalized to Reference LWR (880 MW(e) net)

Site and Reactor Type	Normalized Average Annual Shipments	Cumulative Annual Dose, person-rem/yr per 880 MW(e) (net)[(a,b)]		
		Workers	Public—Onlookers	Public—Along Route
Reference LWR (WASH-1238)	6.3	1.1×10^{-2}	1.8×10^{-2}	2.6×10^{-4}
ABWR				
PSEG Site	4.3	6.2×10^{-3}	1.4×10^{-2}	4.1×10^{-4}
Hunterdon County	4.3	6.2×10^{-3}	1.4×10^{-2}	4.1×10^{-4}
Salem County (7-1)	4.3	6.2×10^{-3}	1.4×10^{-2}	4.1×10^{-4}
Salem County (7-2)	4.3	6.2×10^{-3}	1.4×10^{-2}	4.1×10^{-4}
Cumberland County	4.3	6.2×10^{-3}	1.4×10^{-2}	4.1×10^{-4}
AP1000				
PSEG Site	3.5	5.0×10^{-3}	1.2×10^{-2}	3.3×10^{-4}
Hunterdon County	3.5	5.1×10^{-3}	1.2×10^{-2}	3.4×10^{-4}
Salem County (7-1)	3.5	5.0×10^{-3}	1.2×10^{-2}	3.3×10^{-4}
Salem County (7-2)	3.5	5.0×10^{-3}	1.2×10^{-2}	3.3×10^{-4}
Cumberland County	3.5	5.0×10^{-3}	1.2×10^{-2}	3.4×10^{-4}
U.S. EPR				
PSEG Site	4.9	7.1×10^{-3}	1.6×10^{-2}	4.7×10^{-4}
Hunterdon County	4.9	7.1×10^{-3}	1.6×10^{-2}	4.7×10^{-4}
Salem County (7-1)	4.9	7.0×10^{-3}	1.6×10^{-2}	4.7×10^{-4}
Salem County (7-2)	4.9	7.1×10^{-3}	1.6×10^{-2}	4.7×10^{-4}
Cumberland County	4.9	7.1×10^{-3}	1.6×10^{-2}	4.7×10^{-4}
US-APWR				
PSEG Site	3.5	5.0×10^{-3}	1.2×10^{-2}	3.3×10^{-4}
Hunterdon County	3.5	5.1×10^{-3}	1.2×10^{-2}	3.4×10^{-4}
Salem County (7-1)	3.5	5.0×10^{-3}	1.2×10^{-2}	3.3×10^{-4}
Salem County (7-2)	3.5	5.0×10^{-3}	1.2×10^{-2}	3.3×10^{-4}
Cumberland County	3.5	5.0×10^{-3}	1.2×10^{-2}	3.4×10^{-4}
10 CFR 51.52 (TN250), Table S–4 Condition	<1 per day	4.0×10^{0}	3.0×10^{0}	3.0×10^{0}

(a) Divide person-rem/yr by 100 to obtain doses in person-Sv/year.
(b) Normalized average annual shipments taken from PSEG 2015-TN4280; collective doses per shipment taken from Appendix 7A, PSEG 2015-TN4280; scaling factors for alternative sites taken from PSEG 2012-TN2465.

Maximally Exposed Individuals Under Normal Transport Conditions

A scenario-based analysis was conducted by the NRC staff to develop estimates of incident-free radiation doses to MEIs for fuel and waste shipments to and from the PSEG Site and alternative sites. The following discussion applies to unirradiated fuel shipments to, and spent fuel and radioactive waste shipments from, the PSEG Site and any of the alternative sites. The analysis is based on information in DOE's *Final Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste*

at Yucca Mountain, Nye County, Nevada (DOE 2002-TN1236) and incorporates data about exposure times, dose rates, and the number of times an individual may be exposed to an offsite shipment. Adjustments were made where necessary to reflect the normalized fuel and waste shipments addressed in this EIS. In all cases, the NRC staff assumed that the dose rate emitted from the shipping containers is 10 mrem/hour at 2 m (6.6 ft) from the side of the transport vehicle. This assumption is conservative, in that the assumed dose rate is the maximum dose rate allowed by U.S. Department of Transportation (DOT) regulations in 49 CFR 173.441 (TN298). Most unirradiated fuel and radioactive waste shipments would have much lower dose rates than the regulations allow (AEC 1972-TN22; DOE 2002-TN418). An MEI is a person who may receive the highest radiation dose from a shipment to and/or from the PSEG Site and alternative sites. The analysis of MEIs is described below.

Truck Crew Member

Truck crew members would receive the highest radiation doses during incident-free transport because of their proximity to the loaded shipping container for an extended period. The analysis assumed that crew member doses are limited to 2 rem/year, which is the DOE administrative control level presented in DOE-STD-1098-99, *DOE Standard, Radiological Control*, Chapter 2, Article 211 (DOE 2005-TN1235). This limit is anticipated to apply to spent nuclear fuel shipments to a disposal facility because DOE would take title to the spent fuel at the reactor site. There would be more shipments of spent nuclear fuel from the PSEG Site (or alternative sites) than there would be shipments of unirradiated fuel to, and radioactive waste other than spent fuel from, these sites. This is because the capacities of spent fuel shipping casks are limited due to their substantial radiation shielding and accident resistance requirements. Spent fuel shipments also have significantly higher radiation dose rates than unirradiated fuel and radioactive waste (DOE 2002-TN418). As a result, crew doses from unirradiated fuel and radioactive waste shipments would be lower than the doses from spent nuclear fuel shipments. The DOE administrative limit of 2 rem/year (DOE 2005-TN1235) is less than the NRC limit for occupational exposures of 5 rem/year (10 CFR Part 20-TN283).

The DOT does not regulate annual occupational exposures. It does recognize that air crews are exposed to elevated cosmic radiation levels and recommends dose limits to air crew members from cosmic radiation (Friedberg and Copeland 2003-TN419). Air passengers are less of a concern because they do not fly as frequently as air crew members. The recommended limits are a 5-year effective dose of 2 rem/year with no more than 5 rem in a single year (Friedberg and Copeland 2003-TN419). As a result of this recommendation, a 2-rem/year MEI dose to truck crews is a reasonable estimate to apply to shipments of fuel and waste from the PSEG Site and alternative sites.

Inspectors

Radioactive shipments are inspected by Federal or State vehicle inspectors, for example, at state ports of entry. DOE (2002-TN1236) assumed that inspectors would be exposed for 1 hour at a distance of 1 m (3.3 ft) from the shipping containers. Assuming conservatively that the external dose rate at 2 m (6.6 ft) is at the maximum allowed by regulations (10 mrem/hr), the dose rate at 1 m (3.3 ft) is about 14 mrem/hour (Weiner et al. 2008-TN302). Therefore, the dose per shipment is about 14 mrem. This is independent of the location of the reactor site.

Based on this conservative external dose rate and the assumption that the same person inspects all shipments of fuel and waste to and from the PSEG Site and alternative sites, the annual doses to vehicle inspectors were calculated to be about 2.1 rem/year, based on a combined total of 149 shipments of unirradiated fuel, spent fuel, and radioactive waste per year. This value slightly exceeds the 2-rem/year DOE administrative control level for individual doses (DOE 2005-TN1235) and is about 40 percent of the 5-rem/year NRC occupational dose limit (see 10 CFR Part 20-TN283).

Residents

The analysis assumed that a resident lives adjacent to a highway where a shipment would pass and would be exposed to all shipments along a particular route. Exposures to residents on a per-shipment basis were obtained from the NRC staff's RADTRAN 5.6 output files. These dose estimates are based on an individual located 100 ft from the shipments that are traveling 15 mph. The potential radiation dose to the maximally exposed resident is about 0.09 mrem/year for shipments of fuel and waste to and from the PSEG Site and alternative sites.

Individuals Stuck in Traffic

This scenario addresses potential traffic interruptions that could lead to a person being exposed to a loaded shipment for 1 hour at a distance of 4 ft. The NRC staff's analysis assumed this exposure scenario would occur only one time to any individual, and the dose rate was at the regulatory limit of 10 mrem/hour at 2 m (6.6 ft) from the shipment. The dose to the MEI was calculated in DOE (2002-TN1236) to be 16 mrem.

Persons at a Truck Service Station

This scenario estimates doses to an employee at a service station where all truck shipments to and from the PSEG Site and alternative sites are assumed to stop. DOE (2002-TN1236) assumed this person is exposed for 49 minutes at a distance of 52 ft from the loaded shipping container. The exposure time and distance were based on the observations discussed by Griego et al. (1996-TN69). This results in a dose of about 0.34 mrem/shipment and an annual dose of about 51 mrem/year for the PSEG Site and alternative sites, assuming that a single individual services all unirradiated fuel, spent fuel, and radioactive waste shipments to and from the PSEG Site and alternative sites.

6.2.1.2 Radiological Impacts of Transportation Accidents

Accident risks are a combination of accident frequency and consequence. Accident frequencies for transportation of unirradiated fuel to the PSEG Site and alternative sites are expected to be lower than those used in the analysis in WASH-1238 (AEC 1972-TN22), which forms the basis for Table S–4 of 10 CFR 51.52 (TN250), because of improvements in highway safety and security, and an overall reduction in traffic accident, injury, and fatality rates since WASH-1238 was published. There is no significant difference in the consequences of transportation accidents severe enough to result in a release of unirradiated fuel particles to the environment between the ABWR, AP1000, U.S. EPR, and US-APWR reactors and current-generation LWRs because the fuel form, cladding, and packaging are similar to those analyzed in WASH-1238 (AEC 1972-TN22). Consequently, consistent with the conclusions of WASH-1238, the impacts

of accidents during transport of unirradiated fuel to an ABWR, AP1000, U.S. EPR, and US-APWR reactor at the PSEG Site and alternative sites are expected to be smaller than those listed in Table S–4 for current-generation LWRs.

6.2.1.3 Nonradiological Impacts of Transportation Accidents

Nonradiological impacts are the human health impacts projected to result from traffic accidents involving shipments of unirradiated fuel to the PSEG Site and alternative sites (i.e., the analysis does not consider the radiological or hazardous characteristics of the cargo). Nonradiological impacts include the projected number of traffic accidents, injuries, and fatalities that could result from shipments of unirradiated fuel to the site and return shipments of empty containers from the site.

Nonradiological impacts are calculated using accident, injury, and fatality rates from published sources. The rates (i.e., impacts per vehicle-km traveled) are then multiplied by estimated travel distances for workers and materials. The general formula for calculating nonradiological impacts is as follows:

Impacts = (unit rate) × (round-trip shipping distance) × (annual number of shipments).

In this formula, impacts are presented in units of the number of accidents, number of injuries, and number of fatalities per year. Corresponding unit rates (i.e., impacts per vehicle-km traveled) are used in the calculations.

Accident, injury, and fatality rates were taken from Table 4 in *State-Level Accident Rates for Surface Freight Transportation: A Reexamination* (ANL/ESD/TM-150) (Saricks and Tompkins 1999-TN81). Nationwide median rates were used for shipments of unirradiated fuel to the site. The data are representative of traffic accident, injury, and fatality rates for truck shipments similar to those to be used to transport unirradiated fuel to the PSEG Site and alternative sites. In addition, the DOT Federal Motor Carrier Safety Administration evaluated the data underlying the Saricks and Tompkins (1999-TN81) rates, which were taken from the Motor Carrier Management Information System, and determined that the rates were underreported. Therefore, the accident, injury, and fatality rates in Saricks and Tompkins (1999-TN81) were adjusted using factors derived from data provided by the University of Michigan Transportation Research Institute (UMTRI) (Blower and Matteson 2003-TN410). The UMTRI data indicate that accident rates for 1994 to 1996, the same data used by Saricks and Tompkins (1999-TN81), were underreported by about 39 percent. Injury and fatality rates were underreported by 16 percent and 36 percent, respectively. As a result, the accident, injury, and fatality rates were increased by factors of 1.64, 1.20, and 1.57, respectively, to account for the underreporting.

The nonradiological accident impacts for transporting unirradiated fuel to (and empty shipping containers from) the PSEG Site and alternative sites are shown in Table 6-6. The nonradiological impacts associated with the WASH-1238 reference LWR are also shown for comparison purposes. Note that there are only small differences between the impacts calculated for the ABWR, AP1000, U.S. EPR, and US-APWR reactors at the PSEG Site and alternative sites and the reference LWR in WASH-1238 (AEC 1972-TN22), due entirely to the estimated annual number of shipments. Overall, the impacts are minimal, and there are no

substantive differences among the PSEG Site and alternative sites. In addition, the NRC staff verified PSEG's analysis in the ER and RAI responses (PSEG 2015-TN4280; PSEG 2012-TN2465) by performing independent impact calculations. No significant differences were identified.

Table 6-6. Nonradiological Impacts of Transporting Unirradiated Fuel to the PSEG Site and Alternative Sites with a Single Reactor, Normalized to Reference LWR (880 MW(e) net)

Plant Type	Normalized Annual Shipments	One-Way Shipping Distance (km)	Annual Round-trip Distance (km)	Annual Impacts[a] Accidents per Year	Injuries per Year	Fatalities per Year
Reference LWR (WASH-1238)	6.3	3,200	4.0×10^{4}	1.9×10^{-2}	9.3×10^{-3}	5.8×10^{-4}
ABWR						
PSEG Site	4.3	4,400	3.8×10^{4}	2.1×10^{-2}	1.1×10^{-2}	6.3×10^{-4}
Hunterdon County	4.3	4,420	3.8×10^{4}	2.1×10^{-2}	1.1×10^{-2}	6.3×10^{-4}
Salem County (7-1)	4.3	4,380	3.8×10^{4}	2.1×10^{-2}	1.0×10^{-2}	6.3×10^{-4}
Salem County (7-2)	4.3	4,400	3.8×10^{4}	2.1×10^{-2}	1.1×10^{-2}	6.3×10^{-4}
Cumberland County	4.3	4,410	3.8×10^{4}	2.1×10^{-2}	1.1×10^{-2}	6.3×10^{-4}
AP1000						
PSEG Site	3.5	4,400	3.1×10^{4}	1.7×10^{-2}	8.6×10^{-3}	5.1×10^{-4}
Hunterdon County	3.5	4,420	3.1×10^{4}	1.7×10^{-2}	8.6×10^{-3}	5.2×10^{-4}
Salem County (7-1)	3.5	4,380	3.1×10^{4}	1.7×10^{-2}	8.5×10^{-3}	5.1×10^{-4}
Salem County (7-2)	3.5	4,400	3.1×10^{4}	1.7×10^{-2}	8.6×10^{-3}	5.1×10^{-4}
Cumberland County	3.5	4,410	3.1×10^{4}	1.7×10^{-2}	8.6×10^{-3}	5.1×10^{-4}
U.S. EPR						
PSEG Site	4.9	4,400	4.3×10^{4}	2.4×10^{-2}	1.2×10^{-2}	7.2×10^{-4}
Hunterdon County	4.9	4,420	4.3×10^{4}	2.4×10^{-2}	1.2×10^{-2}	7.2×10^{-4}
Salem County (7-1)	4.9	4,380	4.3×10^{4}	2.4×10^{-2}	1.2×10^{-2}	7.2×10^{-4}
Salem County (7-2)	4.9	4,400	4.3×10^{4}	2.4×10^{-2}	1.2×10^{-2}	7.2×10^{-4}
Cumberland County	4.9	4,410	4.3×10^{4}	2.4×10^{-2}	1.2×10^{-2}	7.2×10^{-4}
US-APWR						
PSEG Site	3.5	4,400	3.1×10^{4}	1.7×10^{-2}	8.6×10^{-3}	5.1×10^{-4}
Hunterdon County	3.5	4,420	3.1×10^{4}	1.7×10^{-2}	8.6×10^{-3}	5.2×10^{-4}
Salem County (7-1)	3.5	4,380	3.1×10^{4}	1.7×10^{-2}	8.5×10^{-3}	5.1×10^{-4}
Salem County (7-2)	3.5	4,400	3.1×10^{4}	1.7×10^{-2}	8.6×10^{-3}	5.1×10^{-4}
Cumberland County	3.5	4,410	3.1×10^{4}	1.7×10^{-2}	8.6×10^{-3}	5.1×10^{-4}

(a) Normalized average annual shipments taken from PSEG 2015-TN4280; accidents, injuries, and fatalities per shipment taken from Appendix 7A; PSEG 2015-TN4280, scaling factors for alternative sites taken from PSEG 2012-TN2465.

6.2.2 Transportation of Spent Fuel

The NRC staff performed an independent analysis of the environmental impacts of transporting spent fuel from the PSEG Site and alternative sites to a spent fuel disposal repository. For the

purposes of these analyses, the NRC staff considered the proposed Yucca Mountain site in Nevada as a surrogate destination. Currently, the NRC has not made a decision about the DOE application for the proposed geologic repository at Yucca Mountain. However, the NRC staff considers that an estimate of the impacts of the transportation of spent fuel to a possible repository in Nevada to be a reasonable bounding estimate of the transportation impacts on a storage or disposal facility because of the distances involved and the representativeness of the distribution of members of the public in urban, suburban, and rural areas (i.e., population distributions) along the shipping routes. Radiological and nonradiological environmental impacts of normal operating conditions and transportation accidents, as well as nonradiological impacts, are discussed in this section. The NRC Yucca Mountain adjudicatory proceeding is currently suspended, and Yucca Mountain-related matters are pending in Federal Court. Regardless of the outcome of these proceedings, the NRC staff concludes that transportation impacts are roughly proportional to the distance from the reactor site to the repository site, in this case, New Jersey to Nevada.

This NRC staff's analysis is based on shipment of spent fuel by legal-weight trucks in shipping casks with characteristics similar to currently available casks (i.e., massive, heavily shielded, cylindrical metal pressure vessels). Due to the large size and weight of spent fuel shipping casks, each shipment is assumed to consist of a single shipping cask loaded on a modified trailer. These assumptions are consistent with those made in the evaluation of the environmental impacts of transportation of spent fuel in Addendum 1 to NUREG–1437 (NRC 1999-TN289). Because the alternative transportation methods involve rail transportation or heavy-haul trucks, which would reduce the overall number of spent fuel shipments (NRC 1999-TN289), thereby reducing impacts, these assumptions are conservative. Also, the use of current shipping cask designs for this analysis results in conservative impact estimates because the current designs are based on transporting short-cooled spent fuel (approximately 120 days out of reactor). Future shipping casks would be designed to transport longer-cooled fuel (greater than 5 years out of reactor) and would require much less shielding to meet external dose limitations. Therefore, future shipping casks are expected to have higher cargo capacities, thus reducing the numbers of shipments and associated impacts.

Radiological impacts of transportation of spent fuel were calculated by the NRC staff using the RADTRAN 5.6 computer code (Weiner et al. 2008-TN302). Routing and population data used in RADTRAN 5.6 for truck shipments were obtained from the Transportation Routing Analysis Geographical Information System (TRAGIS) routing code (Johnson and Michelhaugh 2003-TN1234). The population data in the TRAGIS code are based on the 2000 census. The NRC staff reviewed the 2010 census data and determined that the change in impacts resulting from using 2010 census data would not be significant. Nonradiological impacts were calculated using published traffic accident, injury, and fatality data (Saricks and Tompkins 1999-TN81) in addition to route information from TRAGIS (Johnson and Michelhaugh 2003-TN1234). Traffic accident rates input to RADTRAN 5.6 and nonradiological impact calculations were adjusted to account for underreporting, as discussed in Section 6.2.1.3.

6.2.2.1 Normal Conditions

Normal conditions, sometimes referred to as “incident-free” transportation, are transportation activities in which shipments reach their destination without an accident occurring en route. Impacts from these shipments would be from the low levels of radiation that penetrate the heavily shielded spent fuel shipping cask. Radiation exposures would occur to the following populations: (1) persons residing along the transportation corridors between the PSEG Site and alternative sites and the proposed repository location; (2) persons in vehicles traveling on the same route as a spent fuel shipment; (3) persons at vehicle stops for refueling, rest, and vehicle inspections; and (4) transportation crew workers (drivers). For purposes of this analysis, it was assumed that the destination for the spent fuel shipments is the proposed Yucca Mountain disposal facility in Nevada. This assumption is conservative because it tends to maximize the shipping distance from the PSEG Site and alternative sites.

Shipping casks have not been designed for the spent fuel from advanced reactor designs such as the ABWR, AP1000, U.S. EPR, and US-APWR. Information in the *Early Site Permit Environmental Report Sections and Supporting Documentation* (INEEL 2003-TN71) indicated that advanced LWR fuel designs would not be significantly different from existing LWR designs; therefore, current shipping cask designs were used for the analysis of reactor spent fuel shipments. The NRC staff assumed that the capacity of a truck shipment of reactor spent fuel was 0.5 MTU/shipment, the same capacity as that used in WASH-1238 (AEC 1972-TN22). In its ER and RAI responses (PSEG 2015-TN4280; PSEG 2012-TN2465), PSEG assumed a shipping cask capacity of 0.5 MTU/shipment.

Input to RADTRAN 5.6 includes the total shipping distance between the origin and destination sites and the population distributions along the routes. This information was obtained by running the TRAGIS computer code (Johnson and Michelhaugh 2003-TN1234) for highway routes from the PSEG Site and alternative sites to the proposed Yucca Mountain facility. The resulting route characteristics information is shown in Table 6-7. For truck shipments, all of the spent fuel is assumed to be shipped to the proposed Yucca Mountain facility over designated highway-route controlled-quantity routes. In addition, TRAGIS data were used in RADTRAN 5.6 on a state-by-state basis. This increases precision and could allow the results to be presented for each state along the route between the PSEG Site and alternative sites and the proposed geologic repository at Yucca Mountain, if desired.

Radiation doses are a function of many parameters, including vehicle speed, traffic count, dose rate, packaging dimensions, number in the truck crew, stop time, and population density at stops. A list of the values for these and other parameters and the sources of the information are provided in Table 6-8.

Table 6-7. Transportation Route Information for Shipments from the PSEG Site and Alternative Sites to the Yucca Mountain Spent Fuel Disposal Facility[a,b]

Reactor Site	One-Way Shipping Distance, km				Population Density, persons/km^2			Stop Time per Trip, hr
	Total	Rural	Suburban	Urban	Rural	Suburban	Urban	
PSEG Site	4,474.1	3,428.6	933.4	112.1	11.5	308.7	2,369.6	6.0
Hunterdon	4,496.5	3,445.7	938.1	112.7	11.5	308.7	2,369.6	6.0
Salem (7-1)	4,453.1	3,412.5	929.0	111.6	11.5	308.7	2,369.6	6.0
Salem (7-2)	4,473.7	3,428.3	933.3	112.1	11.5	308.7	2,369.6	6.0
Cumberland	4,481.7	3,434.4	935.0	112.3	11.5	308.7	2,369.6	6.0

(a) This table presents aggregated route characteristics from Appendix 7A, PSEG 2015-TN4280. Input to the RADTRAN 5.6 computer code was disaggregated to a state-by-state level.
(b) Route characteristics for Hunterdon, Salem (7-1 and 7-2), and Cumberland sites are based on the route characteristics for the PSEG Site taken from Appendix 7A of PSEG 2015-TN4280 and alternative site scaling factors from PSEG 2012-TN2465.

Table 6-8. RADTRAN 5.6 Normal (Incident-Free) Exposure Parameters

Parameter	RADTRAN 5.6 Input Value	Source
Vehicle speed, km/hr	88.49	Based on the average speed in rural areas given in DOE 2002-TN418. Conservative in-transit speed of 55 mph assumed; predominantly interstate highways used
Traffic count—Rural, vehicles/hr	530	Rural, suburban, and urban traffic counts are taken from DOE 2002-TN418
Traffic count—Suburban, vehicles/hr	760	
Traffic count—Urban, vehicles/hr	2,400	
Vehicle occupancy, persons/vehicle	1.5	DOE 2002-TN418
Dose rate at 1 m from vehicle, mrem/hr	14	DOE 2002-TN418; DOE 2002-TN1236—approximate dose rate at 1 m that is equivalent to the maximum dose rate allowed by Federal regulations (i.e., 10 mrem/hr at 2 m from the side of a transport vehicle
Packaging dimensions, m	Length—5.2 Diameter—1.0	PSEG 2015-TN4280
Number of truck crew	2	AEC 1972-TN22; NRC 1977-TN417; DOE 2002-TN418
Stop time, hr/trip	Route-Specific	See Table 6-5
Population density at stops, persons/km^2	30,000	Sprung et al. 2000-TN222. Nine persons within 10 m of vehicle. See Figure 6-2
Min/max radii of annular area around vehicle at stops, m	1 to 10	Sprung et al. 2000-TN222
Shielding factor applied to annular area surrounding vehicle at stops, dimensionless	1 (no shielding)	Sprung et al. 2000-TN222
Population density surrounding truck stops, persons/km^2	340	Sprung et al. 2000-TN222
Min/max radius of annular area surrounding truck stop, m	10 to 800	Sprung et al. 2000-TN222
Shielding factor applied to annular area surrounding truck stop, dimensionless	0.2	Sprung et al. 2000-TN222

For the purposes of this analysis, the transportation crew for spent fuel shipments delivered by truck is assumed to consist of two drivers. Escort vehicles and drivers were considered, but they were not included because their distance from the shipping cask would reduce the dose rates to levels well below the dose rates experienced by the drivers and would be negligible (DOE 2002-TN1236). Stop times for refueling and rest were assumed to occur at the rate of 30 minutes per 4 hour of driving time. TRAGIS outputs were used to determine the number of stops. Doses to the public at truck stops have been significant contributors to the doses calculated in previous RADTRAN 5.6 analyses. For this analysis, doses to the public at refueling and rest stops ("stop doses") are the sum of the doses to individuals located in two annular rings centered at the stopped vehicle, as illustrated in Figure 6-2. The inner ring represents persons who may be at the truck stop at the same time as a spent fuel shipment and extends 1 to 10 m from the edge of the vehicle. The outer ring represents persons who reside near a truck stop and it extends from 10 to 800 m from the vehicle. This scheme is similar to that used by Sprung et al. (Sprung et al. 2000-TN222). Population densities and shielding factors were also taken from Sprung et al. (Sprung et al. 2000-TN222), which were based on the observations of Griego et al. (Griego et al. 1996-TN69).

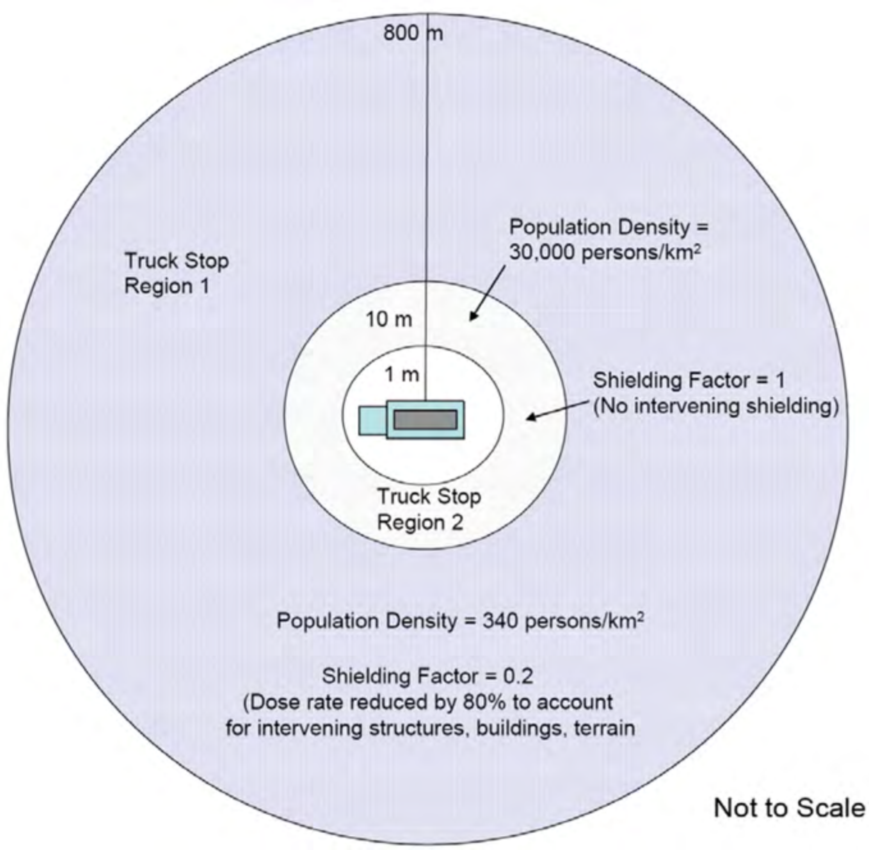

Figure 6-2. Illustration of Truck Stop Model.

The results of these normal (incident-free) exposure calculations are shown in Table 6-9 for the PSEG Site and alternative sites. Population dose estimates are given for workers (i.e., truck crew members), onlookers (doses to persons at stops and persons on highways exposed to the spent fuel shipment), and persons along the route (persons living near the highway).

Shipping schedules for spent fuel generated by the proposed new nuclear power plant have not been determined. The NRC staff determined that it is reasonable to calculate annual doses assuming the annual number of spent fuel shipments is equivalent to the annual refueling requirements. Population doses were normalized to the reference LWR in WASH-1238 (880 MW(e) net) (AEC 1972-TN22). This corresponds to a 1,100-MW(e) LWR operating at 80 percent capacity.

The small differences in transportation impacts among the PSEG Site and four alternative sites evaluated are not substantive, and the differences among sites are relatively minor and are less than the uncertainty in the analytical results.

Table 6-9. Normal (Incident-Free) Radiation Doses to Transport Workers and the Public from Shipping Spent Fuel from the PSEG Site and Alternative Sites to the Proposed HLW Repository at Yucca Mountain, Normalized to Reference LWR (880 MW(e) net)

Site and Reactor Type	Normalized Average Annual Shipments	Normalized Impacts, Person-rem/yr[(a,b)]		
		Workers	Public—Onlookers	Public—Along Route
Reference LWR (WASH-1238)	60	1.2×10^{1}	3.0×10^{1}	6.4×10^{-1}
ABWR				
PSEG Site	54.5	1.1×10^{1}	2.3×10^{1}	6.3×10^{-1}
Hunterdon County	54.5	1.1×10^{1}	2.3×10^{1}	6.4×10^{-1}
Salem County (7-1)	54.5	1.1×10^{1}	2.2×10^{1}	6.3×10^{-1}
Salem County (7-2)	54.5	1.1×10^{1}	2.3×10^{1}	6.3×10^{-1}
Cumberland County	54.5	1.1×10^{1}	2.3×10^{1}	6.3×10^{-1}
AP1000				
PSEG Site	39	7.7	1.6×10^{1}	4.5×10^{-1}
Hunterdon County	39	7.8	1.6×10^{1}	4.6×10^{-1}
Salem County (7-1)	39	7.7	1.6×10^{1}	4.5×10^{-1}
Salem County (7-2)	39	7.7	1.6×10^{1}	4.5×10^{-1}
Cumberland County	39	7.7	1.6×10^{1}	4.5×10^{-1}
U.S. EPR				
PSEG Site	42.7	8.5	1.8×10^{1}	5.0×10^{-1}
Hunterdon County	42.7	8.5	1.8×10^{1}	5.0×10^{-1}
Salem County (7-1)	42.7	8.4	1.8×10^{1}	4.9×10^{-1}
Salem County (7-2)	42.7	8.5	1.8×10^{1}	5.0×10^{-1}
Cumberland County	42.7	8.5	1.8×10^{1}	5.0×10^{-1}
US-APWR				
PSEG Site		7.9	1.6×10^{1}	4.6×10^{-1}
Hunterdon County	39.8	7.9	1.7×10^{1}	4.6×10^{-1}
Salem County (7-1)	39.8	7.8	1.6×10^{1}	4.6×10^{-1}
Salem County (7-2)	39.8	7.9	1.6×10^{1}	4.6×10^{-1}
Cumberland County	39.8	7.9	1.6×10^{1}	4.6×10^{-1}
Table S–4 Condition	–	4×10^{0}	3×10^{0}	3×10^{0}

(a) To convert person-rem to person-Sv, divide by 100.
(b) Normalized average annual shipments taken from PSEG 2015-TN4280; collective doses per shipment taken from Appendix 7A, PSEG 2015-TN4280; scaling factors for alternative sites taken from PSEG 2012-TN2465.

The bounding cumulative doses to the exposed population given in Table S–4 are as follows:

- 4 person-rem/reactor-year to transport workers and
- 3 person-rem/reactor-year to general public (onlookers) and members of the public along the route.

The calculated population doses to the crew and onlookers for the reference LWR and the PSEG and alternative site shipments exceed Table S–4 values. A key reason for the higher population doses relative to Table S–4 is the longer shipping distances assumed for this ESP analysis (i.e., to a proposed repository in Nevada) than the distances used in WASH-1238 (AEC 1972-TN22). WASH-1238 assumed that each spent fuel shipment would travel a distance of 1,000 mi, whereas the shipping distances used in this EIS were about 2,800 mi. If the shorter distance were used to calculate the impacts for the PSEG and alternative sites spent fuel shipments, the doses would be reduced by about 60 percent. Other important differences are the stop model described above and the additional precision that results from incorporating state-specific route characteristics.

Where necessary, the NRC staff made conservative assumptions to calculate impacts associated with the transportation of spent fuel. Some of the key conservative assumptions are as follows.

- Use of the regulatory maximum dose rate (10 mrem/hour at 2 m) in the RADTRAN 5.6 calculations. The shipping casks assumed in the EIS prepared by DOE in support of the application for a geologic repository at the proposed Yucca Mountain repository (DOE 2002-TN1236) would transport spent fuel that has cooled for a minimum of 5 years (see 10 CFR Part 961, Subpart B [TN300]). Most spent fuel would have cooled for much longer than 5 years before it is shipped to a possible geologic repository. Based on this, shipments from the PSEG Site and alternative sites also are expected to be cooled for longer than 5 years. Consequently, the estimated population doses in Table 6-9 could be further reduced if more realistic dose rate projections are used.
- Use of the shipping cask capacity used in WASH-1238 (AEC 1972-TN22). The WASH-1238 analyses that form the basis for Table S–4 assumed that spent fuel would be shipped at least 90 days after discharge from a current LWR. The spent fuel shipping casks described in WASH-1238 were designed to transport 90-day-cooled fuel, so their shielding and containment designs must accommodate this highly radioactive cargo. Shipping cask capacities assumed in WASH-1238 were approximately 0.5 MTU per truck cask. DOE (2008-TN1237) assumed a 10-year cooling period for spent fuel to be shipped to the repository. This allowed DOE to increase the assumed shipping cask capacity to about 1.8 MTU per truck shipment of uncanistered spent fuel. The NRC staff believes this is a reasonable projection for future spent fuel truck shipping cask capacities. If this assumption were to be used in this EIS, the number of shipments of spent fuel would be reduced by about one-third with a similar reduction in incident-free radiological impacts.
- Use of 30 minutes as the average time at a truck stop in the calculations. Many stops made for actual spent fuel shipments are of short duration (i.e., 10 minutes) for brief visual inspections of the cargo (e.g., checking the cask tie-downs). These stops typically occur in minimally populated areas, such as an overpass or freeway ramp in an unpopulated area.

Furthermore, empirical data provided by Griego et al. (1996-TN69) indicate that a 30-minute duration is toward the high end of the stop time distribution. Average stop times observed by Griego et al. (1996-TN69) are about 18 minutes. More realistic stop times would further reduce the population doses in Table 6-9.

A sensitivity study was performed by the NRC staff to demonstrate the effects of using more realistic dose rates and stop times on the incident-free population dose calculations. For this sensitivity study, the dose rate was reduced to 5 mrem/hour, the approximate 50 percent confidence interval of the dose rate distribution estimated by Sprung et al. (2000-TN222) for future spent fuel shipments. The stop time was reduced to 18 minutes per stop. All other RADTRAN 5.6 input values were unchanged. The result is that the annual crew doses were reduced by about 64 percent of the annual doses shown in Table 6-9. Further, the annual doses to onlookers were reduced by about 76 percent and the annual doses to persons along the route were reduced by about 64 percent of the annual doses shown in Table 6-9.

Using the linear no-threshold dose response relationship discussed in Section 6.2.1.1, the annual public dose impacts for transporting spent fuel from the PSEG or alternative sites to Yucca Mountain are about 17 to 23 person-rem, which is less than the 1,754 person-rem value that ICRP (2007-TN422) and NCRP (1995-TN728) suggest would most likely result in no excess health effects. This dose is very small compared to the estimated 300,000 person-rem that the same population along the route from the PSEG Site to Yucca Mountain would incur annually from exposure to natural sources of radiation. The estimated population dose along the PSEG-to-Yucca-Mountain route from natural background radiation is different from the natural background dose calculated by the NRC staff for unirradiated fuel shipments in Section 6.2.1.1 because the route characteristics are different. A generic route and actual highway routes were used in Section 6.2.1.1 for unirradiated fuel shipments and actual highway routes were used in this section for spent fuel shipments.

Dose estimates to the MEI from transport of unirradiated fuel, spent fuel, and wastes under normal conditions are presented in Section 6.2.1.1.

6.2.2.2 Radiological Impacts of Accidents

As discussed previously, the NRC staff used the RADTRAN 5.6 computer code to estimate the impacts of transportation accidents involving spent fuel shipments. RADTRAN 5.6 considers a spectrum of postulated transportation accidents, ranging from those with high frequencies and low consequences (e.g., “fender benders”) to those with low frequencies and high consequences (i.e., accidents in which the shipping container is exposed to severe mechanical and thermal conditions).

Radionuclide inventories are important parameters in the calculation of accident risks. The radionuclide inventories used in this analysis were from the PSEG ER and RAI responses (PSEG 2015-TN4280; PSEG 2012-TN2465; PSEG 2013-TN2463). The spent fuel inventories used in the NRC staff analysis are listed in Table 6-10.

Table 6-10. Radionuclide Inventories Used in Transportation Accident Risk Calculations for the US-APWR, U.S. EPR, ABWR, and AP1000 Reactors(a)

Radionuclide	US-APWR Inventory Ci/MTU	U.S. EPR Inventory Ci/MTU	ABWR Inventory Ci/MTU	AP1000 Inventory Ci/MTU
Am-241	1.8×10^3	1.3×10^3	1.4×10^3	7.3×10^2
Am-242m	2.0×10^1	2.4×10^1	3.3×10^1	1.3×10^1
Am-242	2.0×10^1			
Am-243	7.5×10^1	3.2×10^1	6.0×10^1	3.3×10^1
Ce-144	1.4×10^4	1.5×10^4	1.3×10^4	8.9×10^3
Cm-242	6.1×10^1	4.4×10^1	6.2×10^1	2.8×10^1
Cm-243	5.8×10^1	3.2×10^1	6.2×10^1	3.1×10^1
Cm-244	1.3×10^4	4.8×10^3	1.4×10^4	7.8×10^3
Cm-245	–	6.2×10^{-1}	2.0	1.2
Co-60	8.6×10^{1}(b)	7.6×10^{1}(b)	1.7×10^{2}(b) 3.6×10^{3}(c)	4.1(b)
Cs-134	6.4×10^4	5.8×10^4	7.8×10^4	4.8×10^4
Cs-137	1.8×10^5	1.4×10^5	1.6×10^5	9.3×10^4
Eu-154	1.0×10^4	1.2×10^4	1.6×10^4	9.1×10^3
Eu-155	2.7×10^3	5.7×10^3	8.3×10^3	4.6×10^3
I-129	–	4.7×10^{-2}	–	4.7×10^{-2}
Kr-85	1.1×10^4	1.1×10^4	–	8.9×10^3
Pm-147	5.2×10^4	3.5×10^4	3.1×10^4	1.8×10^4
Pu-238	9.5×10^3	7.0×10^3	1.1×10^4	6.1×10^3
Pu-239	4.1×10^2	4.2×10^2	4.3×10^2	2.6×10^2
Np-239	7.5×10^1	–	–	–
Pu-240	7.0×10^2	7.2×10^2	8.5×10^2	5.4×10^2
Pu-241	1.7×10^5	1.2×10^5	1.4×10^5	7.0×10^4
Pu-242	–	2.3	3.0	1.8
Ru-106	2.5×10^4	2.1×10^4	2.3×10^4	1.6×10^4
Sb-125	3.4×10^3	5.4×10^3	7.2×10^3	3.8×10^3
Sr-90	1.2×10^5	1.0×10^5	1.1×10^5	6.2×10^4
Y-90	1.2×10^5	1.0×10^5	1.1×10^5	6.2×10^4
H-3	6.5×10^2	–	–	–
Tc-99	2.3×10^1	–	–	–
Ag-110m	5.4×10^1	–	–	–
Cd-113m	5.0×10^1	–	–	–
Te-125m	8.3×10^2	–	–	–
Sm-151	6.5×10^2	–	–	–
Total	7.9×10^5	6.4×10^5	7.1×10^5	4.2×10^5

(a) Multiply curie per metric ton uranium (Ci/MTU) by 3.7×10^{10} to obtain becquerel per metric ton uranium (Bq/MTU).
(b) Cobalt-60 is the key radionuclide constituent of fuel assembly crud.
(c) Activation product.

Source: PSEG 2013-TN2463.

Robust shipping casks are used to transport spent fuel because of the radiation shielding and accident resistance required by 10 CFR Part 71 (TN301). Spent fuel shipping casks must be certified Type B packaging systems, meaning they must withstand a series of severe postulated accident conditions with essentially no loss of containment or shielding capability. These casks

also are designed with fissile material controls to ensure that the spent fuel remains subcritical under normal and accident conditions. According to Sprung et al. (2000-TN222), the probability of encountering accident conditions that would lead to shipping cask failure is less than 0.01 percent (i.e., more than 99.99 percent of all accidents would result in no release of radioactive material from the shipping cask). The NRC staff assumed that shipping casks approved for transportation of ABWR, AP1000, U.S. EPR, and US-APWR reactor spent fuel would provide equivalent mechanical and thermal protection of the spent fuel cargo.

Accident frequencies are calculated in RADTRAN 5.6 using user-specified accident rates and conditional shipping cask failure probabilities. State-specific accident rates were taken from Saricks and Tompkins (1999-TN81) and used in the RADTRAN 5.6 calculations. The state-specific accident rates were then adjusted to account for underreporting, as described in Section 6.2.1.3. Conditional shipping cask failure probabilities (i.e., the probability of cask failure as a function of the mechanical and thermal conditions applied in an accident) were taken from Sprung et al (2000-TN222).

The RADTRAN 5.6 accident risk calculations were performed using the radionuclide inventories (curie per metric ton uranium, or Ci/MTU) in Table 6-10 multiplied by the shipping cask capacity (0.5 MTU). The resulting risk estimates were then multiplied by assumed annual spent fuel shipments (shipments/year) to derive estimates of the annual accident risks associated with spent fuel shipments from the PSEG Site and alternative sites to the proposed repository at Yucca Mountain in Nevada. As was done for routine exposures, the NRC staff assumed that the numbers of shipments of spent fuel per year are equivalent to the annual discharge quantities.

For this assessment, release fractions for current-generation LWR fuel designs (Sprung et al. 2000-TN222) were used to approximate the impacts from the ABWR, AP1000, U.S. EPR, and US-APWR reactor spent fuel shipments. This assumes that the fuel materials and containment systems (i.e., cladding and fuel coatings) behave similarly to current LWR fuel under applied mechanical and thermal conditions.

The NRC staff used RADTRAN 5.6 to calculate the population dose from the released radioactive material from four of five possible exposure pathways.(1) These pathways are as follows.

- External dose from exposure to the passing cloud of radioactive material (cloudshine).
- External dose from the radionuclides deposited on the ground by the passing plume (groundshine). The NRC staff's analysis included the radiation exposure from this pathway even though the area surrounding a potential accidental release would be evacuated and decontaminated, thus preventing long-term exposures from this pathway.
- Internal dose from inhalation of airborne radioactive contaminants (inhalation).

(1) Internal dose from ingestion of contaminated food was not considered because the NRC staff assumed evacuation and subsequent interdiction of foodstuffs following a postulated transportation accident.

- Internal dose from resuspension of radioactive materials that were deposited on the ground (resuspension). The NRC staff's analysis included the radiation exposures from this pathway even though evacuation and decontamination of the area surrounding a potential accidental release would prevent long-term exposures.

Table 6-11 presents the environmental consequences of transportation accidents when shipping spent fuel from the PSEG Site and alternative sites to the proposed Yucca Mountain repository. The shipping distances and population distribution information for the routes were the same as those used for the normal "incident-free" conditions (see Section 6.2.2.1). The results are normalized to the WASH-1238 (AEC 1972-TN22) reference reactor (880-MW(e)) net electrical generation, 1,100-MW(e) reactor operating at 80 percent capacity) to provide a common basis for comparison to the impacts listed in Table S–4. Note that the impacts for all site alternatives are less than the reference LWR impacts. Although there are slight differences in impacts among alternative sites, none of the alternative sites would be clearly favored over the PSEG Site. The transportation accident impact analysis conducted by PSEG and RAI responses (PSEG 2015-TN4280; PSEG 2012-TN2465; PSEG 2013-TN2463) used methods and data that are similar to those used in this EIS. Differences are insignificant in terms of the overall results.

Using the linear no-threshold dose response relationship discussed in Section 6.2.1.1, the annual collective public dose estimate for transporting spent fuel from the PSEG and alternative sites to Yucca Mountain is less than 2×10^{-4} person-rem, which is less than the 1,754 person-rem value that the ICRP (2007-TN422) and NCRP (1995-TN728) suggest would most likely result in zero excess health effects. The collective population dose from natural background radiation to the population along the representative routes from the PSEG and alternative sites to Yucca Mountain would be about 300,000 person-rem. Therefore, the radiation doses from transporting spent fuel to Yucca Mountain are minimal compared to the collective population dose to the same population from exposure to natural sources of radiation.

6.2.2.3 Nonradiological Impact of Spent Fuel Shipments

The general approach used to calculate the nonradiological impacts of spent fuel shipments is the same as that used for unirradiated fuel shipments. State-by-state shipping distances were obtained from the TRAGIS output file and combined with the annual number of shipments and accident, injury, and fatality rates by state from Saricks and Tompkins (1999-TN81) to calculate nonradiological impacts. In addition, the accident, injury, and fatality rates from Saricks and Tompkins (1999-TN81) were adjusted to account for underreporting (see Section 6.2.1.3). The results are shown in Table 6-12 for the ABWR, AP1000, U.S. EPR, and US-APWR reactors. Overall, the impacts are minimal and there are no substantive differences among the alternative sites. In addition, the NRC staff verified PSEG's analysis in the ER and RAI responses (PSEG 2015-TN4280) by performing independent impact calculations. No significant differences were identified.

Table 6-11. Annual Spent Fuel Transportation Accident Impacts for a Single Reactor at the PSEG Site and Alternative Sites, Normalized to Reference LWR Reactor (880 MW(e) net)

Site, Reactor Type	Normalized Population Impacts, Person-rem/yr[a,b]
Reference LWR (WASH-1238 [AEC 1972-TN22])[c]	2.2×10^{-4}
ABWR	
PSEG Site	2.0×10^{-4}
Hunterdon County	2.0×10^{-4}
Salem County (7-1)	2.0×10^{-4}
Salem County (7-2)	2.0×10^{-4}
Cumberland County	2.0×10^{-4}
AP1000	
PSEG Site	4.2×10^{-5}
Hunterdon County	4.2×10^{-5}
Salem County (7-1)	4.2×10^{-5}
Salem County (7-2)	4.2×10^{-5}
Cumberland County	4.2×10^{-5}
U.S. EPR	
PSEG Site	1.0×10^{-4}
Hunterdon County	1.0×10^{-4}
Salem County (7-1)	1.0×10^{-4}
Salem County (7-2)	1.0×10^{-4}
Cumberland County	1.0×10^{-4}
US-APWR	
PSEG Site	1.1×10^{-4}
Hunterdon County	1.1×10^{-4}
Salem County (7-1)	1.1×10^{-4}
Salem County (7-2)	1.1×10^{-4}
Cumberland County	1.1×10^{-4}

(a) Divide person-rem/yr by 100 to obtain person-Sv/year.
(b) Normalized average annual shipments taken from PSEG 2015-TN4280; radiological risks per MTU-shipment taken from PSEG 2013-TN2463; scaling factors for alternative sites taken from PSEG 2012-TN2465.
(c) Based on 60 shipments per year.

Table 6-12. Nonradiological Impacts of Transporting Spent Fuel from the PSEG Site and Alternative Sites to Yucca Mountain for a Single Reactor, Normalized to Reference LWR (880 MW(e) net)

Site	One-Way Shipping Distance, km	Normalized Nonradiological Impacts, per year[(a)]		
		Accidents	Injuries	Fatalities
Reference LWR (WASH-1238 [AEC 1972-TN22])[(b)]	4,470	3.1×10^{-1}	1.5×10^{-1}	8.8×10^{-3}
ABWR				
PSEG Site	4,470	2.8×10^{-1}	1.3×10^{-1}	8.0×10^{-3}
Hunterdon County	4,500	2.8×10^{-1}	1.3×10^{-1}	8.0×10^{-3}
Salem County (7-1)	4,450	2.8×10^{-1}	1.3×10^{-1}	8.0×10^{-3}
Salem County (7-2)	4,470	2.8×10^{-1}	1.3×10^{-1}	8.0×10^{-3}
Cumberland County	4,480	2.8×10^{-1}	1.3×10^{-1}	8.0×10^{-3}
AP1000				
PSEG Site	4,470	2.0×10^{-1}	9.5×10^{-2}	5.7×10^{-3}
Hunterdon County	4,500	2.0×10^{-1}	9.6×10^{-2}	5.8×10^{-3}
Salem County (7-1)	4,450	2.0×10^{-1}	9.5×10^{-2}	5.7×10^{-3}
Salem County (7-2)	4,470	2.0×10^{-1}	9.5×10^{-2}	5.7×10^{-3}
Cumberland County	4,480	2.0×10^{-1}	9.6×10^{-2}	5.7×10^{-3}
U.S. EPR				
PSEG Site	4,470	2.2×10^{-1}	1.0×10^{-1}	6.3×10^{-3}
Hunterdon County	4,500	2.2×10^{-1}	1.1×10^{-1}	6.3×10^{-3}
Salem County (7-1)	4,450	2.2×10^{-1}	1.0×10^{-1}	6.2×10^{-3}
Salem County (7-2)	4,470	2.2×10^{-1}	1.0×10^{-1}	6.3×10^{-3}
Cumberland County	4,480	2.2×10^{-1}	1.0×10^{-1}	6.3×10^{-3}
US-APWR				
PSEG Site	4,470	2.0×10^{-1}	9.7×10^{-2}	5.8×10^{-3}
Hunterdon County	4,500	2.0×10^{-1}	9.8×10^{-2}	5.9×10^{-3}
Salem County (7-1)	4,450	2.0×10^{-1}	9.7×10^{-2}	5.8×10^{-3}
Salem County (7-2)	4,470	2.0×10^{-1}	9.7×10^{-2}	5.8×10^{-3}
Cumberland County	4,480	2.0×10^{-1}	9.8×10^{-2}	5.9×10^{-3}

(a) Normalized average annual shipments taken from PSEG 2015-TN4280; accidents, injuries, and fatalities per shipment taken from Appendix 7A, PSEG 2015-TN4280; scaling factors for alternative sites taken from PSEG 2012-TN2465.
(b) Based on 60 shipments per year.

6.2.3 Transportation of Radioactive Waste

This section discusses the environmental effects of transporting radioactive waste other than spent fuel from the PSEG Site and alternative sites. The environmental conditions listed in 10 CFR 51.52 (TN250) that apply to shipments of radioactive waste are as follows.

- Radioactive waste (except spent fuel) would be packaged and in solid form.
- Radioactive waste (except spent fuel) would be shipped from the reactor by truck or railcar.
- The weight limitation of 33,100 kg (73,000 lb) per truck and 90.7 MT (100 T) per cask per railcar would be met.

- Traffic density would be less than the condition of one truck shipment per day or three railcars per month.

Radioactive waste other than spent fuel from ABWR, AP1000, U.S. EPR, and US-APWR reactors is expected to be capable of being shipped in compliance with Federal or State weight restrictions. Table 6-13 presents estimates of annual waste volumes and annual waste shipment numbers for ABWR, AP1000, U.S. EPR, and US-APWR reactors at the PSEG Site normalized to the reference 1,100-MW(e) LWR defined in WASH-1238 (AEC 1972-TN22). The expected annual waste volumes and waste shipments for the ABWR, AP1000, and U.S. EPR reactors were less than the 1,100-MW(e) reference reactor that was the basis for Table S–4. The projected waste-generation rates for the US-APWR reactor (15,280 ft^3 per year is the estimated rate given by PSEG 2015-TN4280) could exceed the reference LWR waste-generation rate. However, projections of the rate of waste generation and the number of shipments are uncertain and are a function of PSEG's radioactive waste-management practices. For example, if all of the dry active waste from the ABWR, AP1000, U.S. EPR, and US-APWR were to be shipped in standard 20-ft Sealand containers holding 28.32 m^3 of waste, the number of normalized annual shipments would range from 6.7 for the AP1000 to 15.5 for the ABWR, compared to 46 for the reference LWR. Therefore, waste-generation rates and the number of shipments for the proposed PSEG reactors are anticipated to be lower than values shown in Table 6-13.

The sum of the daily shipments of unirradiated fuel, spent fuel, and radioactive waste is well below the one-truck-shipment-per-day condition given in 10 CFR 51.52 (TN250), Table S–4, for a ABWR, AP1000, U.S. EPR, or US-APWR reactor located at the PSEG Site and alternative sites. Doubling the shipment estimates to account for empty return shipments of fuel and waste is included in the results.

Dose estimates to the MEI from transport of unirradiated fuel, spent fuel, and waste under normal conditions are presented in Section 6.2.1.1.

The nonradiological impacts of radioactive waste shipments (see Table 6-14) were calculated using the same general approach used for unirradiated and spent fuel shipments. For this EIS, the shipping distance was assumed to be 500 mi one way for the reference LWR (AEC 1972-TN22). Distances from the PSEG and alternative sites to the Barnwell, South Carolina waste disposal site are also listed in Table 6-14. Accident, injury, and fatality rates were used in the calculations (Saricks and Tompkins 1999-TN81). These rates were adjusted to account for underreporting, as described in Section 6.2.1.3. The results are presented in Table 6-14. As shown, the calculated nonradiological impacts for transportation of radioactive waste other than spent fuel from the PSEG Site and alternative sites to the Barnwell waste disposal facility are greater than the impacts calculated for the reference LWR in WASH-1238 (AEC 1972-TN22), principally because of the greater distances to the Barnwell LLW disposal facility and the number of shipments for the US-APWR. Also, the waste-generation rates and number of shipments for the proposed PSEG reactors are anticipated to be lower than values shown in Table 6-13, and impacts would also be less than the reference LWR (AEC 1972-TN22). In addition, the NRC staff verified PSEG's analysis in the ER (PSEG 2015-TN4280) by performing independent impact calculations. Slight differences were identified, but the differences in the estimates of the nonradiological impacts were not significant.

Table 6-13. Summary of Radioactive Waste Shipments from the PSEG Site and Alternative Sites for a Single Reactor, Normalized to Reference LWR (880 MW(e) net)

Reactor Type	Waste-Generation Information, ft^3/yr per unit	Annual Waste Volume, m^3/yr	Electrical Output, MW(e)	Normalized Rate, m^3/1,100 MW(e) Unit (880 MW(e) Net)[(a)]	Shipments/ 1,100 MW(e) (880 MW(e) Net) Electrical Output[(b,c)]
Reference LWR (WASH-1238 [AEC 1972-TN22])	3,800	108	1,100	108	46
ABWR	5,830	165	1,500	100.5	43 (15.5)
AP1000	1,965	55.6	1,150	44.2	19 (6.7)
U.S. EPR	6,620	187.4	1,600	107	45.6 (7.2)
US-APWR	15,280	432.7	1,600	247.1	105.4 (12.8)

Note: Conversions: 1 m^3 = 35.31 ft^3.

(a) Capacity factors used to normalize the waste-generation rates to an equivalent electrical generation output are 80 percent for the reference LWR (AEC 1972-TN22), and 96.3 percent for the ABWR, AP1000, U.S. EPR, and US-APWR reactors (PSEG 2015-TN4280; PSEG 2012-TN2465). Waste generation for the ABWR, AP1000, U.S. EPR, and US-APWR reactors is normalized to 880 MW(e) net electrical output (1,100-MW(e) unit with an 80 percent capacity factor).

(b) The number of shipments per 1,100 MW(e) was calculated assuming the WASH-1238 (AEC 1972-TN22) average waste shipment capacity of 2.34 m^3 (82.6 ft^3 per shipment [108 m^3/yr divided by 46 shipments/yr]) for spent resin, evaporator concentrates, filters, sludges, dry active waste, etc. (PSEG 2013-TN2463).

(c) The values in parentheses represent the number of shipments based on using Sealand containers (28.32 m^3 capacity) for shipping dry active waste (PSEG 2015-TN4280 [Table 5.7-13]).

Table 6-14. Nonradiological Impacts of Radioactive Waste Shipments from the PSEG Site and Alternative Sites with a Single Reactor, Normalized to Reference LWR (880 MW(e) net)[(a)]

	Normalized Shipments per Year	One-Way Distance, km	Normalized Nonradiological Impacts, per Year		
			Accidents	Injuries	Fatalities
Reference LWR (WASH-1238 [AEC 1972-TN22])	46	800	3.4×10^{-2}	1.7×10^{-2}	1.1×10^{-3}
ABWR					
Reference LWR (WASH-1238 [AEC 1972-TN22])	43	800	3.2×10^{-2}	1.6×10^{-2}	9.9×10^{-4}
PSEG Site	43	1,110	6.8×10^{-2}	3.9×10^{-2}	2.4×10^{-3}
Hunterdon County	43	1,210	7.4×10^{-2}	4.3×10^{-2}	2.7×10^{-3}
Salem County (7-1)	43	1,090	6.6×10^{-2}	3.9×10^{-2}	2.4×10^{-3}
Salem County (7-2)	43	1,110	6.8×10^{-2}	3.9×10^{-2}	2.4×10^{-3}
Cumberland County	43	1,120	6.8×10^{-2}	4.0×10^{-2}	2.4×10^{-3}
AP1000					
Reference LWR (WASH-1238 [AEC 1972-TN22])	19	800	1.4×10^{-2}	7.0×10^{-3}	4.4×10^{-4}
PSEG Site	19	1,110	3.0×10^{-2}	1.7×10^{-2}	1.1×10^{-3}
Hunterdon County	19	1,210	3.3×10^{-2}	1.9×10^{-2}	1.2×10^{-3}
Salem County (7-1)	19	1,090	2.9×10^{-2}	1.7×10^{-2}	1.1×10^{-3}
Salem County (7-2)	19	1,110	3.0×10^{-2}	1.7×10^{-2}	1.1×10^{-3}
Cumberland County	19	1,120	3.0×10^{-2}	1.8×10^{-2}	1.1×10^{-3}

Table 6-14. (continued)

	Normalized Shipments per Year	One-Way Distance, km	Normalized Nonradiological Impacts, per Year		
			Accidents	Injuries	Fatalities
U.S. EPR					
Reference LWR (WASH-1238 [AEC 1972-TN22])	45.6	800	3.4×10^{-2}	1.7×10^{-2}	1.1×10^{-3}
PSEG Site	45.6	1,110	7.2×10^{-2}	4.2×10^{-2}	2.6×10^{-3}
Hunterdon County	45.6	1,210	7.8×10^{-2}	4.6×10^{-2}	2.8×10^{-3}
Salem County (7-1)	45.6	1,090	7.0×10^{-2}	4.1×10^{-2}	2.5×10^{-3}
Salem County (7-2)	45.6	1,110	7.2×10^{-2}	4.2×10^{-2}	2.6×10^{-3}
Cumberland County	45.6	1,120	7.2×10^{-2}	4.2×10^{-2}	2.6×10^{-3}
US-APWR					
Reference LWR (WASH-1238 [AEC 1972-TN22])	105.4	800	7.8×10^{-2}	3.9×10^{-2}	2.4×10^{-3}
PSEG Site	105.4	1,110	1.7×10^{-1}	9.7×10^{-2}	6.0×10^{-3}
Hunterdon County	105.4	1,210	1.8×10^{-1}	1.1×10^{-1}	6.5×10^{-3}
Salem County (7-1)	105.4	1,090	1.6×10^{-1}	9.5×10^{-2}	5.8×10^{-3}
Salem County (7-2)	105.4	1,110	1.7×10^{-1}	9.7×10^{-2}	6.0×10^{-3}
Cumberland County	105.4	1,120	1.7×10^{-1}	9.7×10^{-2}	6.0×10^{-3}

(a) Normalized shipments taken from PSEG 2013-TN2463; accidents, injuries, and fatalities per shipment taken from Appendix 7A, PSEG 2015-TN4280; scaling factors for alternative sites taken PSEG 2012-TN2465.

6.2.4 Conclusions for Transportation

The NRC staff performed an independent confirmatory analysis of the impacts under normal operating and accident conditions of transporting fuel and wastes to and from an ABWR, AP1000, U.S. EPR, or US-APWR reactor to be located at the PSEG Site. Four alternative sites also were evaluated, including one site in Hunterdon County, two sites in Salem County, and one site in Cumberland County (PSEG 2015-TN4280; PSEG 2012-TN2465). To make comparisons to Table S–4, the environmental impacts were adjusted (i.e., normalized) to the environmental impacts associated with the reference LWR in WASH-1238 (AEC 1972-TN22) by multiplying the ABWR, AP1000, U.S. EPR, or US-APWR reactor impact estimates by the ratio of the total electric output for the reference reactor to the electric output of the proposed reactors.

Because of the conservative approaches and data used to calculate impacts, the NRC staff does not expect the actual environmental effects to exceed those calculated in this EIS. Thus, the NRC staff concludes that the environmental impacts of the transportation of fuel and radioactive wastes to and from the PSEG Site and alternative sites would be SMALL, and would be consistent with the environmental impacts associated with the transportation of fuel and radioactive wastes to and from current-generation reactors presented in Table S–4 of 10 CFR 51.52 (TN250).

The NRC staff concludes that transportation impacts are roughly proportional to the distance from the reactor site to the repository site, in this case New Jersey to Nevada. The distance from the PSEG Site or any of the alternative sites to any new planned repository in the contiguous United States would be no more than double the distance from the PSEG Site or

alternative sites to Yucca Mountain. Doubling the environmental impact estimates from the transportation of spent reactor fuel, as presented in this section, would provide a reasonable bounding estimate of the impacts to meet the needs of NEPA (42 USC 4321 et seq. -TN661). The NRC staff concludes that the environmental impacts of these doubled estimates would not be significant and, therefore, would still be SMALL.

6.3 Decommissioning Impacts

At the end of the operating life of a power reactor, NRC regulations require that the facility undergo decommissioning. The NRC defines decommissioning as the safe removal of a facility from service and the reduction of residual radioactivity to a level that permits termination of the NRC license. The regulations governing decommissioning of power reactors are found in 10 CFR 50.75 (TN249) and 10 CFR 50.82 (TN249). The radiological criteria for termination of the NRC license are in 10 CFR Part 20 (TN283), Subpart E. Minimization of contamination and generation of radioactive waste requirements for facility design and procedures for operation are addressed in 10 CFR 20.1406 (TN283).

Environmental impacts from the activities associated with the decommissioning of any reactor before or at the end of an initial or renewed license are evaluated in the *Generic Environmental Impact Statement for Decommissioning of Nuclear Facilities: Supplement 1, Regarding the Decommissioning of Nuclear Power Reactors* (GEIS-DECOM), NUREG–0586, Supplement 1 (NRC 2002-TN665). If an applicant for a construction permit or COL referencing the PSEG ESP applies for a license to construct a new nuclear power plant at the PSEG Site, there is a requirement to provide a report containing a certification that financial assurance for radiological decommissioning would be provided. At the time an application is submitted, the requirements in 10 CFR 50.33 (TN249), 10 CFR 50.75 (TN249), and 10 CFR 52.77 (TN251) (and any other applicable requirements) would have to be met.

At the ESP stage, applicants are not required to submit information regarding the process of decommissioning, such as the method chosen for decommissioning, the schedule, or any other aspect of planning for decommissioning. However, PSEG did provide information in ER Section 5.9 concerning the environmental impacts of decommissioning based on NUREG–0586, Supplement 1, and a 2004 DOE report focused on decommissioning costs for advanced reactors, and concluded that the environmental impacts of decommissioning discussed in NUREG–0586, Supplement 1 (NRC 2002-TN665), would be the same as those for advanced reactor designs included in the PSEG ER (AP1000, U.S. EPR, ABWR, US-APWR) (PSEG 2015-TN4280). The NRC staff's evaluation of the environmental impacts of decommissioning presented in the GEIS-DECOM identifies a range of impacts for each environmental issue for a range of different reactor designs. The staff has no reason to believe that the impacts discussed in the GEIS-DECOM are not bounding for reactors deployed after 2002.

The GEIS-DECOM does not specifically address the GHG footprint of decommissioning activities. However, it does list the decommissioning activities and states that the decommissioning workforce would be expected to be smaller than the operational workforce, and that the decontamination and demolition activities could take up to 10 years to complete. Finally, it discusses Safe Storage (also called the SAFSTOR decommissioning option), in which

decontamination and dismantlement are delayed for a number of years. Given this information, the NRC staff estimated the GHG footprint of decommissioning to be on the order of 81,000-MT CO_2e without SAFSTOR. The contributions to this footprint are about one-third from decommissioning workforce transportation and two-thirds from equipment usage. The details of the NRC staff's estimate are presented in Appendix K. A 40-year SAFSTOR period would increase the GHG footprint of decommissioning by about 40 percent. These GHG footprints are roughly three orders of magnitude lower than the GHG footprint presented in Section 6.1.3 for the uranium fuel cycle.

Therefore, the staff relies upon the bases established in GEIS-DECOM and concludes the following.

1. Doses to the public would be well below applicable regulatory standards regardless of which decommissioning method considered in GEIS-DECOM is used.
2. Occupational doses would be well below applicable regulatory standards during the license term.
3. The quantities of Class C or greater than Class C wastes generated would be comparable to or less than the amounts of solid waste generated by reactors licensed before 2002.
4. Air-quality impacts of decommissioning are expected to be negligible at the end of the operating term.
5. Measures are readily available to avoid potential significant water quality impacts from erosion or spills. The liquid radioactive waste system design includes features to limit release of radioactive material to the environment, such as pipe chases and tank collection basins. These features will minimize the amount of radioactive material in spills and leakage that would have to be addressed at decommissioning.
6. The ecological impacts of decommissioning are expected to be negligible.
7. The socioeconomic impacts would be short-term and could be offset by decreases in population and economic diversification.

For a new nuclear power plant at the PSEG Site or at any of the four alternative sites, the impacts from decommissioning are expected to be within the bounds described in NUREG–0586, Supplement 1 (NRC 2002-TN665). Based on the GEIS-DECOM and the evaluation of air-quality impacts from GHG emissions above, the NRC staff concludes that, as long as the regulatory requirements on decommissioning activities to limit the impacts of decommissioning are met, the decommissioning activities would result in a SMALL impact.

7.0 CUMULATIVE IMPACTS

The U.S. Nuclear Regulatory Commission (NRC) regulations in Title 10 of the *Code of Federal Regulations* (CFR) Part 51 (TN250) implementing the National Environmental Policy Act of 1969, as amended (NEPA, 42 USC 4321 et seq. -TN661), require the NRC to consider the cumulative impacts of proposals under its review (10 CFR 51.71(d) [TN250]). Cumulative impacts may result when the environmental effects associated with the proposed action are overlaid or added to temporary or permanent effects associated with past, present, and reasonably foreseeable future projects. Cumulative impacts can result from individually minor, but collectively significant, actions taking place over a period of time.

PSEG Power, LLC, and PSEG Nuclear, LLC (PSEG), submitted an application for an early site permit (ESP), which was accompanied by an Environmental Report (ER) (PSEG 2015-TN4280) that included consideration of a new nuclear power plant that might be constructed and operated at the PSEG Site. When evaluating the potential impacts of building and operating a new nuclear power plant at the PSEG Site, the NRC and the U.S. Army Corps of Engineers (USACE) (collectively, the review team) considered potential cumulative impacts to resources that could be affected by the construction, preconstruction, operation, and decommissioning of a new plant.

Cumulative impacts result when the effects of an action are added to or interact with other past, present, and reasonably foreseeable future effects on the same resources. For purposes of this analysis, past actions are those prior to the receipt of the ESP application. Present actions are those related to resources from the time of the ESP application until the issuance of an ESP. Future actions include those that are reasonably foreseeable through the building of a new nuclear power plant as would occur under a subsequent NRC-authorized construction permit (CP) or combined license (COL), operation of a new plant, and its decommissioning. The geographic area over which past, present, and reasonably foreseeable future actions could contribute to cumulative impacts is dependent on the type of resource considered and is described below for each resource area. The review team considered, among other things, the cumulative effects of a new nuclear power plant with current operations of the existing units at the Salem Generating Station (SGS) and Hope Creek Generating Station (HCGS).

The impacts of the proposed action, as described in Chapters 4 and 5, are combined with other past, present, and reasonably foreseeable future actions in the general area surrounding the PSEG Site that would affect the same resources impacted by a new nuclear power plant, regardless of what agency (Federal or non-Federal) or person undertakes such actions. These combined impacts are defined as “cumulative” in 40 CFR 1508.7 (TN428) and include individually minor but collectively potentially significant actions taking place over a period of time. It is possible that an impact that may be SMALL by itself could result in a MODERATE or LARGE cumulative impact when considered in combination with the impacts of other actions on the affected resource. Likewise, if a resource is regionally declining or imperiled, even a SMALL individual impact could be important if it contributes to or accelerates the overall resource decline.

The description of the affected environment in Chapter 2 serves as the baseline for the cumulative impacts analysis, including the effects of past actions. The incremental impacts related to the activities requiring NRC or USACE authorization are described and characterized in Chapter 4, and those related to operations are described and characterized in Chapter 5. These impacts are summarized for each resource area in the sections that follow. The level of detail is commensurate with the significance of the impact for each resource area.

This chapter includes an overall cumulative impact assessment for each resource area. The NRC staff performed the cumulative impact analysis according to guidance provided in *Interim Staff Guidance on Environmental Issues Associated with New Reactors* (NRC 2014-TN3767). The specific resources and components that could be affected by the incremental effects of the proposed action and other actions in the same geographic area were assessed. This assessment includes the impacts of construction and operation of a new nuclear power plant as described in Chapters 4 and 5; impacts of preconstruction activities as described in Chapter 4; impacts of fuel cycle, transportation, and decommissioning as described in Chapter 6; and impacts of past, present, and reasonably foreseeable future Federal, non-Federal, and private actions that could affect the same resources affected by the proposed actions.

The review team visited the PSEG Site in May 2012 (NRC 2012-TN2498). The team then used the information provided in the ER, PSEG's responses to Requests for Additional Information issued by the NRC and USACE staff, information from other Federal and State agencies, and information gathered at the PSEG Site visit to evaluate the cumulative impacts of building and operating a new nuclear power plant at the PSEG Site. To inform the cumulative impacts analysis, PSEG conducted a search to identify other relevant projects in the vicinity of the PSEG Site (PSEG 2012-TN2214). The search included information available through regional economic development agencies in the states of Delaware and New Jersey, U.S. Environmental Protection Agency (EPA) databases for relevant environmental impact statements (EISs) within the state, the USACE Philadelphia District website for recent permit applications, township and county planning websites, the New Jersey Department of Transportation website, and the Delaware Department of Transportation website. Information was also sought to identify projects in the geographic area funded by the American Recovery and Reinvestment Act of 2009 (Public Law 111-5, 26 USC 1-TN1250). The review team developed Table 7-1, which shows the major projects near the PSEG Site that were considered relevant in the analysis of cumulative impacts. The review team used this information to perform an independent evaluation of the direct and cumulative impacts of the proposed action at the PSEG Site.

Table 7-1. Projects and Other Actions Considered in the Cumulative Impacts Analysis for the PSEG Site

Project Name	Summary of Project	Location	Status
Nuclear Projects			
Hope Creek Generating Station, Unit 1	The station consists of a single operating boiling water reactor (BWR) rated at 3,840 MW(t), adjacent to the Salem units	Adjacent to PSEG Site	Operational, licensed through April 11, 2046 (NRC 2012-TN2626)

Table 7-1. (continued)

Project Name	Summary of Project	Location	Status
Salem Generating Station, Units 1 and 2	The station consists of two operating pressurized water reactors (PWRs) rated at 3,459 MW(t) each, adjacent to the Hope Creek unit	Adjacent to PSEG Site	Operational, licensed through August 13, 2036 and April 18, 2040 (NRC 2012-TN2626)
Peach Bottom Atomic Power Station, Units 2 and 3	The station consists of two operating BWRs rated at 3,514 MW(t) each, and one permanently shut down unit (Unit 1)	44 mi northwest of PSEG Site	Operational, licensed through August 8, 2033 and July 2, 2034 (NRC 2012-TN2626)
Limerick Generating Station, Units 1 and 2	The station consists of two operating BWRs rated at 3,515 MW(t) each	50 mi north of PSEG Site	Operational, licensed through October 26, 2024 and June 22, 2029 (NRC 2012-TN2626)
Oyster Creek Nuclear Generating Station	The station consists of a single operating BWR rated at 1,930 MW(t)	75 mi east-northeast of PSEG Site	Operational, licensed through April 9, 2029 (NRC 2012-TN2626). However, Exelon plans to shut the plant down in 2019 (Exelon 2013-TN2521)
Three Mile Island Nuclear Station, Unit 1	The station consists of a single operating PWR rated at 2,568 MW(t) and one permanently shut down unit (Unit 2)	78 mi northwest of PSEG Site	Operational, licensed through April 19, 2034 (NRC 2012-TN2626)
Calvert Cliffs Nuclear Power Plant Units 1 and 2	The station consists of two operating PWRs rated at 2,737 MW(t) each	90 mi south-southwest of PSEG Site	Operational, licensed through July 31, 2034 and August 13, 2036 (NRC 2012-TN2626)
Energy Projects			
Delaware City Refinery	The Refinery is located on 5,050 ac, and the refining operations occupy about 1,000 ac. The facility processes crude oils and currently produces about 180,000 barrels of petroleum product a day	9 mi northwest of PSEG Site	Operational (EPA 2012-TN2668)
Deepwater Energy Center	158-MW two-unit natural-gas peaking facility	10 mi northeast of PSEG Site	Operational (EPA 2013-TN2504)
Carneys Point Generating Plant	Cogeneration power plant	15 mi northeast of PSEG Site	Operational (EPA 2013-TN2504)
Pedricktown Combined Cycle Cogeneration Plant	120-MW peaking facility	22 mi northeast of PSEG Site	Operational (EPA 2013-TN2504)
Cumberland County Landfill Gas-to-Energy Plant	Methane gas input, provides 6.4 MW of baseload power	33 mi east of PSEG Site	Operational (EPA 2013-TN2515)

Table 7-1. (continued)

Project Name	Summary of Project	Location	Status
Vineland Municipal Electric Utility	Utility owns two natural-gas units: Howard M. Down substation and West Substation, combined 86 MW	32 mi east-northeast of PSEG Site	Operational (EPA 2013-TN2515)
Sherman Ave. Energy Center	92-MW natural-gas peaking facility	26 mi east of PSEG Site	Operational (EPA 2013-TN2515)
Carl's Corner Energy Center	84-MW two-unit natural-gas peaking facility	13 mi northeast PSEG Site	Operational (EPA 2013-TN2515)
Cumberland Generating Station	99-MW natural-gas-fired power plant	21 mi southeast of PSEG Site	Operational (EPA 2013-TN2515)
Grid stability transmission line for Artificial Island	Line needed to support the grid in the area around the island. No specific route is known.	Adjacent to PSEG Site	Proposals requested by PJM Interconnection, LLC (PJM) (PSEG 2013-TN2669)
New Developments/Redevelopment			
Camp Pedricktown Redevelopment	Site redevelopment due to Base Realignment and Closure (BRAC)	20 mi north of PSEG Site	In progress (Davis 2013-TN2533)
Millville Municipal Airport Improvements	Infrastructure upgrades	27 mi east-southeast of PSEG Site	Funding acquired (Menendez 2013-TN2666)
Agricultural Products Business Park	A new business park	28 mi northeast of PSEG Site	Proposed (PSEG 2015-TN4280)
Gateway Business Park	Partially built site	37 mi northeast of PSEG Site	In progress (PSEG 2015-TN4280)
Parks and Recreation Activities			
Mad Horse Creek Wildlife Management Area	Restoration of approximately 200 ac	4 mi east of PSEG Site	In progress (PSEG 2015-TN4280)
Supawna Meadows National Wildlife Refuge	Approximately 3,000-ac refuge with some walking and boating trails	8 mi north of PSEG Site	Operational (FWS 2013-TN2530)
Fort Mott State Park	124-ac park built around a historical site	10 mi north of PSEG Site	Operational (NJDEP 2013-TN2532)
Parvin State Park	2,092-ac park with trails, camping, boating, fishing and hunting	22 mi east of PSEG Site	Operational (NJDEP 2013-TN2531)
Other Actions/Projects			
USACE Delaware River Main Channel Deepening Project	Deepening of river channel Reach D: Delaware River Mile (RM) 55 to 41	Less than 1 mi west of PSEG Site	In progress (USACE 2013-TN2665)
Salem County Solid Waste Landfill	Regional landfill for solid waste	12 mi northwest of PSEG Site	Operational (SCIA 2013-TN2664)

Table 7-1. (continued)

Project Name	Summary of Project	Location	Status
Air emissions sources	Nearby air emissions sources include small-scale commercial facilities (emissions below reporting limits), on-road mobile sources (e.g., cars and trucks), non-road mobile sources (e.g., airplanes, boats, and tractors), and industrial stationary point emissions sources (Mannington Mills Inc. flooring manufacturer, DuPont Dow Performance Elastomers, LLC synthetic rubber manufacturer	Within Salem County	Ongoing
Shieldalloy site decommissioning	Shieldalloy conducted smelting and alloy production at the site from 1940 through 2001. One of the raw materials used by the company was a niobium ore called pyrochlore, which contains uranium and thorium and is subject to NRC licensing requirements. The company has submitted a decommissioning plan which proposes to use a possession-only license for long-term control via an onsite disposal cell	Approximately 28 mi east-northeast of PSEG Site	Pending because of an ongoing Federal court case (Romalino 2013-TN3197)
Surface-water withdrawals and discharges	Surface-water withdrawals for public water supply and other potable use, and wastewater treatment plant discharges	Within 10 RM of the intake and discharge for the PSEG Site	Significant surface-water withdrawals and discharges have been taking place for decades. Withdrawal rates are expected to continue at current rates or increase slightly in the future.
Groundwater withdrawals	Groundwater withdrawals throughout the region supply the majority of freshwater needs. Major pumping centers in Salem, Gloucester, and Camden counties in New Jersey, and New Castle County in Delaware affect groundwater heads and groundwater flow paths throughout the region.	Throughout region	Significant groundwater withdrawals have been taking place since the 1950s. Withdrawal rates are expected to continue at current rates or increase slightly in the future.
Various hospitals and industries that use radioactive materials	Medical and other isotopes	Within 50 mi	Operational in nearby cities and towns

Table 7-1. (continued)

Project Name	Summary of Project	Location	Status
Future Urbanization	Construction of housing units and associated commercial buildings; roads, bridges, and rail; and water and/or wastewater treatment and distribution facilities and associated pipelines, as described in local land-use planning documents	Throughout region	Construction would occur in the future, as described in State and local land-use planning documents

7.1 Land Use

The description of the affected environment in Section 2.2 serves as the baseline for the cumulative impact assessment for land use. As described in Section 4.1, the NRC staff concludes the impacts of NRC-authorized construction on land use would be MODERATE because power block construction would occur on the 85-ac parcel that PSEG would acquire from the USACE, resulting in the loss to the USACE of some dredge spoil disposal capacity at the Artificial Island Confined Disposal Facility (CDF). The combined impacts from construction and preconstruction also are described in Section 4.1 and have been determined by the review team to be MODERATE for both the PSEG Site (because of the loss to the USACE of 85 ac of dredge spoil disposal capacity) and the proposed causeway corridor (because of the permanent change in land use of 45.5 ac from wetlands to developed lands within areas protected by the State of New Jersey under Deeds of Conservation Restriction). As described in Section 5.1, the review team concludes the impacts of operations on land use would be SMALL.

This section describes the cumulative impacts associated with past, present, and reasonably foreseeable future actions that could impact land use in conjunction with the impacts described in Sections 4.1 and 5.1. For this cumulative analysis, the geographic area of interest includes Salem County, New Jersey (in which the PSEG Site is located) and the other 24 counties located in the 50-mi region around the PSEG Site. The 50-mi region includes counties in New Jersey, Delaware, Pennsylvania, and Maryland. The direct and indirect impacts to land use of building and operating a new nuclear power plant at the PSEG Site and the proposed causeway would be confined to Salem County, New Jersey, but the cumulative impacts to land use when combined with other actions (discussed below) would extend to other counties in New Jersey, Delaware, Maryland, and Pennsylvania.

As discussed in Section 2.2.1, the 6-mi vicinity encompassing the PSEG Site is dominated by three major land cover types: open water (primarily the Delaware River) (36 percent), wetlands (35 percent), and agriculture (23 percent). Historically, land uses in the 6-mi vicinity have reflected these land cover types, with shipping and fishing the most prevalent uses of open water; hunting, fishing, trapping, wildlife management, and dredge spoil disposal the most prevalent uses of wetlands; and salt hay production and livestock grazing the most prevalent uses of agricultural lands (PSEG 2015-TN4280).

The 50-mi region surrounding the PSEG Site is dominated by four major land cover types: agriculture (37 percent); forests (24 percent); open water, including both the Delaware River and the Chesapeake Bay (16 percent); and developed lands, including the corridor of urban development from Philadelphia, Pennsylvania, south to Baltimore, Maryland (13 percent). Historically, land uses in the region have reflected these land cover types, with a wide variety of cultivated crop, livestock production, and hay production on agricultural lands; logging, forest management, and wildlife management on the forest lands; shipping, fishing, and trapping on the open water; and a wide variety of residential, commercial, and industrial uses on the developed lands (PSEG 2015-TN4280).

Table 7-1 lists projects that, in combination with building and operating a new nuclear power plant at the PSEG Site and the proposed causeway, could contribute to cumulative impacts in the region. The project closest to the new nuclear power plant and the proposed causeway would be the continued operation of SGS and HCGS on the PSEG Site. In 2011, the NRC issued new operating licenses for SGS Unit 1 (expires 2036), SGS Unit 2 (expires 2040), and HCGS (expires 2046) (NRC 2011-TN3131). The cumulative land-use impact on the PSEG Site would result from the combined commitment of land for the new nuclear power plant with the land already dedicated to SGS and HCGS. With the acquisition of 85 ac from the USACE, the PSEG Site would total 819 ac, of which 373 ac would be occupied by existing facilities at SGS and HCGS and 225 ac would be occupied by facilities at the new nuclear power plant. Thus, 73.0 percent of the total PSEG Site (598 of 819 ac) would be occupied by SGS, HCGS, the new nuclear power plant, and their associated facilities. Although this would represent a relatively large land-use impact on Artificial Island and the immediate vicinity, the cumulative impact to land use in the 50-mi region would be relatively minor.

A second proposed project that could occur in close proximity to a new nuclear power plant on the PSEG Site and the proposed causeway is the USACE Delaware River Main Channel Deepening Project in the Delaware River. In this project, the USACE would conduct dredging operations to deepen a section of the Delaware River, including the portion of the river adjacent to the PSEG Site (USACE 2011-TN2262). The primary land-use impact of this deepening project would be the use by the USACE of some existing CDFs along the Delaware River for the disposal of dredge materials. The total dredging operation would generate an estimated 16 million yd^3 of spoil material, some of which (about 2 million yd^3) would be disposed of at the Reedy Point South CDF and Artificial Island CDF. The NEPA documentation for the channel deepening project (USACE 2011-TN2262) concludes there would be no significant land-use impacts from the project.

The cumulative land-use impact of developing a new nuclear power plant at the PSEG Site and the Delaware River Main Channel Deepening Project would result from the combined commitment of (1) land for the new power plant and the proposed causeway, (2) lands already dedicated to the existing USACE CDFs, and (3) any new land the USACE would develop as a CDF to replace the 85 ac of dredge spoil capacity lost at the Artificial Island CDF in the land exchange with PSEG. The cumulative impact would be reduced if the USACE replaces the 85 ac of dredge spoil capacity by using one of its existing CDFs in the region. However, if the USACE must develop a new CDF to replace the 85 ac of dredge spoil capacity, the cumulative impact would be larger than if an existing CDF is used. To facilitate its proposed land exchange with the USACE, PSEG identified three potential sites for replacing the 85 ac of dredge spoil

capacity (PSEG 2012-TN2282), and the USACE would conduct a separate assessment of the environmental impacts of replacing the 85 ac of capacity. Although developing and using a new or existing CDF could have noticeable land-use impacts at the site of the CDF and in the vicinity, the cumulative land-use impacts of the new nuclear power plant on the PSEG Site, the proposed causeway, and the USACE Delaware River Main Channel Deepening Project would be minor in the context of land use within the 50-mi region.

PJM Interconnection, LLC, (PJM) is the regional transmission organization that coordinates the movement of wholesale electricity in the region of interest (ROI). PJM began accepting proposals for solutions to resolve grid stability issues in the region of Artificial Island where HCGS and SGS are located. Solutions include the construction of a new line that could extend from Pennsylvania to Artificial Island.

To bound the potential impacts of an offsite transmission line corridor, PSEG performed a geographic information system (GIS) analysis using a 5-mi wide macro-corridor known as the western macro-corridor (WMC) and assumed a transmission line right-of-way (ROW) width of 200 ft. However, the PSEG analysis does not identify a specific 200-ft-wide ROW within the WMC, but calculates the amount of each land-use type that would be affected in a 200-ft-wide ROW based on each land-use type as a percentage of total land use within the WMC. Table 7-2 lists the results of this analysis for the portions of the WMC located within the 6-mi vicinity and the 50-mi region of the PSEG Site.

Table 7-2. PSEG Estimates of Land-Use Impacts Associated with a Potential Offsite Transmission Line ROW(a)

Land-Use Category	6-Mi Vicinity (ac)	6- to 50-Mi Region (ac)	Total (ac)	Percent (ac)
Open Water	16	152	168	10.8
Developed–Open Space	1	62	63	4.0
Developed–Low Intensity	1	71	72	4.6
Developed–Medium Intensity	1	30	31	2.0
Developed–High Intensity	2	12	13	0.8
Barren Land	3	21	24	1.5
Deciduous Forest	9	276	285	18.3
Evergreen Forest	0	9	9	0.6
Mixed Forest	0	0	0	0.0
Pasture Hay	8	367	374	24.0
Cultivated Crops	35	255	290	18.6
Woody Wetlands	35	94	129	8.3
Emergent Herbaceous Wetlands	62	36	99	6.4
Totals	**173**	**1,385**	**1,557**	**100.0**

(a) Values are based on a hypothetical 55-mi-long, 200-ft-wide ROW.

Source: PSEG 2015-TN4280.

According to the PSEG analysis, most of the land-use impacts of the potential transmission line corridor would occur on agricultural lands and forested lands (PSEG 2015-TN4280). PJM has

not selected a specific route for the potential new transmission line. However, based on the analysis performed by PSEG and the potential land uses that could be affected, a new transmission line could have a noticeable effect on land uses within the region.

Most of the other projects listed in Table 7-1 are not expected to create noticeable cumulative impacts to land use in the 50-mi region when combined with building and operating a new nuclear power plant on the PSEG Site and the proposed causeway. The new development/redevelopment projects listed (Camp Pedricktown Redevelopment, Agricultural Products Business Park, and Gateway Business Park) are all too far from the PSEG Site and from each other to create noticeable cumulative land-use impacts in the region. The parks and recreation activities listed (Mad Horse Creek Wildlife Management Area restoration and management of existing parks in the 50-mi region) are not expected to contribute to adverse land-use impacts, especially on the regional scale. The future urbanization activities listed would contribute to cumulative land-use impacts in the region but are too speculative and undefined for the review team to reach a conclusion regarding the magnitude of their impacts.

The report *Global Climate Change Impacts in the United States* (GCRP 2014-TN3472), prepared for the U.S. Global Change Research Program, summarizes the projected impacts of future climate changes in the United States. The report divides the United States into nine regions, and the PSEG Site is located in the Northeast region. The report indicates climate change could increase precipitation, sea level, and storm surges in the Northeast region, thus changing land use through the inundation of low-lying areas that are not buffered by high cliffs. However, cliffs could experience increased rates of erosion as a result of frequent storm surges, flooding events, and sea-level rise. Forest growth could increase as a result of more carbon dioxide in the atmosphere. Existing parks, reserves, and managed areas would help preserve wetlands and forested areas to the extent they are not affected by the same factors. In addition, climate change could reduce crop yields and livestock productivity, which might change portions of agricultural land uses in the region (GCRP 2014-TN3472). Thus, direct changes resulting from climate change could cause a shift in land use in the 50-mi region that would contribute to the cumulative impacts of building and operating a new nuclear power plant on the PSEG Site and the proposed causeway.

Overall, when combined with other past, present, and reasonably foreseeable future actions, the cumulative land-use impacts of building and operating a new nuclear power plant on the PSEG Site and the proposed causeway would be sufficient to alter noticeably, but not destabilize, important attributes of existing land uses within the geographic area of interest. Therefore, based on the information provided by PSEG and the review team's independent review, the review team concludes that the cumulative land-use impacts would be MODERATE. This conclusion is based on the acquisition of 85 acres on Artificial Island and the potential of the transmission line corridor to noticeably affect land-use resources in the region. The NRC staff concludes the incremental contribution to cumulative land-use impacts of NRC-authorized activities would contribute to the overall impact in the geographic area of interest.

7.2 Water Use and Quality

This section analyzes the cumulative impacts of a new nuclear power plant at the PSEG Site and other past, present, and reasonably foreseeable projects on water use and water quality.

7.2.1 Water-Use Impacts

This section describes the cumulative water-use impacts from construction, preconstruction, and operation of a new nuclear power plant at the PSEG Site and other past, present, and reasonably foreseeable projects.

7.2.1.1 Impacts on Surface-Water Use

The description of the affected environment in Section 2.3 serves as a baseline for the cumulative impacts assessment for surface-water use. As described in Section 4.2.2, the impacts on surface-water resources from construction and preconstruction activities related to a new nuclear power plant would be SMALL. Also, as stated in Section 5.2.2, the impacts on surface-water resources from operations of a new nuclear power plant would be SMALL.

In addition to impacts from construction, preconstruction, and operations, the cumulative impacts assessment also includes impacts from other past, present, and reasonably foreseeable projects that could affect surface-water use in the vicinity. These projects are listed in Table 7-1. Because the source of surface water for a new nuclear power plant would be the Delaware River, the review team considered the geographic area of interest to be the entire Delaware River Basin. In this analysis, the review team considered all surface-water uses that have occurred in the past, are currently occurring, and are reasonably foreseeable to occur in the future.

Past and present surface-water use in the Delaware River Basin is described in Section 2.3.2. The Delaware River Basin has a long history of water use by the States of New York, New Jersey, Pennsylvania, and Delaware. The Delaware River Basin Commission (DRBC) was created in 1961 through the Delaware River Basin Compact among the Federal government and the four States (DRBC 2004-TN2278). The DRBC is responsible for protecting water quality, allocating and permitting water supply, conserving water resources, managing drought, reducing flood losses, and developing recreation in the Basin (DRBC 2013-TN2366). Surface water from the Delaware River has been extensively used in the past. To better manage the surface-water resources of the Delaware River Basin, the Governors of the four Basin States in 1999 directed the development of a comprehensive water resources plan (DRBC 2004-TN2278). This goal-based plan was developed to manage quantity and quality of the Basin's water for sustainable use, reduce flood losses, improve recreation, and protect riparian and aquatic ecosystems, among other goals. Based on a review of the history of water use and water resources planning in the Delaware River Basin, the review team determined that past and present use of the surface waters in the Basin has been noticeable, necessitating consideration, development, and implementation of careful planning.

To address future water supply demands, the DRBC in its report (DRBC 2008-TN2277) has identified key actions and needs for future water supply planning. The report indicated the need to (1) identify water demand for a growing population, (2) identify alternative sources such as aquifer storage and recovery or reuse, (3) gain a better understanding of irrigation water use, (4) identify water demand for potential growth in thermoelectric power generation, and (5) quantify instream flow needs (DRBC 2008-TN2277). The USACE and DRBC Philadelphia District published water demand projections in the Delaware River Basin through 2030 (USACE

and DRBC 2008-TN3040). Using a subwatershed approach and dividing the Delaware River Basin into 147 study subwatersheds, the USACE and DRBC determined that the peak month water demand in various parts of the Delaware River Basin could range from a greater than 40 percent decrease to a greater than 60 percent increase between 2003 and 2030. Using the 7-day, 10-year low-flow statistic, the USACE and DRBC identified ten subwatersheds as having surface-water supply deficits if the consumptive surface-water use in those subwatersheds exceeds 75 percent of the corresponding low-flow statistic. All ten identified subwatersheds are located in the lower Delaware River Basin. The other subwatersheds were determined to be not deficient in surface-water supply needs.

Of the projects listed in Table 7-1, the ones that were considered for cumulative impacts to the surface-water resource are the continued operation of SGS and HCGS and the Delaware River Main Channel Deepening Project. All other projects listed in Table 7-1 either do not affect the surface-water resource or their surface-water use is insignificant.

The DRBC has permitted the consumptive water use for SGS and HCGS. SGS and HCGS withdraw water from the Delaware River for cooling purposes near the PSEG Site. The water in the Delaware River near the PSEG Site is brackish. The main concern for water withdrawal is that it may induce upstream movement of salt water from the Delaware Bay and therefore affect public water supply intakes located near Trenton, New Jersey. To offset the use of the freshwater component withdrawn by SGS and HCGS, the DRBC requires PSEG to maintain ownership of freshwater in the upstream Merrill Creek reservoir. The DRBC can require PSEG to release freshwater from the Merrill Creek reservoir during declared droughts when the instream flow targets at Trenton, New Jersey, may not be sufficiently met by upstream inflows. PSEG's allocation of freshwater in Merrill Creek may fall approximately 6.9 percent short of that needed for concurrent operations of SGS, HCGS, and a new nuclear power plant at the PSEG Site (see Section 5.2.2.1). However, PSEG has the option to either modify consumptive use of other power plants it owns and supports through its allocation in Merrill Creek reservoir, or to acquire additional storage within Merrill Creek reservoir from other owners (PSEG 2015-TN4280). As stated in Section 5.2.2.1, the review team determined that there is sufficient storage available in the Merrill Creek reservoir for PSEG to meet the requirements of all three plants (SGS, HCGS, and a new nuclear power plant at the PSEG Site) with minor impact to instream flow targets in the Delaware River. Therefore, the review team determined that the cumulative impacts of the three PSEG plants (SGS, HCGS, and a new nuclear power plant) on surface-water resources of the Delaware River Basin would be minor. Furthermore, the Delaware River Main Channel Deepening Project is not expected to affect water use of the Delaware River.

The review team is also aware of the potential climate changes that could affect the water resources available for cooling and the impacts of reactor operations on the water resources for other users. A recent compilation of the state of the knowledge in this area (GCRP 2014-TN3472) has been considered in the preparation of this EIS. The current state of knowledge is dependent upon the computer climate models and assumptions made on future trends in emissions. Projected changes in the climate for the region during the life of a new nuclear power plant at the PSEG Site include an increase in average temperature of 3–4°F and a slight increase in precipitation throughout the year (GCRP 2014-TN3472).

Changes in climate during the life of a new nuclear power plant at the PSEG Site could result in a slight increase in the amount of runoff. At the same time, potential increase in water temperature resulting from climate change could increase evaporative losses.

The USACE and DRBC (USACE and DRBC 2008-TN3040) report was published as a complementary report to the DRBC's Water Resources Plan for the Delaware River Basin. The purpose of the study included establishing a sustainable water use and supply plan for the Basin. The study assumed that the available water supply in the year 2030 would be reduced by 5 percent, an assumption based on a literature review of the current state of knowledge on climate variability and acknowledged by the authors to be an overestimate. The study further assumed that the 25-year baseflow would also be reduced by 5 percent for the year 2030.

The hydrologic changes that are attributed to climate change in these studies are not insignificant nationally or globally. However, while these changes may noticeably alter the resource, the review team did not identify anything that suggests the cumulative impacts would destabilize the water resources locally.

Mainly, because of extensive past and present use of surface waters from the Delaware River, the review team determined that the cumulative impacts to surface-water resources in the geographic area of interest would be MODERATE. However, the review team further concludes that the incremental impact of surface-water use by a new nuclear power plant at the PSEG Site would be SMALL.

7.2.1.2 Impacts on Groundwater Use

The description of the affected environment in Section 2.3 serves as a baseline for the cumulative impacts assessment for groundwater use. As described in Section 4.2.2, the impacts on groundwater resources from construction and preconstruction activities related to a new nuclear power plant would be SMALL. Also, as stated in Section 5.2.2, the impacts on groundwater resources from operations of a new nuclear power plant would be SMALL.

In addition to impacts from construction, preconstruction, and operations, the cumulative impacts assessment also includes impacts from other past, present, and reasonably foreseeable projects that could affect groundwater use in the vicinity. These projects are listed in Table 7-1. Because the source of groundwater for a new nuclear power plant would be the Potomac-Raritan-Magothy (PRM) aquifer system, and because the PRM aquifer system is the most heavily used potable aquifer system in the site area, the review team considered the geographic area of interest to be the PRM aquifer system where groundwater use could affect the PSEG Site or be affected by groundwater use at the PSEG Site. Based on Martin (1998-TN2259), this region of the PRM aquifer system extends from the Fall Line to the Atlantic Ocean and from Camden County, New Jersey, into Delaware. In this analysis, the review team considered all groundwater uses that have occurred in the past, are currently occurring, and are reasonably foreseeable to occur in the future. The geographic area of interest was limited to the PRM aquifer system due to the relative thickness and low conductivity of the overlying confining unit (Martin 1998-TN2259; Dames and Moore 1988-TN3311).

Past and present water use of the entire New Jersey Coastal Plain aquifer system, and the PRM aquifer system in particular, is described in Section 2.3.2 and the U.S. Geological Survey report references therein. Extensive use of the PRM aquifer system in Camden, Gloucester, and Salem Counties, New Jersey, and in New Castle County, Delaware, has noticeably changed the pattern of groundwater flow and reduced groundwater head over the entire region (Martin 1998-TN2259). Concerns over declines in the groundwater and the possible intrusion of saline water led, in 1993, to the designation of Water Supply Critical Area 2 in New Jersey and restriction on withdrawals of water from the PRM aquifer system within New Jersey (Spitz and dePaul 2008-TN2998). This resulted in a recovery of groundwater head elevations within Critical Area 2 by 2003 (Spitz and dePaul 2008-TN2998). In New Castle County, Delaware, in response to droughts in 1999 and 2002, additional development of groundwater resources has alleviated an estimated gap between water supply and demand during drought conditions (DWSCC 2006-TN3041; DWSCC 2006-TN3042). Groundwater heads continued to decrease through 2003 in some PRM aquifer system wells in Delaware (dePaul et al. 2009-TN2948).

Of the projects listed in Table 7-1, the ones that were considered for cumulative impacts to the groundwater resource are the continued operation of SGS and HCGS and the continued regional withdrawal of groundwater from the PRM aquifer system. All other projects listed in Table 7-1 either do not affect groundwater resources or their groundwater use is implicitly considered as part of the regional groundwater withdrawals.

Groundwater withdrawal from the PRM aquifer system for operation of SGS and HCGS averaged 385 gpm from 2002 to 2012 (PSEG 2015-TN4280; NJDEP 2013-TN3223). Normal operational withdrawal for a new nuclear power plant is estimated to be 210 gpm. The combined total of 595 gpm is less than the existing permitted withdrawal rate of 2,900 gpm. Over the course of a year, continuously pumping 595 gpm would exceed by about 3 percent the existing permitted total diversion limit of 300 million gallons. When the reactor technology is selected, PSEG would reevaluate withdrawal against permitted limits. The existing permit would be modified to account for a new nuclear power plant if these withdrawals do not cause the existing limits to be exceeded. Or, a new permit with a higher withdrawal rate would be obtained by PSEG (2015-TN4280).

Regionally, groundwater heads appear to be fairly stable except near major pumping centers. No substantial change in heads was observed (i.e., head change was less than ±5 ft) over the periods 1988–2003 and 1998–2003 in all of Salem County except for a small area nearest major New Castle County pumping (dePaul et al. 2009-TN2948). As described in Section 2.3.1.2, water levels in SGS and HCGS observation wells in the PRM aquifer system varied in response to site pumping over a range of about 40 ft during the period 2003–2013.

As described in Section 5.2.2.2, pumping to support the operation of a new nuclear power plant is expected to produce an additional drawdown in groundwater heads. Although the additional drawdown was estimated in Section 5.2.2.2 to be about 14 ft at a distance of 5 mi from the pumping, the review team expects that it would be less than this in practice due to leakage from overlying and underlying aquitards and aquifers. The interpretation provided in 5-year synoptic reports of groundwater levels (Lacombe and Rosman 2001-TN4194; Lacombe and Rosman 1997-TN4195; Rosman et al. 1995-TN4196; Eckel and Walker 1986-TN4197; Walker 1983-TN4198) is that past and current HCGS/SGS pumping in the middle PRM aquifer reduces

groundwater heads by about 20 ft at a distance of 3 mi from the site. The review team expects that a 55 percent increase in the combined pumping at the site (i.e., from 385 to 595 gpm) would increase the drawdown from the current pumping by about 55 percent. While this would expand the area impacted by site pumping, it is not expected to pose a risk of dewatering offsite wells screened in the middle PRM aquifer. The relative isolation of the site from nearby groundwater users leads the review team to conclude that the cumulative impact from the combined pumping would be minor.

Groundwater recharge throughout the area is likely to be affected by changes in temperature and precipitation resulting from climate change. The review team is unable to determine specific changes in the amounts or pattern or future recharge. However, groundwater withdrawals are permitted by state and regional agencies, and noticeable changes in groundwater conditions have been managed successfully in the past. The review team assumes that permits for future withdrawals will consider changing conditions to prevent destabilization of the groundwater resource.

Based on the information provided above, the review team determined that the past and current regional groundwater withdrawals have noticeably altered the groundwater resource throughout the area of interest. Therefore, the review team concludes that the cumulative groundwater-use impacts of past, present, and reasonably foreseeable future projects, including climate change, would be MODERATE. The incremental impacts from NRC-authorized activities would be SMALL.

7.2.2 Water-Quality Impacts

This section describes the cumulative water-quality impacts from construction, preconstruction, and operation of a new nuclear power plant and other past, present, and reasonably foreseeable projects.

7.2.2.1 Impacts on Surface-Water Quality

The description of the affected environment in Section 2.3 serves as the baseline for the cumulative impacts assessment for surface-water quality. As described in Section 4.2.3, surface-water-quality impacts from construction and preconstruction activities related to a new nuclear power plant at the PSEG Site would be SMALL. Also, as stated in Section 5.2.3, surface-water-quality impacts from operation of a new nuclear power plant at the PSEG Site would be SMALL.

In addition to impacts from construction, preconstruction, and operation of a new nuclear power plant, the cumulative impacts assessment also includes impacts from other past, present, and reasonably foreseeable projects that could affect surface-water quality in the vicinity. These projects are listed in Table 7-1. Because a new nuclear power plant would discharge plant blowdown and other wastewater streams to the Delaware River, the review team considered the geographic area of interest to be the entire Delaware River Basin. In this analysis, the review team considered all actions that have occurred in the past, are currently occurring, and are reasonably foreseeable to occur in the future that may affect surface-water quality.

The surface-water quality of the Delaware River Basin is described in Section 2.3.3. Section 2.3.3 also describes the water-quality assessment reports published by the DRBC and the DRBC's planning and regulation of water quality in the Delaware River Basin. Although there have been improvements in water quality (e.g., improved levels of dissolved oxygen) in the Delaware River Basin because of careful planning and management policies put in place by the DRBC, the presence of toxic compounds has led to advisories for fish consumption (DRBC 2008-TN2277). Zone 5 of the Delaware River, within which the PSEG Site is located, is listed by DRBC as not supporting the aquatic life designated use (DRBC 2012-TN2279). Because continuing issues in the Delaware River Basin related to water quality have resulted in careful planning and management, the review team determined that the water-quality impact on the Delaware River Basin from past and present actions is noticeable but water quality is improving.

As discussed in Section 5.2.3.1, water temperature in the Delaware River (the areas just outside the HCGS heat dissipation area [HDA] and where the excess temperature from the discharge for a new nuclear power plant would reach 1.5°F) could frequently (more than half of the days) exceed 86°F when all units of SGS, HCGS, and a new plant are operating. The area affected by the combined thermal plumes from SGS, HCGS, and the proposed new plant would be small, localized, and completely contained within the SGS HDA. Also, while reviewing the New Jersey Pollutant Discharge Elimination System (NJPDES) application for a new discharge to the Delaware River, DRBC and the New Jersey Department of Environmental Protection (NJDEP) would have the opportunity to designate an HDA for a new nuclear power plant and require discharge rules that would protect the aquatic environment. Therefore, the review team determined the combined discharges from SGS, HCGS, and a new nuclear power plant would not noticeably affect the Delaware River.

Disturbance of bottom sediment while dredging operations are ongoing for the Delaware River Main Channel Deepening Project could affect turbidity and water quality in the Delaware River. However, these effects would be localized near the area actively being dredged, and the disturbed sediment would settle down soon after the activity ceases. Because the effects of the Delaware River Main Channel Deepening Project on Delaware River water quality are expected to be temporary and localized, the review team determined that these effects would be minor.

The review team also evaluated the impact of potential climate changes on water quality as well as the cumulative impact that climate change and reactor operations could have on the quality of water resources for other uses. As mentioned in Section 7.2.1, potential climate change scenarios discussed in a recent compilation of the state of the knowledge in this area (GCRP 2014-TN3472) and a study for the Delaware River Basin (USACE and DRBC 2008-TN3040) were considered during the preparation of this EIS.

Climate change could also potentially impact surface-water quality, such as Delaware River salinity. The study report (USACE and DRBC 2008-TN3040) describes the result of the salinity numerical model for the Delaware River conducted in 2007, as part of the Delaware Deepening Project. The model, based on conservative assumptions for year 2040, predicted that the salinity would increase at Delaware RM 98 but still would remain below current and possible future standards. The review team therefore concludes that the impacts of climate change to surface-water quality would be minor.

Based on the information provided above, the review team determined that the surface-water-quality impacts within the geographic area of interest have been noticeably affected by past and present actions. Therefore, the review team concludes that the cumulative surface-water-quality impacts of past, present, and reasonably foreseeable future projects, including climate change, would be MODERATE. However, the incremental impacts of building and operating a new nuclear power plant would not contribute significantly to the overall cumulative impacts in the geographical area of interest. Therefore, the incremental impacts to surface-water-quality from NRC-authorized activities would be SMALL, and no further mitigation would be warranted.

7.2.2.2 Impacts on Groundwater Quality

The description of the affected environment in Section 2.3 serves as a baseline for the cumulative impacts assessment for groundwater quality. As described in Section 4.2.3, groundwater-quality impacts from construction and preconstruction activities related to a new nuclear power plant would be SMALL. Also, as stated in Section 5.2.3, groundwater-quality impacts from operations of a new nuclear power plant would be SMALL.

In addition to impacts from construction, preconstruction, and operations, the cumulative impacts assessment also includes impacts from other past, present, and reasonably foreseeable projects within the geographic area of interest that could affect groundwater quality. Of the projects listed in Table 7-1, the continued operation of SGS and HCGS and the continued regional withdrawal of groundwater from the PRM aquifer system are the ones considered for cumulative impacts to groundwater quality. All other projects listed in Table 7-1 either do not affect groundwater quality, are at such a distance from the PSEG Site that there would be no interaction with a new nuclear power plant, or their impact on groundwater quality is implicitly considered as part of the regional groundwater withdrawals.

The groundwater quality of the shallow water-bearing units in the vicinity of the site is described in Section 2.3.3. The existing SGS and HCGS have impacted shallow groundwater quality, but these impacts have been minor and have been limited to the immediate vicinity of the PSEG Site. The *Generic Environmental Impact Statement for License Renewal of Nuclear Plants–Supplement 45: Regarding Hope Creek Generating Station and Salem Nuclear Generating Station, Units 1 and 2—Final Report* (NRC 2011-TN3131) and Section 2.3.3 of this EIS describe a tritium leak at SGS that has impacted groundwater in the alluvium and the Vincentown aquifer. In general, tritium concentrations have declined in response to groundwater remediation efforts, and most concentrations are at or below one-half the EPA drinking water standard of 20,000 pCi/L (ARCADIS 2012-TN3310; ARCADIS 2014-TN4207). The available information indicates that the response to the tritium leak has been successful in limiting the impact of the leak on groundwater quality to the immediate area of the existing plants. Impacts of the existing plants on groundwater are also limited because groundwater in the alluvium and the Vincentown aquifer is saline and not suitable for potable use and discharges to the Delaware River. Low-permeability units underlying the Vincentown aquifer limit the potential for vertical movement of contaminants to deeper, potable aquifers.

Routine discharges to groundwater are not planned at a new nuclear power plant. Potential impacts to groundwater quality could come from inadvertent spills that could migrate to the shallow water zones. Best management practices (BMPs) would be used during operations to

minimize the area affected. If a spill occurs, NJDEP requires that it be reported and remediated to minimize or prevent groundwater impacts. The site grade would contain engineered fill of low permeability, which would further limit the risk of groundwater contamination. Based on the natural system, site-management practices, and regulatory oversight, the review team concludes that impacts of inadvertent chemical or radiological releases to groundwater from a new nuclear power plant at the PSEG Site would be contained to the immediate area. As a result, the cumulative impacts of inadvertent releases would be minor.

The groundwater quality of the regional PRM aquifer system is described in Section 2.3.3. The major groundwater-quality concern in the PRM aquifer system is saline intrusion due to large-scale groundwater withdrawals. As described in Sections 2.3.1.2 and 7.2.1.2, the regional reductions in groundwater heads in the PRM aquifer system have been attributed to major groundwater pumping centers in New Jersey and Delaware (dePaul et al. 2009-TN2948). Designation of Water Supply Critical Area 2 in New Jersey and the associated restrictions on water withdrawals from the PRM aquifer system were motivated by concerns of saltwater intrusion from the Delaware River near the Fall Line, where the PRM aquifer system is recharged, and from the Atlantic Ocean side of the aquifer. Salinity intrusions near the recharge areas due to pumping are localized (Navoy et al. 2005-TN3234). As a result, the PSEG Site is not likely to be impacted by or to impact saltwater intrusion from the Delaware River because of the site's distance from the Fall Line and aquifer recharge areas. Section 2.3.3 and Dames and Moore (1988-TN3311) indicate that past and current pumping for HCGS and SGS operations has not significantly impacted chloride concentrations in the HCGS and SGS pumping wells. Pope and Gordon (1999-TN3006) simulated the future movement of the freshwater–saltwater interface in response to a hypothetical 30 percent increase in withdrawals from the major pumping centers. They found that the increased pumping resulted in minimal movement of the seaward freshwater–saltwater interface (i.e., less than 5 ft in the middle PRM aquifer) and concluded that on a regional scale the location and movement of the interface was more sensitive to the historical sea level than to the amount of groundwater pumping. Because the increase in groundwater pumping for a new nuclear power plant would be minimal compared to the increase in regional pumping considered in Pope and Gordon (1999-TN3006), the review team concludes that a new nuclear power plant's cumulative impact on groundwater quality would be minor.

The review team considered climate change effects including sea-level rise on groundwater quality. As described in Pope and Gordon (1999-TN3006), the freshwater–saltwater interface in the New Jersey Coastal Plain aquifer system is most responsive to changes in sea level. The interface is currently moving inland in response to significant past sea-level rise, but this response is very slow (Pope and Gordon 1999-TN3006). As sea level continues to rise as a result of climate change, the response would continue to be slow. Therefore, the review team concludes that saltwater intrusion from sea-level rise over the license period of a new nuclear power plant at the PSEG Site would have a minor impact on groundwater quality.

Based on the information provided above, the review team determined that groundwater withdrawals within the geographic area of interest have noticeably altered the groundwater quality in localized areas where pumping occurs near aquifer recharge areas. Therefore, the review team concludes that the cumulative groundwater-quality impacts of past, present, and reasonably foreseeable future projects, including climate change, would be MODERATE.

Because the PSEG Site is a significant distance from the PRM aquifer system recharge areas, pumping at the site would not result in a noticeable change to groundwater quality. Therefore, the review team concludes that the incremental groundwater-quality impacts from NRC-authorized activities would be SMALL.

7.3 Ecology

This section addresses the potential cumulative impacts on ecological resources from building and operating a new nuclear power plant at the PSEG Site. The evaluation of cumulative impacts also includes consideration of other past, present, and reasonably foreseeable future activities within the geographic area of interest. Section 7.3.1 discusses the cumulative impacts to terrestrial ecological resources, and Section 7.3.2 discusses the cumulative impacts to aquatic ecological resources.

7.3.1 Terrestrial and Wetlands Resources

The description of the affected environment in Section 2.4.1 provides the baseline for the cumulative impacts assessments for terrestrial and wetland ecological resources. As described in Section 4.3.1, the review team concluded that the combined impacts of construction and preconstruction would be MODERATE, and no further mitigation would be warranted. As described in Section 5.3.1, the review team concluded that the impacts of operations on terrestrial and wetland resources would be SMALL.

In addition to impacts from construction, preconstruction, and operation, the following cumulative analysis also considers other past, present, and reasonably foreseeable projects that could affect the same terrestrial and wetland ecological resources affected by building and operating a new nuclear power plant at the PSEG Site. Direct and indirect impacts to terrestrial and wetland resources resulting from the building and operation of a new nuclear power plant on the PSEG Site and the proposed causeway would be limited to Salem County, New Jersey. However, the cumulative impacts on terrestrial and wetland resources, when combined with other actions, would extend to areas within the Middle Atlantic Coastal Plains, Northern Piedmont, and Atlantic Coastal Pine Barrens ecoregions. For purposes of this cumulative analysis, the geographic area of interest for terrestrial and wetland resources is defined as the Middle Atlantic Coastal Plains, Northern Piedmont, and Atlantic Coastal Pine Barrens Level III ecoregions within 50 mi of the PSEG Site. This geographic ROI includes Salem County, New Jersey, and other counties, or portions of counties, in New Jersey, Delaware, Pennsylvania, and Maryland. Table 7-1 lists those projects that would contribute to terrestrial and wetland resources impacts within the geographic ROI.

7.3.1.1 Cumulative Impacts to Terrestrial and Wetland Habitats and Wildlife

The Atlantic Coastal Plains in the geographic ROIs consist of the Middle Atlantic Coastal Plain, Northern Piedmont, and Atlantic Coastal Pine Barrens. The Middle Atlantic Coastal Plain has relatively flat topography and consists of swampy, marshy, and frequently flooded areas. Upland areas are dominated by loblolly-shortleaf pine forests, and lowland and tidally influenced areas support tidal marshes, swamps, floodplain forests, and pocosins. Marshes are dominated by cord grass and salt-meadow grass. The Northern Piedmont is characterized by irregular

plains and low hills. It is dominated by mixed oak, chestnut oak, hemlock-mixed hardwood, and sugar maple-mixed hardwood forests. The Atlantic Coastal Pine Barrens are a low undulating part of the Atlantic Coastal Plain. Native habitat in this area consists of pine-oak woodlands, mixed oak and beech-oak forests, salt marshes, swamps, freshwater marshes, and floodplains (Woods et al. 2007-TN3227).

The Atlantic Coastal Plains ecoregion has been significantly altered since the beginning of European settlement in the 1600s as a result of agriculture, silviculture, and urban development. The geographic ROI includes the same habitat types as are found in the 6-mi vicinity of the PSEG Site. As discussed in Section 2.4.1.1, habitats within the 6-mi vicinity of the site include barren land, developed land, cultivated cropland, pasture hay, deciduous forest, evergreen forest, mixed forest, emergent herbaceous wetland, woody wetland, and open water. However, the overall percentages of each habitat differ when expanding from the 6-mi vicinity to encompass the geographic ROI. Open water associated with the Delaware River, Delaware Bay, and other open water areas occupies 791,821 ac (15.7 percent) of the area. Emergent herbaceous wetland occupies 199,603 ac (4.0 percent), and woody wetland occupies 279,248 ac (5.5 percent). Agricultural land consisting of cultivated cropland (1,075,101 ac) and pasture/hay (774,432 ac) accounts for 36.8 percent of the land cover. Deciduous forest occupies 1,028,552 ac (20.5 percent) of the habitat in the geographic ROI. Developed lands, which include high, medium, low, and open space developed land, occupy 630,983 ac (12.6 percent). Barren lands account for 54,142 ac (1.1 percent) of the landcover. Evergreen and mixed forest habitat accounts for 190,352 ac (3.8 percent) of landcover in the geographic ROI (PSEG 2015-TN4280).

The USACE created Artificial Island in the early 1900s with the authorization of the Rivers and Harbors Appropriation Act of 1899 (33 USC 403 et seq. –TN660). The act authorized the creation of a 30-ft channel from Philadelphia to the Delaware Bay and covered 56 mi of proposed channel. The amount of material to be removed was estimated at 34,953,000 yd^3 of dredge material and 24,000 yd^3 of rock. Six locations, including Baker Shoal and Stony Point Shoal, were evaluated as potential disposal sites. Baker Shoal and Stony Point Shoal were enclosed in 1900 by bulkheads to form a deposit basin now known as Artificial Island (Snyder and Guss 1974-TN2280). Since the development of Artificial Island, several dredging projects have altered the terrestrial and wetland ecology of the region.

Currently, the USACE is deepening the existing Delaware River Federal Navigation Channel from 40 to 45 ft from Philadelphia, Pennsylvania, and Camden, New Jersey, to the mouth of the Delaware River (USACE 2013-TN2665). The USACE Delaware River Main Channel Deepening Project would require the use of a site to dispose of dredge material, and the USACE proposes to dispose of this dredge material at the Fort Mifflin CDF. The USACE determined that the planned impacts are consistent with previous actions and would not result in significant impacts to the affected environment (USACE 2013-TN2665). Similarly, current operations at both the SGS and HCGS (including maintenance dredging for the intake and/or outfall structures) would require a location for disposing of dredge material, and a disposal site also would be needed for dredge material from developing a new barge access area for a new nuclear plant at the PSEG Site. The dredge material associated with a new nuclear plant would be disposed of on the site or at an approved upland disposal facility.

The cumulative impact contribution to terrestrial and wetland resources associated with the acquisition by PSEG of the 85-ac Artificial Island CDF would be dependent on the USACE's actions to develop a new CDF and could add to the overall cumulative impacts for the geographic ROI. The current Artificial Island CDF contains low-quality terrestrial and wetland habitat, and the addition of a new CDF has the potential to affect habitat of higher quality in another location. The USACE has evaluated the potential environmental impacts of a new CDF to replace the Artificial Island CDF (USACE 2015-TN4231) and has concluded that the principal impacts resulting from development of a new CDF would be the unavoidable impact of filling 0.8 ac of Federally nonjurisdictional wetlands and open waters in a drainage ditch internal to the new CDF site and the potential for water-quality impacts due to CDF operations. The overall impacts on existing wildlife and other terrestrial or aquatic resources would be minimal as the new CDF site design includes provisions to address water-quality impacts (USACE 2015-TN4231).

Therefore, the effects on terrestrial and wetland habitat would be expected to be similar to, and consistent with, those of the Delaware River Main Channel Deepening Project and those of the aforementioned development of a new CDF to replace the existing Artificial Island CDF. Consequently, the review team determined that the cumulative impact on terrestrial and wetland ecology habitats from dredging activities as a result of building and operating a new nuclear power plant at the PSEG Site in conjunction with past, present, and reasonably foreseeable dredging activities would be minimal.

Most of the other operational projects listed in Table 7-1 have resulted in the reduction, fragmentation, and degradation of terrestrial and wetland habitat in the geographical ROI. These projects include several fossil-fuel energy facilities such as Delaware City Refinery, Deepwater Energy Center, Carneys Point Generating Plant, Pedricktown Combined Cycle Cogeneration Plant, Cumberland County Landfill Gas-to-Energy Plant, Vineland Municipal Electric Utility, Sherman Avenue Energy Center, Carl's Corner Energy Center, and Cumberland Generating Station. Additionally, there are four operating nuclear power plants located in the geographic ROI that have contributed to adverse cumulative effects to terrestrial and wetland resources, including HCGS, SGS, Peach Bottom Atomic Power Station, and Limerick Generating Station. The Salem County Solid Waste Landfill also operates in this region. These facilities are expected to have continuing impacts to terrestrial and wetland resources in the ROI during the operational period of a new nuclear power plant at the PSEG Site.

Future residential development and further urbanization of the area would result in the continued increase in fragmentation and loss of habitat. The New Jersey Department of Labor and Workforce Development projects that the population of Salem County will increase by approximately 5 percent between 2010 and 2030. The population of the geographic ROI is also expected to increase from 2010 and 2030 (NJLWD 2014-TN3332). Future urbanization in the geographic ROI could result in further losses of agricultural lands, wetlands, and forested areas. Urbanization would reduce areas in natural vegetation and open space and would decrease connectivity among wetlands, forests, and other wildlife habitat. The loss of habitats as a result of urbanization would result in added pressures to the remaining habitat available for wildlife populations. However, it is not expected that these activities would substantially affect the overall availability of wildlife habitat or travel corridors near the geographic ROI.

Some of the projects listed in Table 7-1 include site redevelopment. These projects include redevelopment resulting from a Base Realignment and Closure (BRAC) for Camp Pedricktown, Shieldalloy site decommissioning, the Gateway Business Park, and the Millville Municipal Airport. The Camp Pedricktown Redevelopment and Shieldalloy facility are currently developed/disturbed sites. In addition, the Gateway Business Park, located in Oldmans Township, Salem County, is a light industrial complex consisting of 284 acres. The business park is planning to develop three sites totaling approximately 25 acres. The site is mostly developed with little terrestrial and wetland habitat available (Matrix Development Group 2008-TN3273). The proposed Millville Municipal Airport Improvements would refurbish the apron terminal at the airport. These projects are not expected to further degrade or fragment terrestrial and wetland ecology resources within the geographic ROI.

The transmission service provider has determined that a new transmission line and ROW is needed to support grid stability in the geographic ROI. In its ER (PSEG 2015-TN4280), PSEG conducted a study of a hypothetical 5-mi-wide macro-corridor known as the WMC and transmission line ROW that extends 55 mi from the PSEG Site to the Peach Bottom Substation in Pennsylvania. The transmission line ROW within the corridor is expected to be 200 ft wide. The development of the transmission line corridor would cause disturbances to over 1,500 ac of land. Habitats that could be affected include barren land, deciduous forests, evergreen forests, mixed forest, agricultural land, woody wetlands, and emergent wetlands (PSEG 2015-TN4280). The corridor would be expected to follow existing ROWs to the extent practicable. However, the exact amounts of terrestrial and wetland habitat that would be affected are not known, and it is expected that the project would cause fragmentation and degradation of these resources. The amount of terrestrial and wetland resources affected by the grid stability line would not be a significant amount of the available terrestrial and wetland resources in the region, but mitigation may be required by entities issuing permits for the project.

The report on global *Climate Change Impacts in the United States*, provided by the U.S. Global Change Research Program (GCRP), summarizes the projected impacts of future climate changes in the United States (GCRP 2014-TN3472). The report divides the United States into nine regions, and the PSEG Site is located in the Northeast region. The GCRP climate models for this region project temperatures to rise 2.5 to 4ºF in the winter and 1.5 to 3.5ºF in the summer over the next several decades. Winters are projected to be much shorter with fewer cold days and more precipitation. Cities that currently experience few days above 100ºF each summer would average 20 or more days. Hot summer conditions would come three weeks earlier and last three additional weeks into the fall. Sea level is projected to rise more than the global average, with more frequent, severe flooding and heavy downpours. These projected changes potentially could alter wildlife habitat and the composition of wildlife populations. Large-scale shifts in the ranges of wildlife species and the timing of seasons and animal migration that are already occurring are very likely to continue (GCRP 2014-TN3472).

As described in Section 5.3.1.1, the cooling system for a new nuclear power plant at the PSEG Site would pose the most significant risk to vegetation during operations. These types of structures have the potential to produce salt deposition and increased fogging, icing, humidity, and/or precipitation. Other facilities listed in Table 7-1 that would have similar effects include HCGS, Limerick Generating Station, and potentially the fossil-fuel electricity generating stations. Most native vegetation that comprises the Atlantic Coastal Plains has a medium to high salinity

tolerance, and vegetation damage would be localized to the facility's site. Increased fogging, icing, humidity, and/or precipitation as a result of operating these facilities are expected to be low.

In Section 5.3.1.1, the review team determined that avian mortality as a result of collisions with the natural draft cooling tower design could occur but would not result in a significant decline in avian populations. Additionally, bat species could experience mortality as a result of collisions with human-made structures on the PSEG Site, but collisions are not a significant source of overall population declines (Erickson et al. 2002-TN771). Likewise, other existing and proposed structures for projects listed in Table 7-1 would be expected to have similar effects. The highest rates of mortality as a result of avian collisions occurred with structures taller than 300 ft (Kerlinger 2000-TN3188). A few of the projects listed in Table 7-1 could have structures reaching these heights. PSEG submitted a report on avian collisions at HCGS to the NJDEP in 1987. At the end of the study period, PSEG concluded that the approximately 600-ft-tall HCGS cooling towers appeared to be an insignificant source of bird collisions and mortality. There were a total of 30 mortalities at the PSEG Site during the yearlong study lasting from February 1985 to January 1986, and no Federally or State-listed endangered or threatened species were among the mortalities listed (PSEG 1987-TN2893).

Literature regarding bat collisions with cooling tower structures is limited. However, several studies have been completed regarding bat collisions with other human-made structures. Mortalities as a result of collisions with television and communications facilities were recorded involving eastern red (*Lasiurus borealis*), hoary (*Lasiurus cinereus*), and silver-haired (*Lasionycteris noctivagans*) bats. Similarly, bats have been known to collide with tall buildings. Bat mortalities as a result of collisions with wind turbines are well documented. Over 360 bats were collected from wind turbines in Minnesota, and the highest mortality rate of 32 bat mortalities per three wind turbines was recorded at a single wind turbine in Tennessee. Most of the mortalities occurred in late summer to early fall and involved mostly migratory tree bats species. Erickson et al. (2002-TN771) suggests that bat species may not use echolocation during migration, which can result in higher collision rates with human-made structures. Fewer collisions occurred with resident bat populations that forage near these structures. Projects listed in Table 7-1 potentially having structures taller than 500 ft are spread out through the region and would not be expected to cause significant declines in avian populations. Projects listed in Table 7-1 could affect migratory bat routes, and bat mortality as a result of collisions may be expected. However, evidence suggests that bat collisions with human-made structures are not a significant source of population declines (Erickson et al. 2002-TN771).

Avian and bat mortality as a result of collisions with transmission lines is also a concern. Avian and bat collisions with transmission systems are dependent on site-specific variables such as nesting, bat migration routes, foraging, and roosting. In addition, line orientation to flight patterns and movements, species composition, and line design are factors in avian and bat collisions. The NRC has determined that bird collisions with transmission lines are more likely to occur with large-bodied species such as raptors, while smaller species such as songbirds are more likely to collide with towers (NRC 2013-TN2654). Erickson et al. (2002-TN771) indicated that migrating bats are susceptible to collisions with human-made structures, and foraging bats would be less likely to have collisions. The proposed grid stability line would have similar impacts over a larger area. It is expected that the proposed grid stability line would comply with

Migratory Bird Treaty Act (16 USC 703 et seq. –TN3331) requirements. Avian mortality as a result of collision with transmission systems is not expected to be a significant source of population declines. The transmission system potentially could cross migratory routes of bat species, and mortalities could result from collisions with these structures. However, bat collisions with human-made structures would not be expected to cause a decrease in the overall population of bats (Erickson et al. 2002-TN771).

Increased traffic as a result of the projects listed in Table 7-1 and urban development could result in declines of wildlife populations if roadkill rates exceed the rates of reproduction and immigration in the geographic ROI. However, roadkills occur frequently, and wildlife populations are not significantly affected (Forman and Alexander 1998-TN2250).

The review team has determined that the cumulative effects to terrestrial and wetland habitat and wildlife of past, present, and reasonably foreseeable future projects presented above, including a new nuclear power plant at the PSEG Site, in the geographical ROI would be noticeable but not destabilizing. Building and operating a new nuclear power plant at the PSEG Site would not be a significant source of the impacts.

7.3.1.2 Cumulative Impacts to Important Terrestrial and Wetland Species and Habitats

The discussion of important species and habitat, as defined by the NRC in NUREG–1555, for the PSEG Site and vicinity in Section 2.4.1.3 is applicable to the geographic area of interest defined for the cumulative impact assessment (NRC 2013-TN2654). Future urban and industrial development, new transmission corridors, and the effects of other projects potentially may affect important species in the geographic area of interest, primarily by decreasing or degrading the available habitat for these species. Several projects listed in Table 7-1 have the potential to degrade wetlands. Impacts from development, new transmission corridors, and potential effects of other projects would noticeably alter, but not destabilize, important species and habitat in the geographic area of interest.

Seven birds of prey have been identified as important species in the geographical area of interest for cumulative impacts. These include Cooper's hawk (*Accipiter cooperii*), red-shouldered hawk (*Buteo lineatus*), northern harrier (*Circus cyaneus*), bald eagle (*Haliaeetus leucocephalus*), osprey (*Pandion haliaetus*), American kestrel (*Falco sparverius*), and peregrine falcon (*Falco peregrinus*). Although impacts to these species resulting from a new nuclear power plant are expected to be minimal, the degree of effect on these species could increase when considering overall cumulative impacts on habitats with further development in the geographical area of interest. Potential impacts would include fragmentation of habitat. Additional fragmentation and loss of forested habitat could further impact Cooper's hawk and red-shouldered hawk. Additional loss of open field habitat could further impact American kestrel. Cumulative loss of wetland habitat could have additional impacts on bald eagle, osprey, and northern harrier.

Impacts to waterfowl, wading birds, and other waterbirds resulting from a new nuclear plant on the PSEG Site were found to be negligible. However, the cumulative loss of wetlands habitat as a result of development in the geographical area of interest could result in additional impacts to these species. This would include potential cumulative impacts to recreationally valuable

waterfowl species, Federally listed rufa red knot (*Calidris canutus rufa*), State-listed wading birds, and other listed waterbirds (e.g., pied-billed grebe [*Podilymbus podiceps*]). The nearest known occurrences of the Federally listed threatened rufa red knot are in adjacent Cumberland County, New Jersey and Kent County, Delaware. The rufa red knot has the potential to be impacted by habitat disturbance and collisions with human-made structures. Incremental loss and fragmentation of contiguous open field habitat potentially could impact State-listed passerine species such as horned lark (*Eremophila alpestris*), bobolink (*Dolichonyx oryzivorus*), eastern meadowlark (*Sturnella magna*), grasshopper sparrow (*Ammodramus savannarum*), and savannah sparrow (*Passerculus sandwichensis*).

Although the PSEG Site does not contain suitable habitat for the Federally threatened (State-listed endangered) bog turtle, the potential grid stability transmission lines along with other actions taken in the geographical area of interest could result in impacts to this species. This is also true for the State endangered eastern tiger salamander (*Ambystoma tigrinum tigrinum*).

The PSEG Site does not contain suitable habitat for the Federally threatened northern long-eared bat (*Myotis septentrionalis*). Habitat does exist in the vicinity of the site and in the geographical ROI. The proposed transmission line project to support grid stability has the potential to transect hibernacula, roosting, and foraging habitat important to the northern long-eared bat. The PSEG analysis of the WMC indicated that a new transmission line could cross 294 ac of forestland in the region. However, the exact routing of the transmission corridor is not known, and a greater proportion of forestland could be affected. Northern long-eared bats summer roost in forest habitats that include species of black oak (*Quercus velutina*), northern red oak (*Quercus rubra*), silver maple (*Acer saccharinum*), black locust (*Robinia pseudoacacia*), American beech (*Fagus grandifolia*), sugar maple (*Acer saccharum*), sourwood (*Oxydendrum arboreum*), and shortleaf pine (*Pinus echinata*). Additionally, forestland habitat is important to the northern long-eared bat's foraging methods (78 FR 61046-TN3207). However, the primary threat to the northern long-eared bat is from white nose disease, and more than 1,000,000 ac of forest habitat exist in the region (Table 2-2). Thus, the review team concludes that impacts to the northern long-eared bat could be noticeable, but not destabilizing.

The extent of potential cumulative impacts on listed species would be dependent on the extent to which BMPs are implemented for the various projects in the geographical area of interest. Mitigation or avoidance of sensitive habitat would be an important factor in determining the extent of potential impacts.

The proposed new transmission line to support grid stability has the potential to cross freshwater woody and emergent wetlands. The amount of these wetlands that would be disturbed is unknown at this time. However, impacts to freshwater woody and emergent wetlands may be unavoidable. The addition of the new transmission corridor potentially could cross over 14 mi of stream (PSEG 2015-TN4280). Additionally, future urbanization could result in some limited losses of wetlands and streams. State and/or Federal regulations would provide protection of wetlands and streams from future ROW development and urbanization. However, the impacts to terrestrial and wetland resources from these activities would be noticeable.

Summary

Potential cumulative impacts on terrestrial and wetland resources in the PSEG Site vicinity would result from loss of vegetation as well as loss and fragmentation of wildlife habitat. Such impacts would increase with the continued development of the geographical area of interest. Overall, when combined with other past, present, and reasonably foreseeable future actions, the cumulative impacts to terrestrial and wetland resources resulting from building and operating a new nuclear power plant on the PSEG Site and the proposed causeway would be noticeable but would not be expected to cause significant wildlife species population or ecosystem impacts within the geographic ROI. Therefore, based on the information provided by PSEG and the review team's independent review, the review team concludes that cumulative impacts of past, present, and reasonably foreseeable future actions including climate change on terrestrial and wetland resources would be MODERATE for the geographic ROI. The MODERATE impact level is based primarily on the cumulative impacts to important wetland and forest resources associated with the new transmission line to support grid stability. The NRC-authorized activities associated with building and operating a new nuclear power plant at the PSEG Site would contribute to the MODERATE impact level.

7.3.2 Aquatic Ecosystem

The description of the affected environment in Section 2.4.2 serves as the baseline for the cumulative impacts assessment for aquatic ecological resources. As described in Section 4.3.2, the impacts from NRC-authorized construction activities on aquatic ecological resources would be SMALL, and no further mitigation would be warranted. As described in Section 5.3.2, the review team concludes that the impacts of operations and maintenance on aquatic resources inhabiting the Delaware River Estuary and marsh creeks would be SMALL, and no further mitigation would be warranted.

The combined impacts on aquatic resources from construction and preconstruction are described in Section 4.3.2 and were determined to be SMALL, provided PSEG complies with BMPs required for Federal and State permitting. In addition to the impacts from construction, preconstruction, and operations, the cumulative analysis considers other past, present, and reasonably foreseeable actions that could affect aquatic ecology. These projects are listed in Table 7-1. For this analysis, the geographic area of interest is considered to be water bodies connected to the PSEG Site, the onsite desilt basins and small marsh creeks, the marsh creek system associated with the proposed causeway, and the tidal Delaware River Estuary. The water bodies crossed by a potential transmission line corridor are also included in the geographic area of interest.

A wide variety of historical events have affected the Delaware Estuary and River Basin and its resources (Berger et al. 1994-TN2127). As Europeans began settling the estuary region early in the 17th century, agriculture expanded, and the clearing of forest led to erosion. Dredging, diking, and filling gradually altered extensive areas of shoreline and tidal marsh. By the late 1800s, industrialization had altered much of the watershed of the upper estuary, and fisheries were declining due to overfishing as well as pollution from ships, sewers, and industry. By the 1940s, anadromous fish were blocked from migrating upstream to spawn due to a barrier of low oxygen levels in the Philadelphia area. This barrier, combined with small dams on tributaries,

nearly destroyed the herring and shad fisheries. A large increase in industrial pollution in the early-to-mid 1900s resulted in the Delaware River near Philadelphia becoming one of the most polluted river reaches in the world. Major improvements in water quality began in the 1960s and continued through the 1980s as a result of State, multi-State, and Federal actions, including the Clean Water Act (33 USC 1251 et seq. –TN662) and the activities of the DRBC (PDE 2012-TN2191). The Delaware Estuary and River Basin is the subject of numerous restoration activities and projects under the purview of the Partnership for the Delaware Estuary, the DRBC, and numerous research and academic institutions. In its 2012 annual report, the Partnership for the Delaware Estuary suggested that the overall environmental conditions of the region were fair (PDE 2012-TN2191). Since 2008, some conditions were found to be declining in areas such as sediment removal impairing estuarine habitats and a decline in young-of-year Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*), and some areas were seeing improvements such as a reduction of total organic carbon and an increase in Striped Bass (*Morone saxatilis*) populations (PDE 2012-TN2191).

Other actions in the vicinity that have present and reasonably foreseeable future impacts on the Delaware River Estuary include the continued operation of SGS and HCGS, completion of USACE dredging operations for the Delaware River Main Channel Deepening Project, and potential PJM construction of a new transmission corridor and transmission line for grid stability. Planning and development for the new transmission corridor would avoid or span channelized waterways, perennial streams, and intermittent streams (PSEG 2015-TN4280). New transmission line crossing development would require BMPs to protect water quality and minimize effects to aquatic habitats that may be at risk from clearing activities, runoff, and bank erosion. An estimated 77,088 linear ft of stream habitat (S&L 2010-TN2671) is within the 5-mi-wide macro-corridor for the hypothetical transmission line discussed in Section 7.5. The hypothetical transmission line would cross the Delaware River and would require installation of footings. Placement of footings would result in permanent benthic habitat loss, but this loss would be minimal when compared to available adjacent habitat. Installation activities would be managed through use of BMPs required for Federal and State permitting to minimize siltation and protect adjacent aquatic habitats. PSEG would consult with Federal and State agencies, as required, when an exact route is identified and installation effects to protected species can be directly assessed (PSEG 2015-TN4280).

Water quality in the region may be affected by continued withdrawal and discharge of water to support power generation. There are large commercial and recreational fisheries that harvest fish and invertebrates that make up the ecological community within the Delaware River Estuary. The effects of natural environmental stressors such as climate change and extreme weather events would also affect aquatic communities in the region.

Each of the current and reasonably foreseeable future activities may influence the structure and function of estuarine food webs and result in observable changes to the aquatic resources in the Delaware River Estuary. In most cases, it is not possible to determine quantitatively the impact of individual stressors or groups of stressors on aquatic resources because they affect the region simultaneously, and their effects are cumulative.

7.3.2.1 Continued Operation of the SGS Once-Through Cooling System

Based on the assessment presented in the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants–Supplement 45: Regarding Hope Creek Generating Station and Salem Nuclear Generating Station, Units 1 and 2—Final Report* (NRC 2011-TN3131), NRC staff concluded that "entrainment, impingement, and thermal discharge impacts on aquatic resources from the operation of SGS Units 1 and 2 collectively have not had a noticeable adverse effect on the balanced indigenous community of the Delaware Estuary." However, operation of SGS Units 1 and 2 continues to impinge and entrain aquatic species and would contribute, in part, to the cumulative loss of these species in the Delaware River Estuary. Several improvements to the cooling water intake structures have been made to reduce impingement mortality at SGS. Some of these improvements included installation of modified traveling screens, installation of improved screen mesh, and modifications to spray wash nozzle configurations (PSEG 2009-TN2513). Decades of monitoring and survey data for finfish and aquatic invertebrates have been used to assess species density and richness in the vicinity of SGS as directed under NJPDES permits starting in 1994 and in subsequent renewals (PSEG 2015-TN4280). Impingement, entrainment, and fish assemblage sampling by trawling and seining are conducted each year, in accordance with NJPDES permit requirements for biological monitoring. The reporting emphasis is on targeted representative important species that include Blueback Herring (*Alosa aestivalis*), Alewife (*A. pseudoharengus*), American Shad (*A. sapidissima*), Atlantic Menhaden (*Brevoortia tyrannus*), Bay Anchovy (*Anchoa mitchilli*), Atlantic Silverside (*Menidia menidia*), White Perch (*Morone americana*), Striped Bass, Bluefish (*Pomatomus saltatrix*), Weakfish (*Cynoscion regalis*), Spot (*Leiostomus xanthurus*), and Atlantic Croaker (*Micropogonias undulatus*) (PSEG 2015-TN4280). All of these representative important species are also considered either recreationally or commercially important, or are ecologically important as forage fish for sustainability of the ecosystem within the Delaware River Estuary and are discussed in more detail in Section 2.4.2.3. Although individual species abundances change year to year, the overall trends in community abundances and diversity show no significant changes (PSEG 2015-TN4280).

7.3.2.2 Continued Operation of the HCGS Closed-Cycle Cooling System

HCGS uses closed-cycle cooling and therefore requires substantially less water volume for cooling operations. Accordingly, effects on the aquatic community through impingement, entrainment, and discharge are also expected to be reduced when compared with the once-through cooling system at SGS (NRC 2011-TN3131). Impingement studies at HCGS were only performed in 1986 and 1987 at the commencement of operation for the single unit, and showed a reduced overall impingement rate when compared to SGS (see Section 5.3.2). Because HCGS was operating concurrently with SGS, the NJPDES permit-directed biological monitoring of the aquatic community through trawling and seining studies also reflected the combined effect of both HCGS and SGS operations. Therefore, the conclusions regarding effect of continued operation of SGS apply also to HCGS in that the overall species diversity and community abundances near the PSEG Site are expected to continue to show no noticeable effects from operations (NRC 2011-TN3131).

7.3.2.3 Commercial and Recreational Harvest of Fish and Shellfish

The Delaware River Estuary supports a diverse commercial and recreational fishery for finfish and invertebrates. Losses to the ecosystem from fishery harvest are managed at the Federal and State levels through catch limits, regulations on fishing gear, and seasonal closures. Unintended harvest or mortality is another source of loss through bycatch while targeting a different species. While these activities have the potential to contribute to cumulative effects on aquatic species in the Delaware River Estuary, the direct contribution is difficult to assess as many of these fish populations have life histories that involve a large migratory territory offshore and along the Atlantic coast of the United States, and therefore, effects to populations are difficult to directly attribute to Delaware River Estuary habitat effects.

7.3.2.4 Habitat Loss and Restoration

Current and future land-use development for industry, agriculture, or other habitat alterations in the Delaware River Estuary watershed may affect water quality. These types of activities may also result in shoreline habitat loss.

Dredging activities from past efforts to maintain navigation in the Delaware River Estuary may have affected estuarine habitats, and future dredging activities are planned that may continue to affect the aquatic ecosystem. Starting in 2010, the USACE began implementing the Delaware River Main Channel Deepening Project to deepen the existing navigation channel from 40 to 45 ft (USACE 2011-TN2262). To deepen the channel, material would be dredged by hydraulic and hopper dredges and placed in USACE CDFs or used for beneficial reuse purposes (e.g., wetland restoration, beach restoration, and habitat creation) in lower Delaware Bay. The USACE estimates that 1,012,428 yd^3 of material were dredged from Reach D of the Delaware River Estuary near Artificial Island and placed in the Federally owned CDF on Artificial Island (USACE 2013-TN2851). When completed, the entire Deepening Project would remove and dispose of an estimated 16 million yd^3 of sediments from the Delaware River in Philadelphia down to the mouth of the Delaware Bay. The subsequent maintenance dredging would remove an estimated 4,317,000 yd^3 of sediment from the 45-ft-deep channel each year (USACE 2011-TN2262). Maintenance dredging would be carried out as needed, generally over a 2-month period between August and December. As with building in-river components of a new nuclear power plant at the PSEG Site, fish and benthic invertebrates in the Delaware River Estuary would be displaced during the USACE dredging activities but are expected to recolonize the affected areas. The USACE would implement appropriate measures required by Federal and State agencies and organizations to protect aquatic resources, including endangered species (e.g., sturgeon and sea turtles), sharks, horseshoe crabs (*Limulus polyphemus*), blue crabs (*Callinectes sapidus*), freshwater mussels, and American Eels (*Anguilla rostrata*) (USACE 2011-TN2262). For example, mechanical dredge activities between March 15 and June 30 would be avoided within selected reaches of the project area to prevent sedimentation and turbidity effects on reproduction of Atlantic Sturgeon, Striped Bass, American Shad, and river herring (USACE 2013-TN2851).

While aquatic habitats continue to be affected by natural and anthropogenic activities in the Delaware River Estuary, efforts to restore salt marsh and estuary habitat have met with some success and are expected to continue in the future. For example, ongoing restoration activities

within the Mad Horse Creek Wildlife Management Area (WMA), which is located 4 mi east of the PSEG Site, would restore nearly 200 ac of the Mad Horse Creek WMA to address injuries to shoreline and bird resources resulting from the 2004 *Athos I* oil spill (NOAA 2008-TN2721). NJDEP and the National Oceanic and Atmospheric Administration (NOAA) proposed a tidal wetland restoration project that would allow development of smooth cordgrass (*Spartina alterniflora*) habitat to improve habitat quality in the area. Restoration would be accomplished through fill material removal to lower the marsh elevation and allow tidal inundation (PSEG 2015-TN4280). As described in Section 4.3.1, unavoidable impacts to wetlands by developing a new nuclear power plant at the PSEG Site and the proposed causeway would be mitigated by habitat restoration and enhancement, using experience and proven techniques developed by the PSEG Estuary Enhancement Program (EEP). Sensitive species that utilize such marsh habitats would be positively affected by the proposed Mad Horse Creek WMA restoration effort and by the proposed mitigation for a new nuclear power plant at the PSEG Site and causeway (i.e., restoration of low-quality marsh habitats) (PSEG 2015-TN4280).

7.3.2.5 Climate Change

The potential impacts of climate change on aquatic organisms and habitat in the geographic area of interest are not precisely known. In addition to rising sea levels, climate change could lead to regional increases in the frequency and intensity of extreme precipitation events, increases in annual precipitation, and increases in average temperature (GCRP 2014-TN3472). Such changes in climate could alter aquatic community composition on or near the PSEG Site through changes in species diversity, abundance, and distribution. For example, in 2012, Hurricane Sandy created increased storm surge during this event within the Delaware River Estuary and had moderate effects on water quality and coastal habitats within the southernmost portion of the Delaware River Estuary through erosion, sedimentation, and resuspension of contaminants within sediments (ALS 2012-TN2720). Elevated water temperatures, droughts, and severe weather phenomena could adversely affect or severely reduce aquatic habitat; however, specific predictions on aquatic habitat changes in this region due to climate change are inconclusive at this time. The level of impact resulting from these events would depend on the intensity of the perturbation and the resiliency of the aquatic communities. The DRBC stated in the State of the Delaware River Basin report for 2013 that increases in temperature and salinity are expected with future sea-level rise and climate change over a period of time in the future (DRBC 2013-TN2609). The DRBC conclusion is supported by the U.S. Global Change Research Program regarding the very high likelihood that sea levels will rise and create different environmental conditions within this century (GCRP 2014-TN3472). Because the Delaware River Estuary near the PSEG Site is already a zone of tidally influenced fluctuation with variable salinity and temperature, these potential changes are likely to result in movement of populations of marine and euryhaline species farther up the Delaware River Estuary. For example, in a recent report, hard bottom areas north and south of the Chesapeake and Delaware Canal (upriver of the PSEG Site) were identified as having potential as reef sites for the establishment of new oyster beds and were discussed as a future conservation target due to changing climate conditions resulting in increases in salinity further upriver (PDE 2011-TN2190).

7.3.2.6 Summary of Cumulative Impacts on Aquatic Resources

Aquatic resources of the Delaware River Estuary are cumulatively affected to varying degrees by multiple activities and processes that have occurred in the past, are occurring currently, and are likely to occur in the future. The food web and the abundance of important aquatic forage species and other species have been substantially affected by these stressors historically as is described in Section 2.4.2. The impacts of some of these stressors associated with human activities are addressed by management actions (e.g., cooling system operation, regulation of fishing pressure, water-quality improvements, and habitat restoration).

Other stressors, such as climate change and increased human population and associated development in the Delaware River Basin, cannot be directly managed and their effects are more difficult to quantify and predict. It is likely, however, that future anthropogenic and natural environmental stressors would cumulatively affect the aquatic community of the Delaware River Estuary sufficiently that they would noticeably alter important attributes, such as species ranges, populations, diversity, habitats, and ecosystem processes, just as they have in the past. These stressors have modified important attributes of aquatic resources, and would continue to exert an influence in the future, potentially destabilizing some of the attributes of the aquatic ecosystem. Based on these observations, the review team concludes that cumulative impacts have been noticeable and destabilizing for some aquatic resources, primarily based on past stressors affecting aquatic resources in the Delaware Estuary and River Basin.

Cumulative impacts on aquatic ecology resources are estimated based on the information provided by PSEG, NMFS, and the review team's independent review. The significant history of the degradation of the Delaware River Estuary has had a noticeable and sometimes destabilizing effect on many aquatic species and communities. Commencement of operations at SGS Units 1 and 2 resulted in significant numbers of aquatic species being entrained and impinged, which led to required restoration of the area through the EEP as a form of mitigation. In addition, present and reasonably foreseeable future activities such as the continued operation of SGS and HCGS and the completion of dredging operations for the Delaware River Main Channel Deepening Project would continue to have effects on the aquatic resources in the Delaware River Estuary. Therefore, the review team concludes that the cumulative impacts of past, present, and reasonably foreseeable future activities, including climate change, on the aquatic resources of the Delaware River Estuary would be MODERATE to LARGE. However, the review team concludes that the incremental contribution of the NRC-authorized activities related to construction and operation of a new nuclear power plant at the PSEG Site would not be a significant contributor to the cumulative MODERATE to LARGE impact.

7.4 Socioeconomics and Environmental Justice

The evaluation of cumulative impacts on socioeconomics and environmental justice is described in the following sections.

7.4.1 Socioeconomics

The description of the affected environment in Section 2.5 serves as a baseline for the cumulative impacts assessment in these resource areas. As described in Section 4.4, the

review team concluded that most of the socioeconomic impacts of NRC-authorized construction activities would be SMALL with the exceptions discussed as follows. In Sections 4.4.1 and 5.4.1, the review team found that physical impacts near the PSEG Site would be SMALL, with the exception of MODERATE physical impacts to the local road network. Aesthetic and recreational impacts would be MODERATE.

As described in Section 5.4, the review team determined that demographic effects of plant operations would be SMALL. The physical impacts would be SMALL for all physical categories except aesthetics, which would be MODERATE. Economic impacts from salaries, sales, and expenditures would be SMALL and beneficial throughout the region; property tax impacts would be SMALL and beneficial throughout the region with the exception of MODERATE and beneficial income tax impacts to the State of New Jersey, and LARGE and beneficial property tax impacts for Salem County. Impacts on infrastructure, transportation, and community services would be SMALL. Aesthetic and recreational impacts near the PSEG Site would be MODERATE.

The impact analyses in Chapters 4 and 5 are cumulative by nature. The combined impacts from construction and preconstruction are described in Section 4.4 and were determined to be the same as described above for NRC-authorized activities. In addition to socioeconomic impacts from preconstruction, construction, and operations, the cumulative analysis considers other past, present, and reasonably foreseeable future actions that could contribute to cumulative socioeconomic impacts. For this cumulative impacts analysis, the review team considered a geographic area of a 50-mi radius around the PSEG Site. The review team determined the impacts within the 50-mi radius primarily affected four counties—New Castle County in Delaware and Salem, Gloucester, and Cumberland Counties in New Jersey—that make up the economic impact area (geographic area of interest) that would be most affected by the proposed project.

The PSEG Site is located adjacent to the existing HCGS and SGS, Units 1 and 2, in Lower Alloways Creek Township, Salem County, New Jersey. The site is located on the southern part of Artificial Island on the east bank of the Delaware River, about 15 mi south of the Delaware Memorial Bridge; 18 mi south of Wilmington, Delaware; 30 mi southwest of Philadelphia, Pennsylvania; and 7.5 mi southwest of Salem, New Jersey.

The nearest residences to the PSEG Site are located about 2.8 mi to the west in New Castle County, Delaware, and about 3.4 mi to the east-northeast in the Hancock’s Bridge community of Salem County, New Jersey (PSEG 2015-TN4280). The closest recreational areas are the Augustine Beach Access Area and Augustine Wildlife Area, which are approximately 3.1 and 3.6 mi across the Delaware River from the PSEG Site.

As shown in Table 2-13, the combined population of the four counties in the economic impact area was 1,045,640 in 2011. More than half of this population (51.31 percent) lives in New Castle County; 6.31 percent reside in Salem County, the home of the PSEG Site; 14.93 percent live in Cumberland County; and 27.45 percent live in Gloucester County (USCB 2002-TN2297; USCB 2008-TN2344; USCB 2012-TN2743). Table 2-14 lists the population of municipalities and townships within 10 mi of the site. The largest population centers are Middletown, Delaware, with 17,608 residents and Pennsville Township, New Jersey, with 13,405 residents.

Salem, New Jersey, located about 8 mi north of the site, has a population of 5,239 (USCB 2012-TN2743). In the economic impact area, Salem County is the least populated and most rural. New Castle County is the most populated and least rural.

New Castle County has been strongly influenced by favorable corporate tax laws where large companies have offices. New Castle also has a manufacturing history with DuPont and AstraZeneca. Health care providers also contribute significantly to the economic base in New Castle County. Wilmington is the largest city in the economic impact area and is in northern New Castle County. The three New Jersey counties have smaller populations and are less industrialized. Manufacturing (glass and food), health care, and retail trade are the largest employers (PSEG 2015-TN4280). The counties have matured based upon these characteristics.

Table 7-1 lists the present and future projects that could contribute to the cumulative impacts of building and operating a new nuclear power plant at the PSEG Site. The project with the greatest contribution to cumulative socioeconomic impacts would be continued operations at HCGS and SGS. According to Section 2.5.1.3, approximately 1,300 people are employed at HCGS and SGS, and most of the workforce lives in the four counties in the economic impact area. Each reactor has outages on a staggered 18–24 month schedule that employ an additional 1,034 to 1,361 workers at the site for a month. Operations at HCGS and SGS also contribute to economic activity and tax revenue to the local communities. These characteristics are discussed further in Section 2.5 and the HCGS and SGS License Renewal EIS (NRC 2011-TN3131).

The other projects listed in Table 7-1 involve continued development in the economic impact area and are included in county comprehensive plans and in other public agency planning processes. Currently, every 6 months over 1,000 workers are employed at the HCGS and SGS site for outages for approximately 1 month. During the peak building period at the PSEG Site, an additional 4,100 workers would be employed. The review team already considers the impacts from this larger workforce in Section 4.4. The greatest chance for impacts would be on traffic and roads, but the traffic impact analysis (TIA) includes the outage workforce and peak building workforce in its analysis. The TIA analyzed the impacts of the current workforce at HCGS and SGS as part of the traffic baseline (PSEG 2013-TN2525). Assuming a plant parameter envelope of two Advanced Passive 1000 Reactors (AP1000) reactors as discussed in Chapter 3, the PSEG Site would have two outages every 18 to 24 months, which is equivalent to a staggered schedule of every 9 to 12 months for the two AP1000 reactors. These outages would occur on a staggered schedule with the HCGS and SGS outages. Therefore, assuming evenly staggered schedules, there would be an outage every 2 to 3 months at the site instead of the current schedule of every 6 months. The impacts of outage workforces for HCGS and SGS would be similar to those impacts discussed in Chapter 5.

The operating license for SGS Units 1 and 2 and HCGS expire in 2036, 2040, and 2046, respectively. Salem County would see a loss in property tax revenue, supplies and materials purchases made by PSEG, and employment. However, this loss would be offset by the continued operations at the PSEG Site compared to the baseline discussed in Section 2.5.

Independent of new construction at the PSEG Site, PJM plans to solicit bids for upgrading transmission lines for grid stability and/or to relieve congestion. PJM has not selected a company or a route for the project. However, PSEG has indicated that a 55-mi corridor running from the PSEG Site to the Peach Bottom substation is a potential route. It is expected that most of the transmission lines would follow existing corridors, but some properties might be purchased along the ROW (PSEG 2013-TN2525). Where clearing would be necessary, there would be fugitive dust, emissions, and noise that would be short term and minimal. Transmission line noise during operations would be within regulatory limits at the edge of the ROW. The workers that would be needed for the transmission line expansion and maintenance are expected to already reside within the 50-mi region, and their impacts are already included in the region's baseline discussed in Chapter 2. Therefore, demographic, housing, education, and public service impacts would be minimal. Transmission line construction would not be in a centralized location but scattered over miles, so cumulative impacts on traffic and transportation would be minimal. Because transmission lines, to the extent practicable, would be co-located with other transmission lines, in accordance with established industry practices and procedures regarding vegetation and screening, building and operations of the transmission lines would have a minimal impact on aesthetics (PSEG 2013-TN2525).

On the basis of the above considerations, PSEG's ER, and the review team's independent evaluation and outreach, the review team concludes that building activities at the PSEG Site would have short-term cumulative, MODERATE, and adverse impacts associated with traffic and a SMALL cumulative impact during operations and outages within the economic impact area. The new cooling towers would also have cumulative MODERATE and adverse impacts associated with aesthetics in certain locations.

Cumulative tax impacts would also be SMALL and beneficial for most of the economic impact area, except for a LARGE and beneficial impact in Salem County. The review team concludes that the incremental cumulative impacts from NRC-authorized activities on other socioeconomic impact categories would be SMALL, except for continued MODERATE aesthetic impacts from the cooling towers and from traffic during construction. All other cumulative impacts are deemed to be SMALL.

7.4.2 Environmental Justice

The description of the affected environment in Sections 2.5 and 2.6 serves as a baseline for the cumulative impacts assessment of environmental justice impacts. The combined physical and socioeconomic impacts from construction and preconstruction and from operations are summarized in Sections 4.5.6 and 5.5.6. As discussed in Sections 4.5 and 5.5, the review team concluded that no disproportionately high and adverse impacts on minority and low-income populations would result from NRC-authorized construction activities or from operation of a new nuclear power plant at the PSEG Site.

In addition to environmental justice impacts from preconstruction, construction, and operation of a new plant at the PSEG Site, the cumulative analysis considers other past, present, and reasonably foreseeable future actions that could contribute to cumulative environmental justice impacts. For this cumulative analysis, the general geographic area of interest is considered to be the 50-mi region described in Section 2.5.1.

As shown in Section 2.6, the greatest concentrations of census block groups with minority and low-income populations that meet the criteria discussed in Section 2.6 are located in or near Philadelphia, Camden County, and northern New Castle County. The closest minority populations are in Salem County in Salem City, approximately 8 mi north of the site. The closest low-income populations are also in Salem City, approximately 8 mi north of the site. (Note: These are linear distances from the PSEG Site center; driving distances to all communities are greater.)

As discussed in Section 7.4.1 for socioeconomic cumulative impacts, continued operations at HCGS and SGS have the greatest potential to affect cumulative environmental justice impacts within the region.

HCGS and SGS are located next to the PSEG Site. The review team found no environmental pathways in Sections 4.5 and 5.5 that could result in disproportionately high and adverse human health, environmental, physical, or socioeconomic impacts to minority and low-income populations from building and operating a new nuclear power plant at the PSEG Site. In the HCGS and SGS License Renewal EIS, no disproportionately high and adverse impacts to minority and low-income populations were found from continued operations at HCGS and SGS (NRC 2011-TN3131).

As discussed in Section 7.4, PJM has not selected a company or a route for the transmission line project. PSEG indicated that a 55-mi corridor running from the PSEG Site to the Peach Bottom substation is a potential route. Because the potential PSEG to Peach Bottom Substation route follows existing corridors and very few properties would need to be purchased, the review team does not expect disproportionately high and adverse impacts to minority and low-income populations (PSEG 2013-TN2525).

On the basis of the above considerations, information provided by PSEG, and the review team's independent evaluation and outreach, the review team concludes that there would be no disproportionately high and adverse cumulative impacts on minority or low-income populations beyond those described in Chapters 4 and 5.

7.5 Historic and Cultural Resources

The description of the affected environment in Chapter 2 serves as the baseline for the cumulative impact assessments in this resource area. The geographic area of interest for this resource area is defined in Chapters 4 and 5 (the direct Area of Potential Effect (APE) is the proposed plant boundary and the indirect APE is 4.9 mi). As described in Section 4.6, the construction of two natural draft cooling towers (NDCTs) (if selected) is anticipated to have a noticeable, but mitigable, indirect adverse visual impact on three historic properties. The use of mechanical draft cooling towers would have no impact on historic properties. Therefore, the impacts of NRC-authorized construction activities on historic and cultural resources could range from SMALL to MODERATE. Even though the proposed project is over 4 mi from a National Historic Landmark (NHL) and other historic properties and the visibility of the NDCTs is dependent on climatic conditions which could obscure them (see Figure 2-30 and 2-31 in Section 2.7), the visual impact would remain noticeable. The indirect adverse visual effect would be cumulative because the current setting already contains a NDCT immediately south of

the proposed project site. USACE National Historic Preservation Act of 1966 (54 USC 300101 et seq. –TN4157) Section 106 consultation with the New Jersey State Historic Preservation Office (SHPO) on impacts from the proposed causeway and the wetland mitigation area is ongoing, but would be resolved prior to issuance of any Department of the Army authorization. As described in Section 5.6, the review team concludes that the impacts of operations also could range from SMALL to MODERATE for the reasons stated above. In addition to the impacts from construction, preconstruction, and operations, the cumulative analysis also considers other past, present, and reasonably foreseeable actions that could affect historic and cultural resources.

This cumulative analysis considers the effects from other activities in the region in combination with building and operating a new nuclear power plant at the PSEG Site. No other activities are anticipated within the Artificial Island project area. Because most historic and cultural resources are location dependent, no cumulative effects are expected within the Artificial Island project area. Other activities that could contribute to cumulative impacts include the Delaware River Main Channel Deepening Project and the potential construction of a new transmission line by PJM for grid stability.

As part of its NEPA review, the USACE evaluated the visual impacts of the proposed causeway. The National Register of Historic Places (NRHP) site closest to the proposed causeway is the Abel and Mary Nicholson House NHL, which is located about 1 mi from the northern end of the causeway. The effect from the proposed causeway on historic properties is still being evaluated.

Independent of the potential construction and operation of a plant at the PSEG Site, PJM has determined that additional grid improvements are necessary to address voltage and stability constraints in the region of Artificial Island. PJM has solicited proposals for system enhancements to address these constraints. While PJM has not formally assessed the scope and structure of this future transmission upgrade, given the solicitation of interest PJM issued for new transmission lines, the staff considers new transmission lines to be reasonably foreseeable, and they are considered a cumulative impact. PSEG has identified the potential impacts of a new offsite transmission line with technical attributes that best meet PJM's goal of resolving these regional constraints. Developing the new transmission line corridors could adversely affect historic and cultural resources within the APEs. Prior to development of any new lines, if a Federal permit is needed, then the Federal agency permitting the new lines must consult with the appropriate SHPOs. This consultation would involve archival research and field investigations to determine if any significant historic and cultural resources would be present in the routes considered. If significant resources (i.e., NRHP-eligible) are located within the proposed route, and it is determined that impacts could occur to those resources, consultation with the appropriate SHPOs, Native American tribes, and interested parties would be necessary to avoid, minimize, or mitigate the adverse effects on historic properties.

To evaluate the potential cumulative impacts, the review team considered that PJM could build a transmission line 55 mi in length, generally following existing transmission line corridors from the PSEG Site to the Peach Bottom Substation in Pennsylvania, some of which could fall within the APEs. From the PSEG Site, the hypothetical corridor extends north and then west across

the Delaware River to the Red Lion Substation. From this location, the potential corridor extends to the Peach Bottom Substation.

The review team considered the PSEG analysis of historic properties within a 5-mi-wide corridor of the hypothetical transmission line. Based on GIS analysis of NRHP-listed sites, the macro-corridor contains 52 NRHP-listed sites. The three counties containing NRHP-listed sites in the macro-corridor are New Castle, Delaware (21); Cecil, Maryland (20); and Salem, New Jersey (11).

Based on its evaluation, the review team concludes that the cumulative historic and cultural resources impact from construction, preconstruction, operations, and other Federal and non-Federal projects would be MODERATE. The impacts could be greater if archaeological resources are present in the transmission line corridors and could not be avoided. Building and operating the plant would be a significant contributer to the MODERATE cumulative impact if NDCTs are selected. The incremental contribution of NRC-authorized activities on historic and cultural resources would not be a significant contributor to the cumulative impact.

7.6 Air Quality

The description of the affected environment in Section 2.9 serves as the baseline for the cumulative impact assessment for air quality. As described in Section 4.7, the review team concludes that the impacts on air quality from preconstruction and NRC-authorized construction would be SMALL, and that no further mitigation would be warranted. As described in Section 5.7, the review team concludes that the impacts on air quality from operations would be SMALL, and that no further mitigation would be warranted.

7.6.1 Criteria Pollutants

In addition to the impacts from construction, preconstruction, and operations, this cumulative analysis also considers other past, present, and reasonably foreseeable future actions that could contribute to cumulative impacts to air quality. For this cumulative analysis of criteria pollutants, the geographic area of interest is Salem County, New Jersey. This geographic area of interest was chosen because EPA air-quality designations are made on a county-by-county basis.

The existing PSEG property currently has three operating nuclear reactors. SGS Units 1 and 2 are Westinghouse pressurized water reactors (PWRs) rated at 3,459 MW(t) each. HCGS Unit 1 is located north of the SGS units. HCGS is a General Electric boiling water reactor (BWR), rated at 3,840 MW(t). Surrounding SGS and HCGS are many support facilities, including circulating and service water intake structures, switchyards, administration buildings, and an independent spent fuel storage installation (ISFSI). The PSEG Site is located north of and adjacent to HCGS (PSEG 2015-TN4280).

As discussed in Section 2.9.2, air quality in Salem County is in attainment with or better than the National Ambient Air Quality Standards (NAAQS) for criteria pollutants with the exception of the 8-hour ozone (O_3) NAAQS, for which it is in nonattainment (40 CFR Part 81-TN255). At such a time when a CP or COL is submitted to the NRC, a Clean Air Act (42 USC 7401 et seq. –

TN1141) general conformity applicability analysis and determination would be performed pursuant to 40 CFR Part 93, Subpart B (TN2495) to determine whether additional mitigation may be warranted.

Section 4.7 discusses air-quality impacts associated with preconstruction and construction activities at the PSEG Site. Emissions from these activities primarily would be the fugitive dust from ground-disturbing activities and engine exhaust from heavy equipment and vehicles. Emissions are expected to be temporary and limited in magnitude and are anticipated to be SMALL.

Section 5.7 discusses air-quality impacts during operations. Emissions during operation would primarily be from operation of the cooling towers, auxiliary boilers, diesel generators and/or gas turbines, and commuter traffic. Stationary sources (e.g., diesel generators and/or gas turbines [operating infrequently] and auxiliary boilers [operating mostly during winter months]) would be operated according to State and Federal regulatory requirements. Impacts to air quality during operations are expected to be SMALL.

There are 13 major sources of air emissions in Salem County with existing Title V operating permits (EPA 2013-TN2504). These existing sources include the energy and industrial projects listed in Table 7-1. The permitted air emission sources closest to the PSEG Site are those associated with SGS and HCGS. The addition of emission sources associated with a new nuclear power plant at the PSEG Site would require modification to the existing SGS and HCGS Title V Operating Permit (PSEG 2015-TN4280). Title V operating permits are legally enforceable documents issued for all major sources by State and local permitting authorities after the source has begun to operate. The permits include all air pollution requirements that apply to the source, including emissions limits on the types and amounts of emissions allowed, operating requirements for pollution control devices or pollution prevention activities, and monitoring and record keeping requirements. These permits also require the source to report its compliance status with respect to permit conditions to the permitting authority. These permits aid the State in meeting NAAQS, thereby limiting potential air-quality impacts.

Future development near the PSEG Site also could lead to increases in gaseous and particulate emissions related to transportation. Table 7-1 lists low potential for growth within Salem County. Most projects listed in Table 7-1 would not increase air emissions enough to exceed current air-quality standards. Given the low potential for growth in Salem County, and the minor contribution of emissions from building and operation, the cumulative impact on air quality with exception of greenhouse gas (GHG) emissions would be minimal.

7.6.2 Greenhouse Gas Emissions

As discussed in the state of the science report issued by GCRP, "The majority of the warming at the global scale over the past 50 years can only be explained by the effects of human influences, especially the emissions from burning fossil fuels (coal, oil, and natural gas) and from deforestation…Oil used for transportation and coal used for electricity generation are the largest contributors to the rise in carbon dioxide that is the primary driver of observed changes in climate over recent decades" (GCRP 2014-TN3472).

GHG emissions associated with building, operating, and decommissioning a nuclear power plant are addressed in Sections 4.7, 5.7, 6.1.3, and 6.3. The review team has concluded that the atmospheric impacts of the emissions associated with each aspect of building, operating, and decommissioning a single nuclear power plant would be minimal. The review team also concluded that the impacts of the combined emissions for the full plant life cycle would be minimal.

It is difficult to evaluate cumulative impacts of a single source or combination of GHG emission sources for the following reasons:

- the impact is global rather than local or regional;
- the impact is not particularly sensitive to the location of the release point;
- the magnitude of individual GHG sources related to human activity, no matter how large compared to other sources, is small when compared to the total mass of GHGs that exist in the atmosphere; and
- the total number and variety of GHG emission sources are extremely large and are ubiquitous.

The above points are illustrated by the comparison of annual emission rates of carbon dioxide (CO_2), one of the principal GHGs, as shown in Table 7-3.

Table 7-3. Comparison of Annual Carbon Dioxide (CO_2) Emissions

Source	Metric Tons per Year[(a)]
Global emissions from fossil-fuel combustion (2010)	3.2×10^{10}[(b)]
United States emissions from fossil-fuel combustion (2011)	5.3×10^{9}[(b)]
New Jersey energy-related emissions (2010)	1.3×10^{8}[(c)]
1,000-MW(e) nuclear power plant (including fuel cycle, 80% capacity factor)	260,000[(d)]
1,000-MW(e) nuclear power plant (operations only)	4,500[(d)]
Average U.S. passenger vehicle	5[(e)]

Note: 1 MT = 1.1 U.S. ton (at 2,000 lb per U.S. ton).
(a) Expressed in MT per year of CO_2e, except MT per year of CO_2 for global emissions from fossil-fuel combustion.
(b) Source: EPA 2013-TN2815.
(c) Source: NJDEP 2008-TN2776; includes emissions from electricity generation, residential/commercial/industrial fuel combustion, transportation, and fossil-fuel industry.
(d) Source: Appendix K of this EIS.
(e) Source: EPA 2013-TN2505.

In the U.S., the national annual GHG emission rate was 6.7 billion metric tons (MT) carbon dioxide equivalent (CO_2e) in 2011, and of that amount, 5.3 billion MT CO_2e was from fossil-fuel combustion (EPA 2013-TN2815). The total GHG emissions in New Jersey were projected to be 143 million MT of gross CO_2e in 2010 and, of that total, the energy-related emissions from electricity generation, residential/commercial/industrial fuel combustion, transportation, and fossil-fuel industry were projected to be about 131 million MT CO_2e (NJDEP 2008-TN2776). Appendix A to Attachment 1 of the *Interim Staff Guidance on Environmental Issues Associated with New Reactors* (NRC 2014-TN3767) provides details of the review team's estimate for a reference 1,000-MW(e) nuclear power plant. The review team estimated the total nuclear power plant lifecycle footprint to be 10,500,000 MT CO_2e, with a 7-year preconstruction and

construction phase, 40 years of operation, and 10 years of decommissioning. This value may differ for a new nuclear power plant at the PSEG Site, depending on which reactor technology is chosen and the electrical output of the new plant. The uranium fuel-cycle phase is projected to generate the highest emissions (see Appendix K). Table 7-3 lists GHG emissions from normal operations, including the uranium fuel cycle, as 260,000 MT CO_2e per year. These emissions are significantly less than the GHG emissions projected for New Jersey or from fossil-fuel combustion in the United States for the year 2011.

Even though GHG emission estimates from normal operations are small compared to other sources, the applicant should consider measures that would reduce GHG emissions. These could include, but would not necessarily be limited to, energy-efficient design features and features to reduce space heating and air conditioning energy requirements, use of renewable energy sources, use of low-GHG-emitting vehicles, and other policies to reduce GHG emissions from vehicle use, such as anti-idling policies and vanpooling or carpooling.

An evaluation of cumulative impacts of GHG emissions requires the use of a global climate model. The GCRP report (GCRP 2014-TN3472) provides a synthesis of the results of numerous climate modeling studies; hence, the cumulative impacts of GHG emissions around the world as presented in the GCRP report provide an appropriate basis for the evaluation of cumulative impacts. Based primarily on the scientific assessments of GCRP and the National Research Council, the EPA Administrator issued a determination in 2009 (74 FR 66496-TN245) that GHGs in the atmosphere may reasonably be anticipated to endanger public health and welfare, based on observed and projected effects of GHGs, their impact on climate change, and the public health and welfare risks and impacts associated with such climate change. Therefore, national and worldwide cumulative impacts of GHG emissions reflect conditions within the MODERATE impact level for air quality related to GHG emissions, which are noticeable but not destabilizing.

Based on the impacts set forth in the GCRP report and on the GHG emissions criteria in the final EPA GHG Tailoring Rule (75 FR 31514-TN1404), the review team concludes that the national and worldwide cumulative impacts of GHG emissions are noticeable but not destabilizing, with or without the contribution of GHG emissions from a new nuclear power plant at the PSEG Site.

Consequently, the review team recognizes that GHG emissions, including CO_2, from individual stationary sources and, cumulatively, from multiple sources can contribute to climate change. Section 9.2.5 contains a comparison of carbon footprints of the viable energy alternatives.

7.6.3 Summary

Cumulative impacts to air-quality resources are estimated based on the information provided by PSEG and the review team's independent evaluation. Other past, present, and reasonably foreseeable future activities exist in the geographic areas of interest (local and regional for criteria pollutants and global for GHG emissions) that could affect air-quality resources. The cumulative impacts on criteria pollutants from emissions of effluents from a new nuclear power plant at the PSEG Site and other projects would not be noticeable. The new plant and the other projects listed in Table 7-1 would have minimal impacts. The national and worldwide cumulative

impacts of GHG emissions are noticeable but not destabilizing. The review team concludes that the cumulative impacts would be noticeable but not destabilizing, with or without the GHG emissions from a new nuclear power plant at the PSEG Site. The review team concludes that cumulative impacts from other past, present, and reasonably foreseeable future actions on air-quality resources in the geographic areas of interest would be SMALL for criteria pollutants and MODERATE for GHGs. The incremental contribution of NRC-authorized activities on air-quality resources for both criteria pollutants and GHGs would not be a significant contributor to the cumulative impact. Operation of a new nuclear power plant on the PSEG ESP site would considerably reduce emissions of criteria pollutants and GHGs from fossil-fueled plants that would otherwise be needed to supply the demand for power (see Section 8.5).

7.7 Nonradiological Health

The description of the affected environment in Section 2.10 serves as the baseline for the cumulative analysis for nonradiological health. As described in Section 4.8, the nonradiological health impacts from noise, air quality, and occupational injuries from preconstruction- and construction-related activities for a new nuclear power plant at the PSEG Site would be SMALL, and no mitigation beyond that proposed by PSEG would be warranted. Transportation of personnel and construction materials would result in a minimal increase in traffic accident impacts associated with the impacts of the construction workforce traveling to and from the PSEG Site. Mitigation of traffic impacts discussed in Section 4.4 would reduce traffic accident impacts related to building activities, and no further mitigation would be warranted (PSEG 2015-TN4280). As described in Section 5.8, the review team concludes that the impacts of operations of a new nuclear power plant on nonradiological health would be SMALL, and no further mitigation would be warranted.

In addition to the impacts from preconstruction, construction, and operations, this cumulative analysis also considers other past, present, and reasonably foreseeable future actions that could contribute to cumulative impacts on nonradiological health (see Table 7-1). Most of the nonradiological impacts of building and operating a new nuclear power plant (e.g., noise, etiological agents, and occupational injuries) would be localized and would not have a significant impact at offsite locations. However, impacts such as vehicle emissions associated with transporting personnel to and from the PSEG Site would affect a larger area. Therefore, for nonradiological health impacts, the geographic area of interest for cumulative impacts analysis includes projects within a 50-mi radius of the PSEG Site based on the influence of vehicle and other air emissions sources. For cumulative impacts associated with potential transmission lines, the geographical area of interest is the potential transmission line corridor. These geographical areas of interest are expected to encompass areas where public and worker health could be influenced by a new nuclear power plant and future transmission lines (if needed), in combination with any past, present, or reasonably foreseeable future actions. For occupational injuries, the geographical area of interest is Artificial Island, including the workers at the existing SGS and HCGS units and at the PSEG Site.

Current projects within the geographic area of interest that could contribute to cumulative nonradiological health impacts include the energy projects listed in Table 7-1, as well as vehicle emissions and existing urbanization-related activities. Reasonably foreseeable future projects

in the geographic area of interest that could contribute to cumulative nonradiological health impacts include new industrial/business projects and future urbanization.

The existing SGS and HCGS projects could contribute to cumulative occupational injuries. However, adherence to existing Occupational Safety and Health Administration requirements at both the existing SGS and HCGS units and at the PSEG Site would help keep cumulative occupational injuries to a minimal level.

Existing and potential development of new transmission lines could increase nonradiological health impacts from exposure to acute electromagnetic fields (EMFs). However, adherence to Federal criteria and State utility codes would help keep any cumulative nonradiological health impacts at a minimal level. With regard to the chronic effects of EMFs, the scientific evidence on human health does not conclusively link extremely-low-frequency EMFs to adverse health impacts. Cumulative impacts from noise and vehicle emissions associated with current urbanization and the current operations of SGS and HCGS could occur. However, as discussed in Sections 4.8 and 5.8, the relative contribution of a new nuclear power plant at the PSEG Site to these impacts would be temporary and minimal, and it is expected that the SGS and HCGS facilities would continue to comply with local, State, and Federal regulations governing noise and emissions.

Nonradiological traffic accident impacts are related to the additional traffic on the regional and local highway networks leading to and from the PSEG Site. Additional traffic would result from shipments of construction materials and movements of construction personnel to and from the site. The additional traffic would increase the risk of traffic accidents, injuries, and fatalities. A review of the projects listed in Table 7-1 identified one transportation-related project in the 50-mi region surrounding the PSEG Site: road widening associated with the Salem-Hancocks Bridge Road. This project is in progress and would be completed by the time building activities at the PSEG Site commenced. Therefore, it is unlikely to contribute to cumulative transportation impacts.

Three new development or redevelopment projects listed in Table 7-1 could involve new construction with the potential to increase nonradiological impacts: Camp Pedricktown Redevelopment, construction of the Agricultural Products Business Park, and construction of the Gateway Business Park. These projects are located between 19.9 and 36.9 mi from the PSEG Site, and they would have a smaller scope and lower resource and personnel requirements than construction of a new nuclear power plant at the PSEG Site. Therefore, these projects are not likely to result in a measurable cumulative impact.

Based on the magnitude of new nuclear power plant construction relative to the other construction activities discussed above, the review team concludes the cumulative nonradiological transportation impacts of building and operating a new nuclear power plant at the PSEG Site and other past, present, and reasonably foreseeable future impacts would be minimal, and no further mitigation beyond that discussed Sections 4.8 and 5.8 is warranted.

The health impacts of operating the existing SGS and HCGS and a new nuclear power plant at the PSEG Site were evaluated relative to the Delaware River and the potential propagation of etiological microorganisms. As discussed in Section 5.8, the thermal discharges from the

operation of a new plant would not have impacts on the concentration levels of indigenous or etiological microorganisms.

The review team also is aware of the potential climate changes that could affect human health and has considered a recent compilation of the state of knowledge in this area (GCRP 2014-TN3472) in preparing this EIS. Projected changes in the climate for the region during the life of a new nuclear power plant at the PSEG Site include

- reduced cooling system efficiency at a new plant at the PSEG Site (and other power generation facilities), which would result in increased temperature of the cooling tower discharge water and possible increased growth of etiological agents;
- increased incidence of diseases transmitted by food, water, and insects following heavy downpours and severe storms; and
- increased severity of water pollution associated with sediments, fertilizers, herbicides, pesticides, and thermal pollution caused by projected heavier rainfall intensity and longer periods of drought.

The review team did not identify anything that would alter its conclusion that a new nuclear power plant would have no appreciable impact on nonradiological human health including the presence of etiological agents or the incidence of waterborne diseases.

Cumulative nonradiological health impacts were determined on the basis of information from PSEG and the review team's independent evaluation of impacts resulting from a new nuclear power plant at the PSEG Site, along with a review of potential impacts from other past, present, and reasonably foreseeable future projects and from urbanization in the geographic areas of interest. The review team concludes that cumulative impacts on the nonradiological health of the public and workers would be SMALL and that mitigation beyond that discussed in Sections 4.8 and 5.8 would not be warranted. The review team acknowledges, however, that there is still uncertainty associated with the chronic effects of EMFs.

7.8 Radiological Impacts of Normal Operation

The description of the affected environment in Section 2.11 serves as the baseline for the cumulative impacts assessment in this resource area. As described in Section 4.9, the NRC staff concludes that the radiological impacts to construction workers engaged in building activities would be SMALL, radiological impacts from NRC-authorized construction would be SMALL, and no further mitigation would be warranted. As described in Section 5.9, the NRC staff concludes that the radiological impacts from normal operations would be SMALL, and no further mitigation would be warranted.

The combined radiological impacts from construction and preconstruction were described in Section 4.9 and determined to be SMALL. In addition to impacts from construction, preconstruction, and operations, this cumulative analysis also considers other past, present, and reasonably foreseeable future actions that could contribute to cumulative radiological impacts. For the purposes of this analysis, the geographic area of interest is the area within a 50-mi radius of a new nuclear power plant at the PSEG Site. Historically, the NRC has used the 50-mi radius as a standard bounding geographic area to evaluate population doses from routine

releases from nuclear power plants. The area within a 50-mi radius of the PSEG Site includes HCGS; SGS Units 1 and 2; Peach Bottom Atomic Power Station, Units 1 and 2; and Limerick Generating Station, Units 1 and 2. The Shieldalloy radioactive materials decommissioning site in Newfield, New Jersey, is also within 50 mi of the PSEG Site. Also, within the 50-mi radius of the site, there are likely to be hospitals and industrial facilities that use radioactive materials.

As described in Section 4.9, the estimates of doses to workers during construction of a new nuclear power plant at the PSEG Site are well within the NRC annual exposure limits (i.e., 100 millirem [mrem] per year) designed to protect the public health. This estimate includes exposure to construction workers from the existing units at SGS, the unit at HCGS, ISFSI, and the first unit of an AP1000 during construction of the second unit, if an AP1000 is selected for the PSEG Site (PSEG 2015-TN4280). The dose to the maximally exposed individual from existing units and a new nuclear power plant at the PSEG Site would be well within the EPA's regulatory standard of 40 CFR Part 190 (TN739). In addition, based on results of the Radiological Environmental Monitoring Program (REMP) and the estimates of doses from a new nuclear power plant to biota other than humans given in Chapter 5.9, the NRC staff concludes that the cumulative radiological impact on biota other than humans would not be significant. The results of the REMP indicate that effluents and direct radiation from area hospitals and industrial facilities that use radioactive materials do not contribute measurably to the cumulative dose (PSEG 2015-TN4280).

Therefore, the NRC staff concludes that the cumulative radiological impacts of operating a new nuclear power plant at the PSEG Site, along with the existing units at SGS and HCGS, the ISFSI, and the influence of other human-made sources of radiation nearby, would be SMALL, and no further mitigation would be warranted.

7.9 Nonradiological Waste Systems

Cumulative impacts on water and air from nonradiological waste are discussed in Sections 7.2 and 7.6, respectively. The description of the affected environment in Chapter 2 serves as the baseline for the cumulative impact assessments in this resource area. As described in Sections 4.10 and 5.10, the impacts from construction and preconstruction and operation were determined to be SMALL, and further mitigation would not be warranted. In addition to the impacts from construction, preconstruction, and operations, the cumulative analysis also considers other past, present, and reasonably foreseeable future actions that could affect nonradiological waste systems.

Cumulative impacts on water and air from nonradiological waste are discussed in Sections 7.2 and 7.6, respectively. The cumulative impacts of nonradioactive waste destined for land-based treatment and disposal are related to (1) the available capacity of the area treatment and disposal facilities and (2) the amount of solid waste generated by a new nuclear power plant at the PSEG Site and the current and reasonably foreseeable future projects listed in Table 7-1. For this cumulative analysis, the geographic area of interest includes Salem County, New Jersey (in which the PSEG Site is located) and the other 24 counties located in the 50-mi region around the PSEG Site. The 50-mi region includes counties in New Jersey, Delaware, Maryland, and Pennsylvania (Section 2.2.3). The direct and indirect impacts of building and operating a new nuclear power plant at the PSEG Site and the proposed causeway would be confined to

Salem County, New Jersey, but the cumulative impacts when combined with other actions (see Table 7-1) would extend to other counties in New Jersey, Delaware, Maryland, and Pennsylvania.

Nonradioactive wastes generated by SGS, HCGS, and a new nuclear power plant at the PSEG Site would be managed in accordance with applicable Federal, State, and local laws and regulations and with permit requirements. As described in the PSEG ER (PSEG 2015-TN4280), nonradiological waste management practices for a new plant would be similar to those currently implemented for operation of SGS and HCGS and would include the following:

- nonradioactive solid waste would be collected and stored temporarily on the PSEG Site and disposed of offsite only at authorized and licensed commercial waste-disposal sites or recovered at an offsite permitted recycling or recovery facility, as appropriate;
- sanitary waste would be treated on the site;
- debris (e.g., vegetation) collected on trash screens at the water intake structure would be disposed of offsite as solid waste, in accordance with State regulations;
- scrap metal, lead acid batteries, and paper on the PSEG Site would be recycled;
- water discharges from cooling and auxiliary systems would be discharged directly and indirectly to the Delaware River through permitted outfalls; and
- air emissions from operations of SGS, HCGS, and a new plant at the PSEG Site would be compliant with air-quality standards as permitted by NJDEP.

During preconstruction and construction, offsite land-based waste treatment and disposal would be minimized by production and delivery of modular plant units; by segregation of recyclable materials; and by management of vegetative waste, excavated materials, and dredged materials onsite (PSEG 2015-TN4280). As described in Section 4.10.1, the solid waste impacts from building a new nuclear power plant at the PSEG Site would be expected to be minimal with no additional mitigation warranted. The few reasonably foreseeable future projects listed in Table 7-1 generally either would not coincide with building a new plant at the PSEG Site or would produce waste streams of a different nature.

The types of nonradioactive solid waste that would be generated, handled, and disposed of during operation of a new nuclear power plant would include municipal waste, dredge spoils, sewage treatment sludge, and industrial wastes. In addition, small quantities of hazardous waste and mixed waste (waste that has both hazardous and radioactive characteristics), would be generated during operations (PSEG 2015-TN4280). As described in Section 5.10.1 and mentioned above, the effective practices already in place at SGS and HCGS for recycling, minimizing, and managing waste would be used at a new nuclear plant at the PSEG Site; thus, expected impacts on land from nonradioactive wastes generated during operation of a new plant would be minimal, and no further mitigation would be warranted. Several of the projects listed in Table 7-1 would generate municipal and industrial waste. However, no known capacity constraints exist for the treatment or disposal of such types of waste within New Jersey, Delaware, or the nation as a whole (EPA 2011-TN2723; PSEG 2015-TN4280). Of the projects listed in Table 7-1, SGS, HCGS, hospitals, and other industrial facilities that use radioactive materials have the potential to generate mixed waste. However, none of the considered

projects is expected to generate mixed waste in significant quantities above the current rates, and therefore cumulative impacts would be minimal.

Overall, when combined with other past, present, and reasonably foreseeable future actions, the nonradioactive and mixed waste impacts of building and operating a new nuclear power plant at the PSEG Site and the proposed causeway would be minimal. Therefore, based on the information provided by PSEG and the review team's independent review, the review team concludes that the cumulative impacts from nonradioactive waste would be SMALL for the 50-mi region.

7.10 Postulated Accidents

As described in Section 5.11.4, the NRC staff concludes that the potential environmental impacts (risks) of a postulated accident from the operation of a new nuclear power plant at the PSEG Site would be SMALL. Section 5.11 considers both design basis accidents (DBAs) and severe accidents. As described in Section 5.11.1, the staff concludes that the environmental consequences of DBAs at the PSEG Site would be SMALL for a U.S. Advanced Pressurized Water Reactor (US-APWR), two AP1000s, a U.S. Evolutionary Power Reactor (U.S. EPR), or an Advanced Boiling Water Reactor (ABWR). DBAs are addressed specifically to demonstrate that a reactor design is robust enough to meet NRC safety criteria. The consequences of DBAs are bounded by the consequences of severe accidents.

As described in Section 5.11.2, the NRC staff concludes that the severe-accident probability-weighted consequences (i.e., risks) of a US-APWR, two AP1000s, a U.S. EPR, or an ABWR at the PSEG Site would be minimal compared to risks to which the population is generally exposed, and no further mitigation would be warranted.

The cumulative analysis considers risk from potential severe accidents at all other existing and proposed nuclear power plants that have the potential to increase risks at any location within 50 mi of the PSEG Site. The 50-mi radius was selected to cover any potential overlaps from two or more nuclear plants. Existing reactors that contribute to risk within the geographic area of interest include HCGS (Unit 1), SGS (Units 1 and 2), Peach Bottom Atomic Power Station Units 2 and 3, Limerick Generating Station Units 1 and 2, Oyster Creek Nuclear Generating Station, Three Mile Island Nuclear Station Unit 1, and Calvert Cliffs Nuclear Power Plant Units 1 and 2.

Tables 5-30 and 5-31 in Section 5.11.3.2 provide comparisons of estimated risk for the proposed new reactor (a US-APWR, two AP-1000s, a U.S. EPR, or an ABWR) and current-generation reactors. The estimated population dose risk for the new reactor(s) is well below the mean and median value for current-generation reactors. In addition, estimates of average individual early fatality and latent cancer fatality risks are well below the Commission's safety goals (51 FR 30028-TN594). For existing nuclear generating stations within the geographic area of interest—namely HCGS (Unit 1), SGS (Units 1 and 2), Peach Bottom Atomic Power Station Units 2 and 3, Limerick Generating Station Units 1 and 2, Oyster Creek Nuclear Generating Station, Three Mile Island Nuclear Station Unit 1, and Calvert Cliffs Nuclear Power Plant Units 1 and 2—the Commission has determined that the probability-weighted consequences of severe accidents are small (10 CFR Part 51-TN250).

It is expected that risks for any new reactors at the PSEG Site would be well below risks for current-generation reactors and would meet the Commission's safety goals. The severe accident risk due to any particular nuclear power plant gets smaller as the distance from that plant increases. However, the combined risk at any location within 50 mi of the PSEG Site would be bounded by the sum of risks for all these operating and proposed nuclear power plants. Even though there potentially would be several plants included in the combination, this combined risk still would be low. On this basis, the NRC staff concludes that the cumulative risks of postulated accidents at any location within 50 mi of the PSEG Site likely would be SMALL, and no further mitigation should be warranted.

7.11 Fuel Cycle, Transportation, and Decommissioning

The cumulative impacts related to the fuel cycle, radiological and nonradiological aspects of transportation, and facility decommissioning for a new nuclear power plant at the PSEG Site are described below.

7.11.1 Fuel Cycle

As described in Section 6.1, the NRC staff concludes that the impacts of the fuel cycle due to operation of a new nuclear power plant at the PSEG Site would be SMALL. Fuel-cycle impacts not only would occur at the site but also would be scattered through other locations in the United States or, in the case of foreign-purchased uranium, in other countries.

Table S-3 of 10 CFR 51.51 (TN250) provides the environmental impacts from uranium fuel-cycle operations for a model 1,000-MW(e) light water reactor operating at 80 percent capacity with a 12-month fuel-loading cycle and an average fuel burnup of 33,000 megawatt-days per metric ton of uranium (MWd/MTU). Per 10 CFR 51.51(a) (TN250), the NRC staff concludes that those impacts would be acceptable for the 1,000-MW(e) reference reactor. The impacts of producing and disposing of nuclear fuel include mining the uranium ore, milling the ore, converting the uranium oxide to uranium hexafluoride, enriching the uranium hexafluoride, fabricating the fuel (where the uranium hexafluoride is converted to uranium oxide fuel pellets), and disposing of the spent fuel in a proposed Federal waste repository. As discussed in Section 6.1, advances in reactors since the development of Table S-3 in 10 CFR 51.51 (TN250) would reduce environmental impacts relative to the operating reference reactor. For example, a number of fuel-management improvements have been adopted by nuclear power plants to achieve higher performance and to reduce fuel and separative work (enrichment) requirements. As discussed in Section 6.1, the environmental impacts of fuel-cycle activities for a proposed new nuclear power plant would conservatively be about 3 times those presented in Table S-3 of 10 CFR 51.51 (TN250).

Existing nuclear facilities in close proximity to the proposed PSEG Site include SGS Units 1 and 2 and HCGS Unit 1. Other plants, such as Peach Bottom Atomic Power Station and Limerick Generating Station, are sufficiently distant that environmental impacts resulting from fuel-cycle activities at these facilities would remain isolated from those associated with proposed and existing facilities in the vicinity of the PSEG Site. The net environmental impacts of fuel-cycle activities for the proposed new nuclear power plant combined with the existing Salem and Hope Creek units would conservatively be about 7 times those presented in Table S–3 of 10 CFR 51.51 (TN250). Only a small portion of this impact would be realized near the PSEG

Site. The staff concludes that the cumulative fuel-cycle impacts of operating a new nuclear power plant at the PSEG Site would be minimal, and additional mitigation would not be warranted.

7.11.2 Transportation of Radioactive Material

As described in Section 6.2, the NRC staff concludes that impacts of transporting unirradiated fuel to the PSEG Site and irradiated fuel and radioactive waste from the site would be SMALL. In addition to impacts from preconstruction, construction, and operations, the cumulative analysis considers other past, present, and reasonably foreseeable future actions that could contribute to cumulative transportation impacts. For this analysis, the geographic area of interest is the 50-mi region surrounding the PSEG Site.

Historically, the radiological impacts on the public and environment associated with transportation of radioactive materials in the 50-mi region surrounding the PSEG Site have been associated with shipments of fuel and waste to and from the existing SGS Units 1 and 2 and HCGS, located adjacent to the PSEG Site. Radiological impacts of transporting radioactive materials would occur along the routes leading to and from the PSEG Site, SGS, HCGS, and fuel-fabrication facilities and waste-disposal sites located in other parts of the United States. Because of their distance from the PSEG Site, it is not likely that shipments to or from the Peach Bottom Atomic Power Station or the Limerick Generating Station would be associated with cumulative radiological transportation impacts. No other major activities with the potential for cumulative radiological transportation impacts were identified in the geographic area of interest. Based on Table S-4 in 10 CFR 51.52 (TN250), the impacts of transporting unirradiated fuel to SGS and HCGS and irradiated fuel and radioactive waste from SGS and HCGS would be minimal. When combined with the impacts of transporting unirradiated fuel to the PSEG Site and irradiated fuel and radioactive waste from the site, the cumulative impacts of transporting unirradiated fuel to the PSEG Site and to SGS and HCGS, as well as irradiated fuel and radioactive waste from the PSEG Site and from SGS and HCGS, also would be minimal. The past, present, and reasonably foreseeable future impacts in the region surrounding the PSEG Site are also a small fraction of the impacts from natural background radiation.

Advances in reactor technology and operations since the development of Table S-4 would reduce environmental impacts relative to the values in Table S-4 (10 CFR Part 51-TN250); therefore, the values in Table S-4 remain bounding. For example, improvements in fuel management have been adopted by nuclear power plants to achieve higher performance and reduce fuel requirements. This leads to fewer unirradiated fuel and spent fuel shipments than the 1,000-MW(e) reference reactor discussed in 10 CFR 51.52 (TN250). In addition, advances in shipping cask designs to increase capabilities would result in fewer shipments of spent fuel to offsite storage or disposal facilities. This would reduce the cumulative impacts of transporting unirradiated fuel to the PSEG Site and to SGS and HCGS and irradiated fuel and radioactive waste from the PSEG Site and from SGS and HCGS.

Therefore, the NRC staff considers the cumulative impacts of transporting unirradiated fuel to and irradiated fuel and radioactive waste from a new nuclear power plant at the PSEG Site to be minor, and no further mitigation would be warranted.

7.11.3 Decommissioning

As discussed in Section 6.3, the environmental impacts from decommissioning a new nuclear power plant at the PSEG Site are expected to be SMALL because the licensee would have to comply with decommissioning regulatory requirements.

In this cumulative analysis, the geographic area of interest is within a 50-mi radius of the PSEG Site. SGS Units 1 and 2 and HCGS Unit 1 are located in close proximity to the PSEG Site. Other nuclear facilities located within 50 mi of the PSEG Site include Peach Bottom Atomic Power Station Units 2 and 3 about 44 mi northwest of the PSEG Site, and Limerick Generating Station Units 1 and 2 about 50 mi north of the PSEG Site. In Supplement 1 to the *Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities*, the NRC found the impacts on radiation dose to workers and the public, waste management, water quality, air quality, ecological resources, and socioeconomics to be small (NRC 2002-TN665). In addition, in Section 6.3, the NRC staff concluded that the impact of GHG emissions on air quality during decommissioning would be minimal. Therefore, the cumulative impacts from decommissioning a new nuclear power plant proposed for the PSEG Site would be minimal, and additional mitigation would not be warranted.

7.11.4 Summary of Cumulative Fuel Cycle, Transportation, and Decommissioning Impacts

Based on the analysis above, the cumulative impacts from fuel-cycle activities, transportation of radioactive material, and decommissioning would be SMALL, and additional mitigation would not be warranted.

7.12 Conclusions

The review team considered the potential cumulative impacts resulting from construction, preconstruction, and operations of a new nuclear power plant at the PSEG Site together with other past, present, and reasonably foreseeable future actions. The specific resources that could be affected by the proposed action and other past, present, and reasonably foreseeable actions in the same geographic area were assessed. This assessment included the impacts of construction and operations for a new nuclear power plant as described in Chapters 4 and 5, respectively; impacts of preconstruction activities as described in Chapter 4; impacts of fuel-cycle, transportation, and decommissioning impacts described in Chapter 6; and impacts of other past, present, and reasonably foreseeable future Federal and non-Federal actions (listed in Table 7-1) that could affect the same resources as the proposed action.

Table 7-4 summarizes the cumulative impacts by resource area. The cumulative impacts for most of the resource areas would be SMALL, although there could be MODERATE or LARGE cumulative impacts for some resources, as described below.

Table 7-4. Cumulative Impacts on Environmental Resources, Including the Impacts of a New Nuclear Power Plant at the PSEG Site

Resource Category	Comments	Impact Level
Land-Use	In addition to the land requirements for a new nuclear power plant at the PSEG Site, causeway, and other associated facilities, the surrounding area is expected to experience continued low-density urban growth including transmission lines. The acquisition of 85 ac on Artificial Island and potential new transmission line being developed by PJM could have a noticeable impact on land-use resources in the region. Thus, cumulative land-use impacts would be noticeable for the 50-mi region. Building and operating a new nuclear power plant on the PSEG Site would contribute to impacts to land-use resources.	MODERATE
Water-Related		
Surface-Water Use	There would be noticeable cumulative surface-water-use impacts, primarily due to the extensive past and present use of surface water from the Delaware River. The incremental contribution to cumulative surface-water-use impacts from building and operating a new nuclear power plant at the PSEG Site would be minor because the consumptive water use would be a small percentage of the river flow, even under drought conditions, and it is reasonably foreseeable that there would be sufficient water in the Merrill Creek reservoir to offset a new plant's consumptive use. However, the ESP plant parameter envelope may require surface-water withdrawals from the Delaware River that would cause the currently permitted PSEG allocation in the Merrill Creek reservoir to fall short by 6.9 percent. PSEG has the option to either revise the consumptive water-use allocations of other power plants it owns and supports through its storage allocation in the Merrill Creek reservoir or acquire additional storage from the existing rights of other Merrill Creek co-owners.	MODERATE
Groundwater Use	There would be noticeable cumulative groundwater-use impacts, primarily because of the extensive past and present regional groundwater withdrawals from the PRM aquifer system. The incremental contribution to cumulative groundwater-use impacts from building and operating a new nuclear power plant at the PSEG Site would be minor because of the relative isolation of the site from the nearest groundwater users and the limits on the maximum permitted withdrawal.	MODERATE
Surface-Water Quality	There would be noticeable cumulative surface-water-quality impacts, primarily because of the adverse effects of past and present activities in the Delaware River Basin. However, the incremental contribution to cumulative surface-water-quality impacts from building and operating a new nuclear power plant at the PSEG Site would be minor because the volume of discharge is small relative to the volume of the Delaware River, and discharges are subject to permit limits.	MODERATE

Table 7-4. (continued)

Resource Category	Comments	Impact Level
Groundwater Quality	There would be noticeable cumulative groundwater-quality impacts, primarily because of increases in aquifer salinity from past and present groundwater withdrawals in the region. However, these groundwater-quality impacts have been localized to areas where pumping occurs near aquifer recharge areas. The incremental contribution to cumulative groundwater-use impacts from building and operating a new nuclear power plant at the PSEG Site would be minor because the PSEG Site is a significant distance from the PRM aquifer system recharge areas and is relatively isolated from the nearest groundwater users. In addition, the presence of aquitards between the PRM aquifer system and the overlying saltwater-impacted aquifers limits the potential for localized saline intrusion.	MODERATE
Ecology		
Terrestrial Ecosystems and Wetlands	Past and present projects listed in Table 7-1 have resulted in fragmentation and loss of habitat in the geographical ROI. Habitat loss and fragmentation is expected to increase as a result of future projects in the region. Most of the projects are expected to contribute only minor impacts. However, important wetlands and forestland habitat could be affected by the proposed grid stability transmission line being developed by PJM. Although the amount of forestland and wetlands converted for the use of the transmission is expected to be minor relative to the amount available in the region, the disturbance could have a noticeable effect on the bog turtle and northern long-eared bat. Building and operating a new nuclear power plant on the PSEG Site would contribute to impacts to important wetland resources.	MODERATE
Aquatic Ecosystems	The significant history of the degradation of the Delaware River Estuary has had a noticeable and sometimes destabilizing effect on many aquatic species and communities. Commencement of operations at SGS Units 1 and 2 resulted in significant numbers of aquatic species being entrained and impinged, which led to required restoration of the area through the EEP as a form of mitigation. In addition, present and reasonably foreseeable future activities such as the continued operation of SGS and HCGS and the completion of dredging operations for the Delaware River Main Channel Deepening Project would continue to have effects on the aquatic resources in the Delaware River Estuary. The cumulative impacts of past, present, and reasonably foreseeable future activities, including climate change, on the aquatic resources of the Delaware River Estuary would be MODERATE to LARGE. However, the incremental contribution of the NRC-authorized activities related to construction and operation of a new nuclear power plant at the PSEG Site would not be a significant contributor to the cumulative MODERATE to LARGE impact.	MODERATE to LARGE

Table 7-4. (continued)

Resource Category	Comments	Impact Level
Socioeconomic Resources		
Physical Impacts	New cooling towers would have noticeable, but not destabilizing, adverse impacts associated with the aesthetics in certain locations.	SMALL to MODERATE
Demography	Small and temporary demographic impacts would occur in the communities nearest the PSEG Site as associated with building a new nuclear power plant at that location.	SMALL
Taxes and Economy	Substantial beneficial economic impacts from operation of a new nuclear power plant at the PSEG Site would occur in Salem County. Noticeable but not destabilizing beneficial impacts would occur from tax revenues to the State of New Jersey. Other economic impacts in the region would be minimal.	SMALL (beneficial for the region) to LARGE (beneficial for Salem County)
Infrastructure and Community Services	Traffic impacts would be noticeable but not destabilizing during peak building employment for any new nuclear power plant at the PSEG Site. Other infrastructure and community services impacts would be minimal.	SMALL to MODERATE
Environmental Justice	There would be no disproportionately high and adverse cumulative impacts to minority or low-income populations.	None[(a)]
Historic and Cultural Resources	The principal contributor to the impact level is the impact from the PJM transmission line upgrade. The incremental contribution of NRC-authorized would be a significant contributor to the cumulative impact if natural draft cooling towers are selected.	MODERATE
Air Quality		
Criteria Pollutants	The cumulative impacts on criteria pollutants from air emissions from a new nuclear power plant at the PSEG Site and other projects would be minimal.	SMALL
Greenhouse Gas Emissions	The national and worldwide cumulative impacts of GHG emissions are noticeable but not destabilizing. A new nuclear power plant at the PSEG Site would not significantly contribute to GHG emissions in the region.	MODERATE
Nonradiological Health	Cumulative impacts on public and worker nonradiological health would not be noticeable.	SMALL
Radiological Impacts of Normal Operation	Public and occupational doses predicted from operating a new nuclear power plant at the PSEG Site would be below regulatory limits and standards. The cumulative radiological impact on biota other than humans would not be significant. The cumulative radiological impacts of operating a new nuclear power plant at the PSEG Site, along with the existing units at SGS and HCGS, the ISFSI, and the influence of other human-made sources of radiation nearby, would be minimal.	SMALL
Nonradioactive Waste	Available treatment and disposal capacity exists in New Jersey for municipal solid waste and construction, demolition, and land-clearing debris, and the generation of mixed and hazardous waste would be minimal.	SMALL

Table 7-4. (continued)

Resource Category	Comments	Impact Level
Postulated Accidents	The probability-weighted consequences of severe accidents are SMALL for all of the existing plants within the geographic area of interest, and the combined risk would be low.	SMALL
Fuel Cycle, Transportation, and Decommissioning	The cumulative impacts related to the fuel cycle, transportation of radioactive materials (fuel and waste), and facility decommissioning for all nuclear facilities located within 50 mi of the PSEG Site would be minimal.	SMALL

(a) The entry "None" for Environmental Justice does not mean there are no adverse impacts to minority or low-income populations from the proposed action. Rather, "None" means that, while there may be adverse impacts, those impacts do not affect minority or low-income populations in any disproportionate manner, relative to the general population.

8.0 NEED FOR POWER

PSEG Power, LLC, and PSEG Nuclear, LLC (PSEG), has submitted to the U.S. Nuclear Regulatory Commission (NRC) an application for an early site permit (ESP) to expand its nuclear generation capacity. PSEG Power, LLC, and PSEG Nuclear, LLC, are merchant power generators, separate entities from Public Service Electric and Gas Company (PSE&G), which is one of four electric delivery companies (EDCs) in the State of New Jersey. The New Jersey Board of Public Utilities (NJBPU) has limited or no regulatory authority over PSEG. Instead, NJBPU's regulatory authority is limited to the EDCs that are responsible for the distribution of electricity throughout New Jersey, including the array of social programs and renewable technologies required to meet New Jersey's Renewable Portfolio Standard (New Jersey 2011-TN2115). Any new nuclear power plant built and operated on the PSEG Site would function as a merchant power vendor supplying wholesale power to the competitive power markets administered by PJM Interconnection, LLC (PJM), which is the regional transmission organization (RTO) for the area. PSEG indicated in its Environmental Report (ER) that the relevant service area (RSA) for the new nuclear power plant is the State of New Jersey (PSEG 2015-TN4280). For consistency between the need for power analysis and the applicant's stated purpose and need for the action, the review team determined that a need for power assessment that looked exclusively at the demand and generating assets of the four utility regions of New Jersey was a reasonable area of study.

In accordance with guidance from NUREG–1555, *Standard Review Plans for Environmental Reviews for Nuclear Power Plants: Environmental Standard Review Plan* (NRC 2000-TN614), and the staff's internal guidance, ISG-026, *Interim Staff Guidance on Environmental Issues Associated with New Reactors* (NRC 2014-TN3767), the need for power analysis period extends 3 years past the planned commercial operation date. Because of limitations in the data upon which the review team relied, forecasts for demand, supply, and the need for power are provided only through 2023—2 years after the planned commercial operation date of 2021. However, given the method used to develop the forecasts, the review team determined that the difference in projections between the second and third year of operation—12 and 13 years past the beginning of forecasted data—would be sufficiently small that the assessment considering 2 years after planned operation was a reasonable approximation of the need for power in the PSEG service area.

PSEG prepared the initial forecasts for electricity demand, supply, and need for power in early 2010 using data and information available at that time. The review team assessed the applicant's need for power determination and the impact of key changes in the economy and electric power markets that have occurred since 2010, based on 2013 PJM data and information. This chapter represents the review team's assessment of the need for power based on the information in the applicant's ER, important changes in the power market that have emerged since 2010 (in particular, the burgeoning natural gas market), and their impact on the RSA.

The ESP application is based on a plant parameter envelope approach that considers the environmental impacts of a nuclear power plant using design parameters from four potential power plant designs: the U.S. Evolutionary Power Reactor, Advanced Boiling Water Reactor,

U.S. Advanced Pressurized Water Reactor, and Advanced Passive 1000 (two-unit) designs. Because the two-unit Advanced Passive 1000 plant has a larger net electrical output at 2,200 MW(e) than a single unit of any of the other reactor designs, the review team selected it as the basis for the ESP need for power determination (PSEG 2015-TN4280). The need for power analysis establishes a framework for evaluating project benefits for the region in which the majority of the benefits from a new nuclear power plant would be distributed.

The following is a summary of the relevant factors considered in the review team's need for power analysis. The results of the need for power analysis are presented in detail in the remaining sections of this chapter.

- The applicant determined the market area for a new nuclear power plant to be the State of New Jersey.
- Average retail electricity rates in New Jersey are currently ranked tenth highest in the United States (DOE/EIA 2013-TN2874) because of the lack of baseload generation in the market area, which means PJM must use intermediate and peaking units within New Jersey and generating units from other states to provide baseload power. In addition to being more expensive, using intermediate or peaking units to provide baseload power also contributes to higher emissions because they are typically fossil-fueled.
- PSEG identified, as part of the benefits of a new nuclear power plant, achieving two of the five overarching goals of Governor Chris Christie's New Jersey power policy, the 2011 New Jersey Energy Master Plan (NJEMP). Those two goals are to drive down the cost of energy for all customers and promote a diverse portfolio of new, clean, in-state generation (New Jersey 2011-TN2115).

The review team's need for power analysis relies on data from the same PJM source as the applicant used in its ER, but for later years. In addition, while the applicant made its need for power determination based on baseload conditions, the staff made its determination based on total demand and capacity because baseload data at the RTO level of aggregation are extremely difficult to obtain. However, the review team determined that both the applicant's need for power assessment and that performed by the NRC staff are both reasonable approximations of the future (total and baseload) demand and supply of electricity in 2023. The review team's findings are discussed in detail in the remainder of this chapter, which is organized into four sections. Section 8.1 describes the market area and the overall power market for a new nuclear power plant, addressing characteristics such as the geographic scope, population, major load centers, EDCs, independent system operator requirements, status of deregulation, and competitive wholesale markets. Section 8.2 describes the historical and forecasted demand for electricity in the market area served by a new nuclear power plant at the PSEG Site. Section 8.3 describes the existing and planned power supply available to meet the demand for power in the market area. Section 8.4 assesses the need for the power that would be generated by a new nuclear power plant at the PSEG Site by comparing the forecasted demand for electricity to the planned power supply. Other considerations, such as the impact generation from a new plant would have on imports, transmission congestion, regional emissions including greenhouse gases, and cost of power, are topics discussed in Section 10.6.

8.1 Description of Power System

The applicant has chosen the State of New Jersey as its market area. This section discusses the rationale for that choice and describes factors in and near New Jersey that affect power markets in New Jersey.

8.1.1 Rationale for Choosing New Jersey as the Market Area

The market area for PSEG's ESP application is the State of New Jersey, which is part of the power market area administered by PJM, the RTO for the area. The market area is based on the region where PSEG delivers most of its current generation, where it anticipates its future new generation will be delivered, and where it expects new generation would provide the greatest benefit. The market area has a large population and several major load centers. Currently, most of New Jersey's baseload power needs are met by imported power, with a heavy reliance on local intermediate and peaking units, all of which run on fossil fuels. The location of a new nuclear power plant at the PSEG Site is in a favorable geographic area for serving the market area because a new plant would reduce reliance on intermediate and peaking power generation sources in the market area and would decrease the amount of baseload power currently imported into the RSA. In addition, a significant portion of the existing transmission system directly servicing the PSEG Site extends directly into the regions of major load within New Jersey.

PJM expects New Jersey will continue to rely on imported power to meet growth in peak power demand. However, importing large amounts of power often leads to transmission congestion, a condition where increased power flows challenge the operational limits of critical portions of the transmission system, resulting in higher electricity costs in New Jersey.

Construction of new transmission lines and upgrades to existing transmission lines is a long, costly, and public process that is required for increased importation of power into the RSA. The new Susquehanna–Roseland 500-kV transmission line project creates a more stable link from generation sources in northeastern and north-central Pennsylvania, across northeastern Pennsylvania and into New Jersey. This new link is required by PJM as part of its Regional Transmission Expansion Plan (RTEP) to meet system reliability requirements in the immediate future. However, due to lower regional load growth, the installation of new intermediate and peaking gas-fired power plants, and the increase in demand response (DR) programs, the PJM Board cancelled two other transmission line construction projects that were designed to improve the transfer of power from western PJM into the Eastern Mid-Atlantic Area Council (EMAAC) region of the PJM system, of which New Jersey is a part. Consequently, imports of baseload capacity from western PJM to New Jersey cannot be increased to accommodate increasing demand without causing increased congestion, higher power prices, and potential reliability issues.

Finally, choosing New Jersey as the market area is aligned with two of the five overarching goals of the NJEMP (New Jersey 2011-TN2115).

To drive down the cost of energy for all customers: While nuclear power plants have high construction costs, those costs are considered "sunk costs" for purposes of setting the price of

electricity. For price determination, firms only consider variable costs—the cost of actually producing electricity (operations, maintenance, fuel, etc.)—and nuclear power plants are among the lowest variable cost producers in the PJM market. Introducing up to 2,200 MW of new, low-cost electricity to the PJM Day-Ahead Market (DAM) for energy would displace the same amount of electricity that had formerly been among the last units bid into the market (i.e., the highest priced units that established the market price in the bid process), thereby reducing the price of wholesale electricity.[(1)]

To promote a diverse portfolio of new, clean, in-state generation: The intermediate and peaking units in New Jersey that are dispatched due to the lack of baseload capacity are typically fossil-fueled. Even considering the congestion relief projected by the approved Susquehanna–Roseland transmission project, the types of generating units that supply imported power from the western portion of PJM also are often fossil-fueled and typically coal-fired. A new nuclear power plant at the PSEG Site would generate electricity while producing only minimal criteria or hazardous air pollutants or carbon dioxide emissions and, while some displaced fossil-fuel-based generation would find markets elsewhere, some of the displaced generating capacity likely could be retired, resulting in a net reduction of these pollutants.

8.1.2 Structure of Power Markets Serving New Jersey

PJM maintains the bulk electricity power supply system reliability for 13 states and Washington, D.C. In doing so, PJM serves 51 million people, including the major U.S. load centers from the western border of Illinois to the Atlantic coast: the metropolitan areas in and around Baltimore, Chicago, Columbus, Dayton, Newark and northern New Jersey, Norfolk, Philadelphia, Pittsburgh, Richmond, and Washington, D.C. Figure 8-1 displays the PJM service area. The service areas of the EDCs serving New Jersey are shown in Figure 8-2. These companies are PSE&G, Rockland Electric Company (RECO), Jersey Central Power & Light Company (JCPL), and Atlantic City Electric (AE). PSE&G is one of the largest combined electric and gas companies in the United States and is also New Jersey's oldest and largest publicly owned utility. PSE&G has more than 1.8 million gas and 2.2 million electric customers in more than 300 urban, suburban, and rural communities, including the six largest New Jersey cities (Newark, Jersey City, Paterson, Elizabeth, Edison, and Woodbridge Township) (BGS-Auction 2013-TN2284).

PSE&G currently serves nearly three-quarters of New Jersey's population in a service area covering a 2,600-mi^2 diagonal corridor from Bergen County in the northeastern portion to Gloucester County in the southwest. PSE&G is the largest provider of electric and gas service in New Jersey.

RECO is a wholly owned subsidiary of Orange and Rockland Utilities, Inc., an electric and gas utility headquartered in Pearl River, New York. RECO provides electric service within the

(1) While the NRC recognizes the economic consequences of interjecting a new, lower cost source of electricity into the market that will drive out marginally priced generators, thereby lowering the wholesale price for electricity in the market, the NRC also recognizes that the retail price paid by customers is dependent on a large number of variables. Therefore, discussion of retail prices or rates is too speculative for the purposes of an environmental impact statement.

northern parts of Bergen and Passaic Counties and small areas in the northeastern and northwestern parts of Sussex County, New Jersey (BGS-Auction 2013-TN2284).

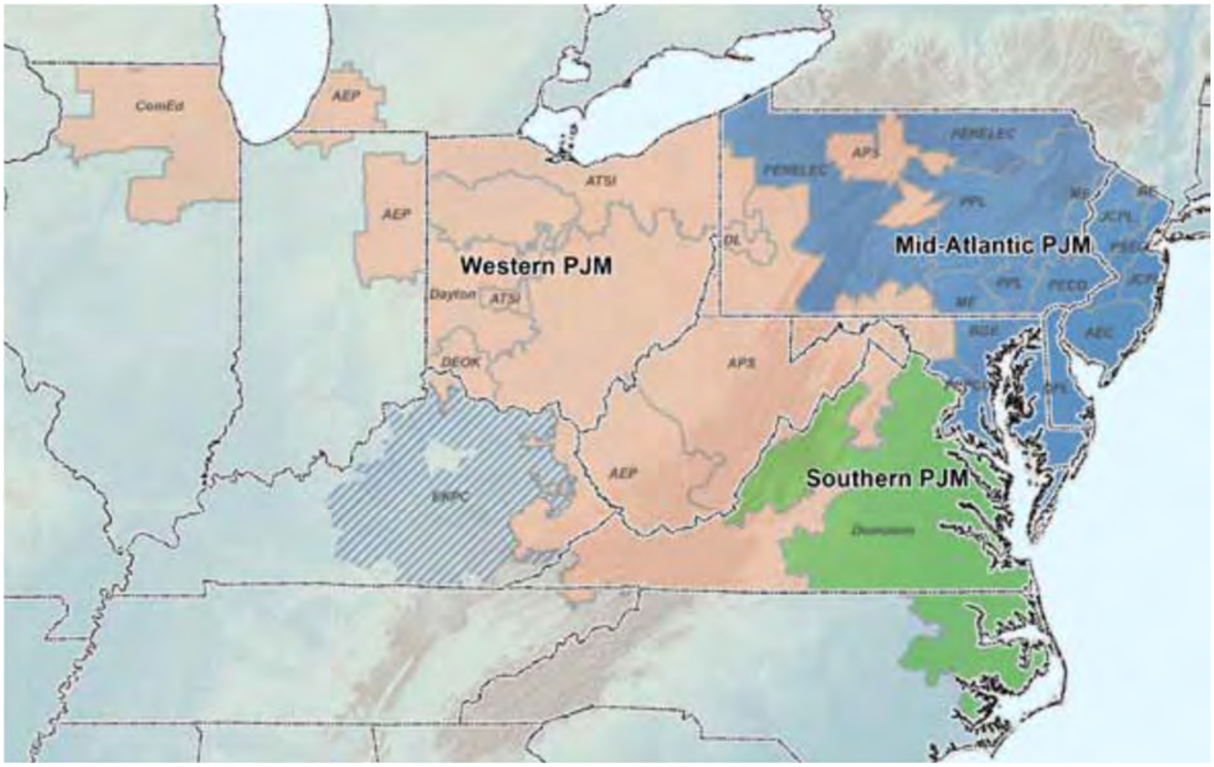

Figure 8-1. PJM Interconnection, LLC, Service Area (Source: PJM 2012-TN1549)

JCPL is headquartered in Morristown, New Jersey, and provides electric service to roughly one million residential and business customers within 3,200 mi^2 of northern and central New Jersey. JCPL is a member of the *First*Energy family of companies (BGS-Auction 2013-TN2284).

AE, a subsidiary of Pepco Holdings, Inc., is a regulated utility that provides electric service to more than 574,000 customers in southern New Jersey (BGS-Auction 2013-TN2284).

New Jersey has restructured the manner in which utilities are regulated, and utilities no longer engage in traditional integrated resource planning. In 1999, New Jersey electricity customers were allowed to choose their electricity provider through the Electric Discount and Energy Competition Act (State of New Jersey 1999-TN3292). As a result of this Act, the different utility responsibilities were unbundled and the power industry was separated into four divisions: generation, transmission, distribution, and energy services. Utilities were essentially required to divest generating plants, and, as a result, utilities are no longer the sole producers of electricity. New Jersey, in turn, no longer issues certificates of convenience and necessity for deregulated merchant power vendors. This means that merchant power vendors operate “at risk” rather than under rate-of-return regulation. The transmission and distribution sectors remain subject to regulation by the Federal government through the Federal Energy Regulatory Commission and NJBPU. NJBPU has adopted an auction mechanism for procurement of electric supply covering the power needs of the state.

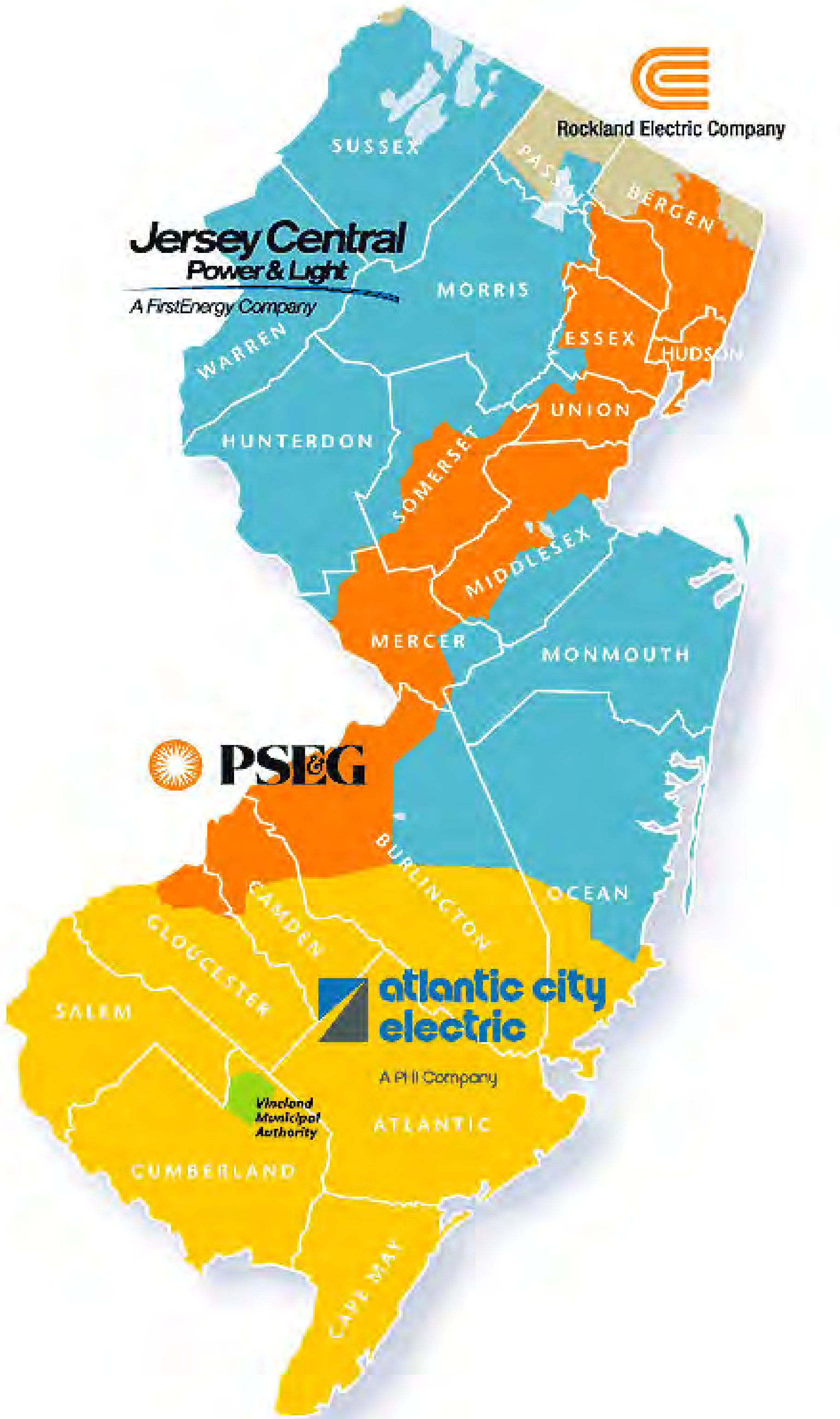

Figure 8-2. New Jersey Electric Utility Service Areas (Source: NJCEP 2014-TN3127)

8.1.3 Electric System Reliability in New Jersey

Electricity provided to consumers in New Jersey is bought and sold in the competitive wholesale electricity markets administered by PJM through the DAM, an auction where, 1 day before delivery of the power, electricity suppliers make offers to provide a specific amount of electricity at a specific price. PJM separates DAM participants into two groups: (1) self-scheduling power generators and (2) day-ahead auction participants. Self-scheduling power generators are generators of electricity that sign annual agreements with PJM to participate in the daily auction market for planning purposes but to provide power to the grid at whatever price PJM determines as the market price. Day-ahead auction participants do not ensure their maximum participation by acting as price takers but instead compete hourly for a portion of the remaining electricity market (after the self-scheduled capacity is accounted for) by bidding a specific price and quantity.

Through the DAM, PJM incrementally accepts bids from day-ahead auction participants, starting with the lowest remaining offer price (after the capacity of the self-scheduling generators has been accounted for), until the sum of the accepted capacity is sufficient to meet the next day's expected demand for each hour. This auction establishes the lowest possible electricity market price for that day. To ensure grid reliability, PJM divides its region into three locational deliverability areas, allowing the RTO to anticipate areas where transmission of needed power may be constrained.

New Jersey is under the jurisdiction of Reliability*First* Corporation (RFC) for electric system reliability. RFC was organized to develop regional standards for reliability planning and operation of the regional electric power system and to provide nondiscriminatory compliance monitoring and enforcement of both the North America Electric Reliability Corporation (NERC) and RFC standards in its region (TDW 2005-TN2286). PJM establishes reserve margin requirements in compliance with RFC standards and coordinates a capacity market to ensure that generation is available to meet these requirements. Figure 8-3 displays a map of the ReliabilityFirst region.

A new nuclear power plant at the PSEG Site would increase power grid reliability by adding up to 2,200 MW of baseload generation within New Jersey. The agreements that PJM holds with adjacent NERC regions and subregions would allow a new plant to support New Jersey loads and potentially alleviate conditions that can create localized areas of congestion in the region. As shown in Figure 8-4, the U.S. Department of Energy (DOE) has identified New Jersey and EMAAC as part of a larger region within PJM having congestion problems that adversely affect local economies (known as "critical congestion areas") (DOE 2013-TN2287). Limitations in the west-to-east transmission of power across the Allegheny Mountains and the growing demand for baseload power at load centers in New Jersey and along the East Coast contribute to these areas of congestion. Section 8.3 discusses regional 500-kV transmission projects that have been approved by PJM to help address congestion issues.

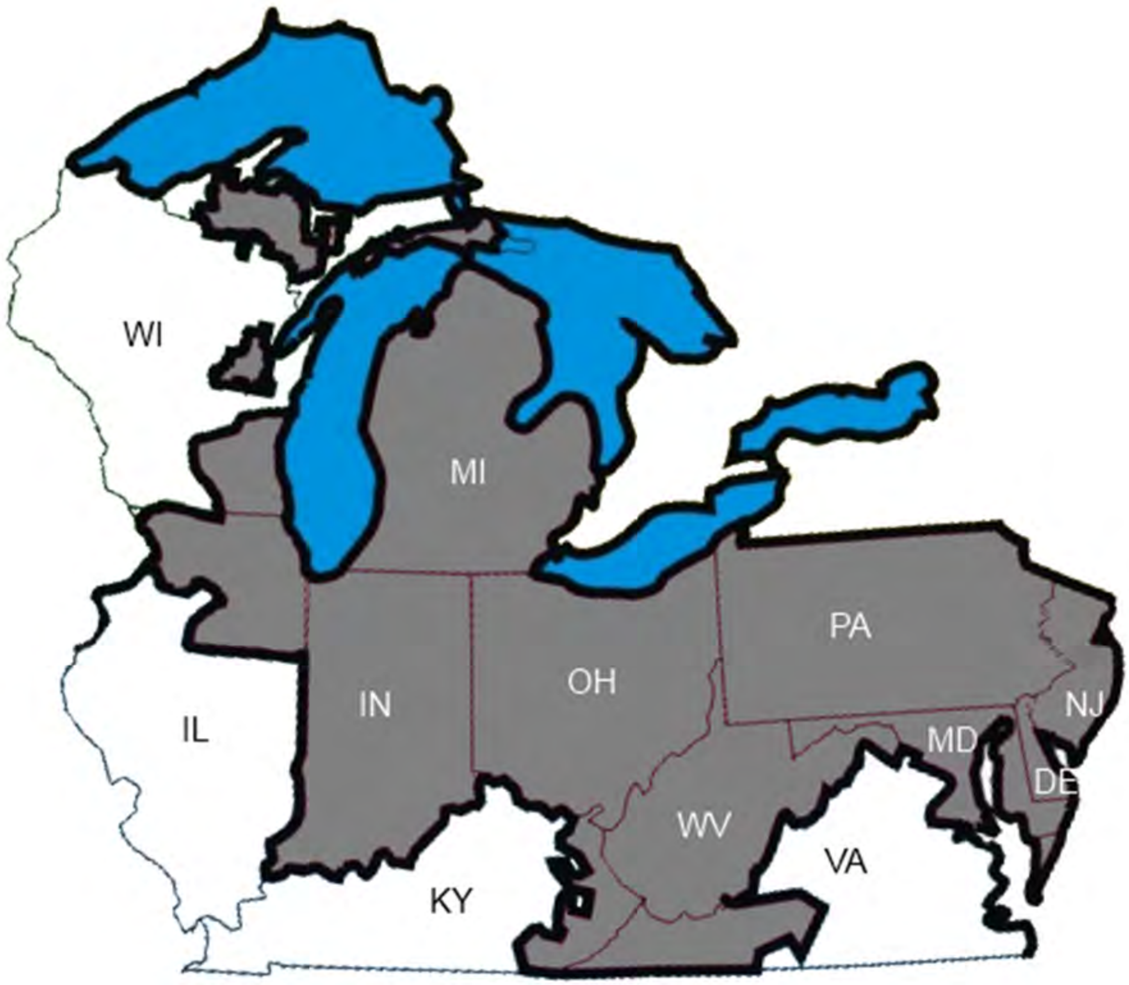

Figure 8-3. Map of the Reliability*First* Region (Source: NERC 2012-TN1547)

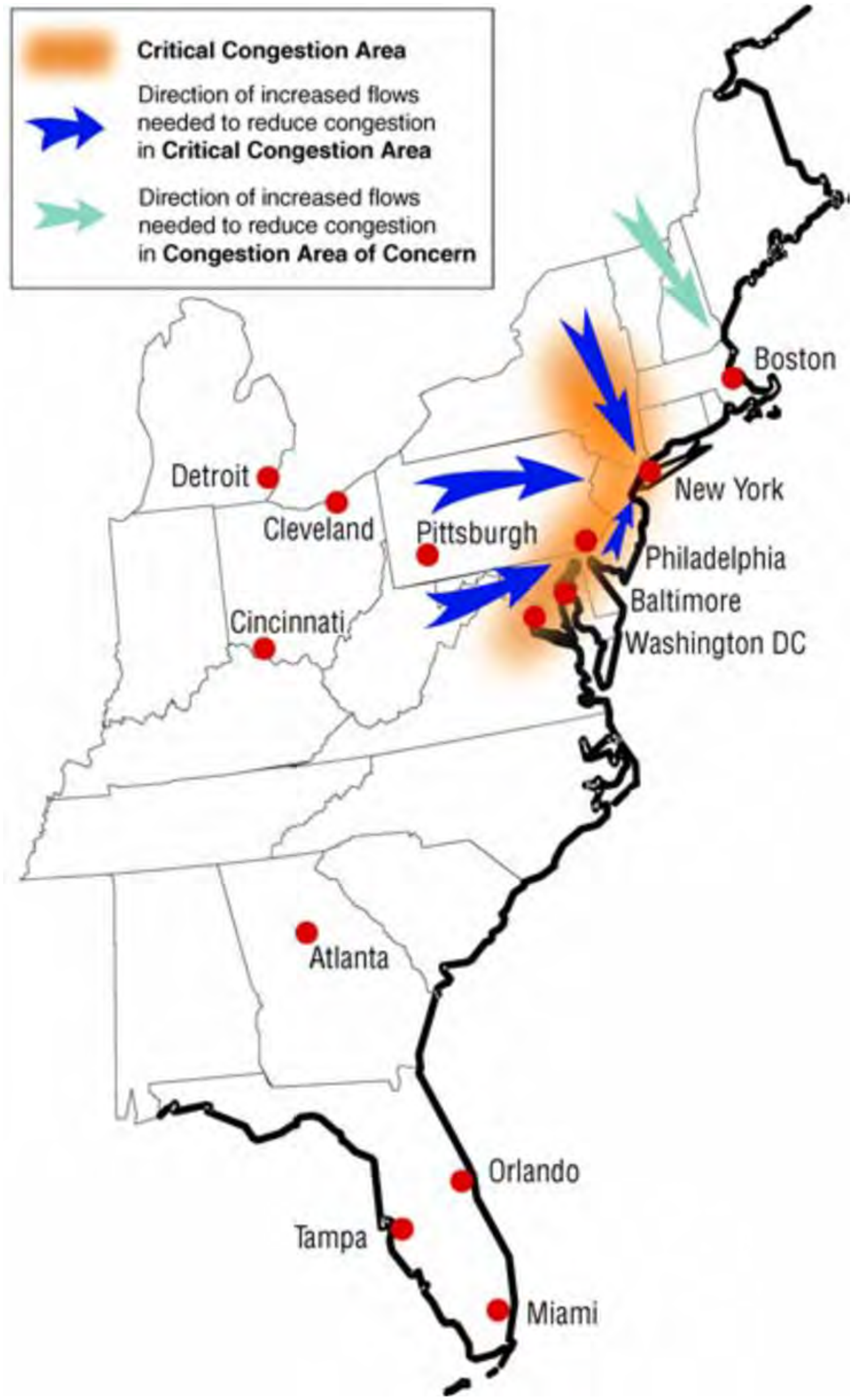

Figure 8-4. DOE-Designated Critical Congestion Area and Congestion Area of Concern in the Eastern Interconnection (Source: DOE 2006-TN2288)

8.1.4 Forecasting Model Methodology and Sufficiency Attributes

For the review team to rely on the forecasting conclusions of an independent third party, the NRC guidance in NUREG–1555 states that the analysis must be (1) systematic, (2) comprehensive, (3) subject to confirmation, and (4) responsive to forecasting uncertainty (NRC 2000-TN614). PJM produces and publishes an annual peak load and energy forecast report with detail sufficient to determine a 15-year load and energy forecast for New Jersey. No other current load forecast for New Jersey matches the detail of the PJM Forecast Model in a manner that can be validated according to NUREG–1555 (NRC 2000-TN614). Other than the annual peak load and energy forecasts performed by PJM, the NRC staff is not aware of any other comparable forecasting system that is publicly available and meets the NRC's four sufficiency criteria for reliability. The following discussion addresses how the PJM forecasts meet the NRC's four criteria.

Criteria 1: The PJM Load Forecast Model is systematic. The PJM forecast process is documented in *PJM Manual 19: Load Forecasting and Analysis* (PJM 2015-TN4306). It employs econometric multiple regression processes to estimate and produce 15-year monthly peak demand forecasts assuming normal weather for each PJM zone and the RTO as a whole. The model incorporates three classes of variables: (1) calendar effects, such as day of the week, month, and holidays; (2) economic conditions; and (3) weather conditions across the RTO. The model is used to set the expected peak loads for capacity obligations for reliability studies, and to support transmission planning. PJM uses gross metropolitan product (GMP) in the econometric component of its forecast model to account for localized treatment of economic effects within a zone. GMP is defined as the market value of all final goods and services produced within a metropolitan area in a given period of time. Ongoing economic forecasts for all areas within the PJM market area are also inputs into the analysis. Weather conditions across the region are considered by calculating a weighted average of temperature, humidity, and wind speed as inputs. PJM has access to weather data from about 34 weather stations across the PJM area (PJM 2013-TN3475). All models of non-coincident peak (NCP) used GMP and forecasts of coincident peak (CP). NCP is the peak load of a zone, and CP is the load of a zone coincident with one of the five highest loads used in the weather normalization of the PJM season peak. PJM incorporates estimates of load management, energy efficiency (EE), and distributed generation to supplement the base forecast. This accounts for changes in energy use resulting from actions taken to achieve the 2011 NJEMP goal to reward EE and energy conservation and reduce peak demand. Forecasted power needs within the market area are based on the PJM peak load and energy forecast. The PJM CP and zonal NCP forecasts are published in the annual PJM Load Forecast Report (PJM 2013-TN3475).

Criteria 2: The PJM Load Forecast Model is comprehensive. PJM develops 15-year monthly energy forecasts assuming normal weather for each PJM zone and the RTO. The PJM Load Forecast Model incorporates a broad sample of independent variables that may have an effect on the demand for electricity in the relevant area. Each candidate variable is tried in the model and its impact on demand is determined. If the candidate variable does not prove to be statistically significant, or if that candidate variable is shown to display some degree of serial or autocorrelation with any existing variables, then that candidate variable is not included in the model.

Criteria 3: The PJM Load Forecast Model is subject to confirmation. The PJM Load Forecast Model is subject to confirmation as a part of its requirements as a member of RFC:

“PJM is responsible for calculating the amount of resource capacity required to meet the defined reliability criteria. This calculation process is reviewed by the Resource Adequacy Analysis Subcommittee. This process satisfies the Reliability*First* Corporation’s Standard BAL-502-RFC-02 for the PJM region, as PJM is the Planning Coordinator of which this Standard applies” (PJM 2013-TN3475).

The PJM forecast is reviewed by both the PJM Load Analysis Subcommittee and the PJM Planning Committee to ensure the accuracy of the forecast. A third-party review of the PJM forecast concluded that the PJM forecasts for the summer of 2006 were generally consistent with EDC forecasts, which are developed independently. PJM updates its load forecasts annually. Figure 8-5 compares the actual and forecasted demand for electricity in the PJM RTO for each of the 7 years between 2006 and 2012. Based on this comparison, PJM estimates its annual error in forecasts to be about 2 percent (PJM 2013-TN2290; PJM 2013-TN2291). Load forecasts were compiled by PJM from forecasts supplied by member companies from 1999 to 2005 and produced by PJM thereafter to maintain independence from market participants and to improve forecast accuracy (PJM 2013-TN2038).

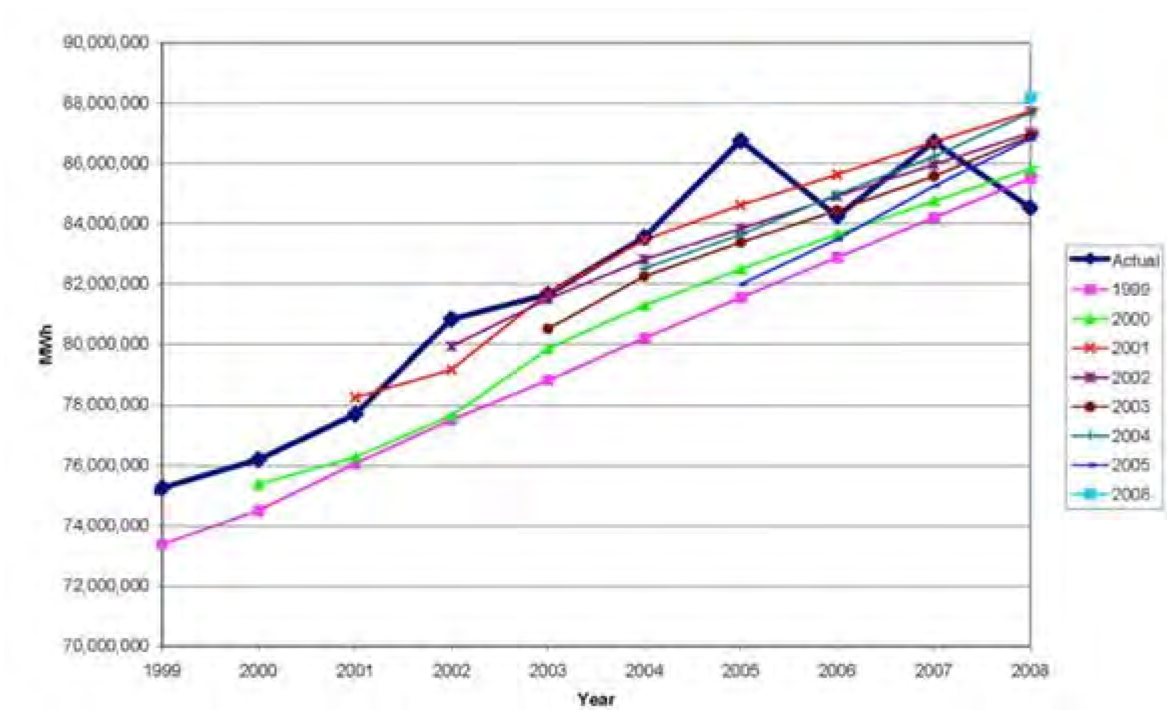

Figure 8-5. Actual and Forecast Summer Peak Demand in the PJM RTO 2006–2012 (Source: PJM 2013-TN3493)

Criteria 4: The PJM Load Forecasting Model is responsive to forecasting uncertainty. Through its annual load forecast development, changes in economic inputs affecting the forecasted loads are examined. For example, the 2009 load forecast showed a reduction in forecasted peak load and energy due to the effects of the recession beginning in 2008

(PJM 2008-TN1553). By incorporating recent load history into its econometric model, trends such as the potential load growth associated with plug-in electric vehicles are captured in the PJM load forecast methodology. In addition, a distribution of NCP forecasts is produced using a Monte Carlo simulation process based on observed historical weather data. The median result is used as the base (50/50) forecast; the values at the 10th percentile and 90th percentile are assigned to the 90/10 weather bands. Changing economic conditions and energy usage as a result of EE and DR programs are captured through updating of inputs in the annual forecasting process.

8.2 Power Demand

This section describes the development of the New Jersey power forecasts used in Section 8.4 to determine the need for power. The power demand estimates presented in this section were developed in 2013 and are based on the load forecast published by PJM in January 2013 (PJM 2013-TN2038). The 2012 PJM load forecast has been reviewed to assess any changes in the demand for peak load and energy demand over the 3-year period. As described in Section 8.2.2, the forecasted growth in peak and energy demands within New Jersey is substantially lower than prior forecasts because of the impact of the 2008 to 2009 economic recession. However, despite this reduced load growth, the need for power analysis, as described in this chapter, still identifies a substantial need for baseload generation in New Jersey for the year 2021, the expected service date for a new nuclear power plant at the PSEG Site. The increase in energy needs forecasted by PJM is driven by economic and population growth, but to a degree is offset by EE and demand-side management (DSM) programs and the promotion of distributed generation using renewable resources. These factors are assessed in detail in the following sections.

8.2.1 Factors Affecting Power Growth and Demand

This section describes the major factors affecting the growth of electricity demand in New Jersey: economic and demographic trends, substitution effects, EE and DSM programs, and price and rate structures. In each case, PJM includes the effects by incorporating them into the models used to prepare the PJM load forecast or, in the case of EE programs, directly through explicit bidding of EE or DSM programs into the PJM reliability pricing model (RPM) auction.

8.2.1.1 Economic and Demographic Trends

The PJM load forecast for New Jersey is driven by three factors: calendar effects, economic and demographic trends, and weather variations. Economic and demographic trends have the most significance in the period of interest. The econometric model and its supporting data used by Moody's, a PJM consultant for load forecasting, are proprietary and not publicly available. However, publicly available information can be used to approximate the economic and demographic trends within New Jersey. The trends identified by the review team from publicly available sources support the PJM load forecast for growth in electricity demand. Only three states are smaller in area than New Jersey, yet it had the eighth largest gross domestic product (GDP) in the United States in 2012. About half of New Jersey's economy is dependent on services such as professional, scientific, technical, health care, financial, and insurance services

(PSEG 2015-TN4280). The 2012 GDP for New Jersey was $503 billion (Knoema 2013-TN2875). Private service-providing industries accounted for 78.3 percent of New Jersey's 2012 GDP, and private goods-producing industries accounted for an additional 10.8 percent. Government contributed about 11.0 percent to the New Jersey GDP (NJLWD 2013-TN3314).

Historical population trends and projections are available for New Jersey from the U.S. Census Bureau (USCB-TN2289). The New Jersey population grew at an annual rate of 0.9 percent between 1990 and 2000, from 7,700,000 in 1990 to 8,400,000 in 2000. The estimated population in 2008 was 8,700,000. Table 8-1 shows U.S. Census Bureau historical and forecasted annual population growth rates for New Jersey. While Table 8-1 shows that New Jersey is expected to experience population growth over the next 20 years, the U.S. Census Bureau projects that New Jersey's population growth rate will slow from 0.6 percent per year for 2005 to 2010 to 0.3 percent per year in 2025 to 2030.

Table 8-1. Historical and Projected Average Annual Growth Rate of New Jersey's Population, 1995 to 2025

	1995–2000	2000–2005	2005–2015	2015–2025
New Jersey	2.9%	2.6%	6.3%	7.1%
Source: U.S. Census Bureau (USCB 2009-TN2289).				

Historical personal income data are available for New Jersey, indicating personal income in New Jersey increased during the period 1993 to 2008 (NJLWD 2013-TN3314). The average annual income growth rate was 4.4 percent over this 15-year period.

8.2.1.2 Current Pattern of Electricity Use

Table 8-2 shows New Jersey electricity use by customer class and the national total. New Jersey residential, commercial, and transportation energy use by customer class were above the national median. In 2013, New Jersey ranked twelfth among the 50 states and District of Columbia in commercial energy consumption and eighth in transportation use. Table 8-2 also shows that New Jersey industrial use was below the national median.

Table 8-2. Energy Use by Customer Class, New Jersey, 2013

	Annual Use in 2013 (millions of kWh)			
	Residential	**Commercial**	**Industrial**	**Transportation**
New Jersey	1,988	2,977	614	22
United States	97,812	103,449	77,536	562
New Jersey National Ranking	18th	12th	36th	8th
Source: DOE/EIA 2013-TN3170.				

8.2.1.3 Substitution Effects and Energy Efficiency Programs

This section reviews substitution effects and EE programs in New Jersey and describes how these effects are incorporated into the PJM load forecast. The regional investments in alternative energy projects and efficiency described in this section have produced results in terms of additional electrical production and net reduction in electrical demand. The effects of

these results are reflected in and carried through subsequent peak load and energy forecasts developed by PJM.

Energy Efficiency, Demand Response, and Renewables

In an effort to enact energy conservation measures and reduce energy demand, New Jersey has established several government and corporate programs. These can be characterized as

- EE programs designed to reduce permanently the consumption of energy by residential, commercial, and industrial users;
- DSM programs designed to reduce peak power demand by temporarily reducing load or by shifting peak period load to off-peak periods; and
- distributed generation programs designed to encourage the use of renewable technologies by end users to self-supply some of their electricity need.

The effect of these programs on future projections of power needs has been incorporated into PJM planning indirectly through the development of its load forecast and directly through the bidding of EE and DR resources into the annual RPM auctions. As described in Section 8.2.1.1, PJM uses an econometric modeling approach to the forecasting of future peak power demand and energy use. EE, DSM, and distributed generation programs affect the forecast to the extent that the historical data used to develop the econometric model reflect the impact of the programs. As discussed in Section 8.3, the EE and DR resources that clear the RPM auction become part of the regional power supply and reduce the need for additional generation. Both of these effects, indirectly through the load forecast and directly through the supply forecast, are incorporated into the need for power forecast discussed in Section 8.4.

State-Sponsored Energy Efficiency and Demand-Side Management Programs

New Jersey released an Energy Master Plan in December 2011 that outlines a strategy for developing an adequate, reliable supply of electricity that keeps up with the growth in demand. The major energy conservation goals of the Energy Master Plan are to (1) maximize energy conservation and EE by reducing energy consumption by at least 20 percent by 2020, using 1999 energy consumption as the baseline; and (2) reduce peak electricity demand to 18,000 MW by 2020, a reduction of 3,364 MW relative to the 2011 PJM load forecast (New Jersey 2011-TN2115).

New Jersey's Clean Energy Program™, administered through the New Jersey Office of Clean Energy, is an NJBPU initiative that provides education, information, and financial incentives for EE measures. New Jersey's Clean Energy Program is a statewide program that supports technologies that save electricity and natural gas and increase the amount of electricity generated from renewable resources. The program establishes a set of objectives and measures to track progress in reducing energy use while promoting increased EE. Each year, the program provides an average of $145 million in financial incentives, programs, and services to residential customers, businesses, schools, and municipalities that install energy-efficient and renewable energy technologies.

PSE&G has explored various disciplined investments and implemented programs to address the New Jersey State goals regarding EE, including the following (PSEG 2007-TN2292):

- Residential Whole House Efficiency;
- Residential Programmable Thermostat Installation Program;
- Industrial/Commercial Programs;
- Small Business Direct Installation Program (over 4 years);
- Large Business Best Practices and Technology Demonstration Program; and
- Hospital Efficiency Program.

The PSE&G Energy Efficiency Economic Stimulus Initiative includes the following (PSEG 2013-TN2293):

- Residential Whole House Efficiency Program;
- Multi-Family Housing Program;
- Industrial/Commercial Programs;
- Small Business Direct Install Program;
- Municipal/Local/State/Government Direct Install Program;
- Hospital Efficiency Program;
- Data Center Efficiency Program;
- Building Commissioning/Operations and Maintenance Pilot Program; and
- Technology Demonstration Program.

In July 2009, PSE&G received NJBPU approval for $190 million in EE projects (Long 2009-TN3171). The EE program is part of nearly $1.7 billion in spending planned by the Public Service Enterprise Group to expand its investment in EE programs. The efficiency plan results in a slight rate increase for PSE&G customers. The EE projects include residential customers, businesses, and government projects.

8.2.2 Historic and Forecast Electricity Demand

The review team based its actual and forecasted energy demand for New Jersey on the January 2013 *PJM Load Forecast Report* (PJM 2013-TN2038). In this report, PJM projected summer peak load growth in the entire PJM region would increase at an average rate of 1.3 percent between 2013 and 2023. PJM also projected the winter peak demand for electricity would increase at a rate of 1.1 percent for the same 10-year period. For the four service regions of New Jersey, the 10-year summer peak growth rates were 1.1 percent (AE), 1.2 percent (JCPL), 0.8 percent (PSE&G), and 0.6 percent (RECO). The NRC staff guidance calls for the inclusion of historic demand for electricity for the applicant's proposed service area, extended to 3 years beyond the commercial operation of the full project. PSEG defined full commercial operations to occur in 2021 for purposes of the ESP application. Because the PJM supply forecast did not extend to 2024, the review team determined that the projections to 2023 were not unreasonable as an approximation of the expected supply and demand for electricity in 2024. Therefore, this analysis extends to 2023. The review team used PJM's summer projections because they serve as a reasonable estimate of the future need for electricity in the state. Figure 8-6 contains a graphical representation of the past and projected demand for

electricity in New Jersey, disaggregated by EDC, and Table 8-3 displays the associated 2014–2023 forecast data for that figure (PJM 2013-TN2038).

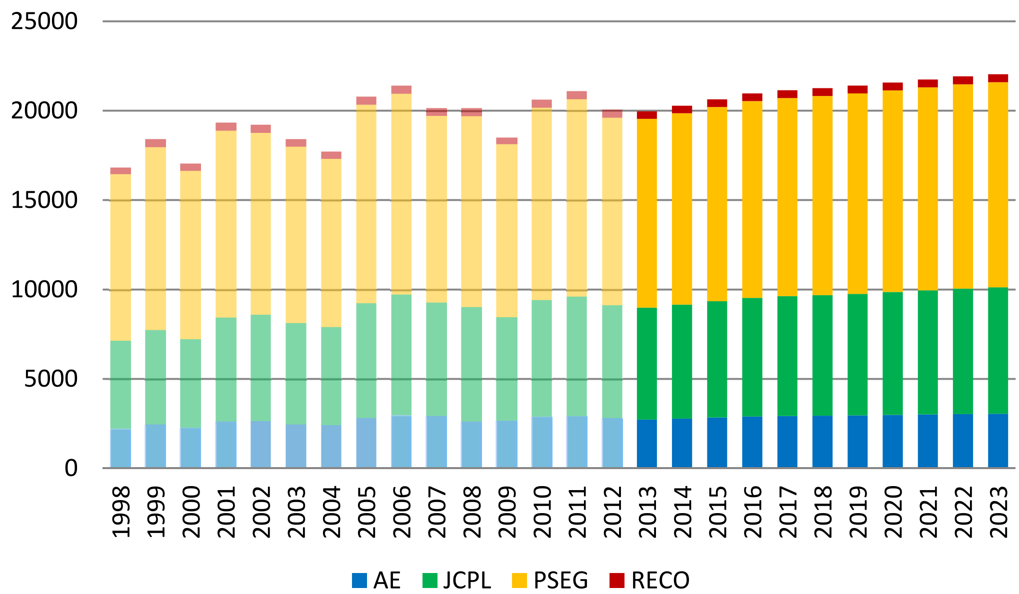

Figure 8-6. Historic and Projected Electricity Demand in New Jersey (MW) 1998–2023 (Source: PJM 2013-TN2038)

Table 8-3. Electricity Demand in New Jersey for 2014–2023 (MW)

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
AE	2,785	2,845	2,900	2,920	2,945	2,965	2,990	3,100	3,333	3,055
JCPL	6,340	6,515	6,635	6,705	6,720	6,810	6,880	6,950	7,020	7,070
PSEG	10,680	10,850	11,015	11,098	11,145	11,200	11,275	11,340	11,415	11,500
RECO	425	429	434	436	437	439	441	444	445	447
Total	**20,230**	**20,639**	**20,984**	**21,159**	**21,247**	**21,414**	**21,586**	**21,834**	**22,213**	**22,072**

Source: PJM 2013-TN2038.

Demand data in Figure 8-6 and Table 8-3 include residential, industrial, commercial, institutional, and all other demand segments. In addition, each electricity demand estimate includes DSM, EE measures, and any other strategies employed in New Jersey to reduce the level of demand for electricity.

The review team uses forecasted demand as the basis for establishing the total amount of electricity that must be available in the RSA. Energy consumption grew at an annual rate of 1.8 percent from 1993 to 2005 but fell at an annual rate of nine-tenths of 1 percent from 2005 to 2008. The forecast projected energy requirements to grow at an annual rate of 2.9 percent from 2008 to 2012, as the economy recovers, and in the long term at an annual rate of 1.2 percent from 2012 to 2024. The current growth rate forecast for energy consumption of 1.2 percent from 2012 to 2024 is lower than the historical growth rate of 1.8 percent before the 2008 to 2009 recession and reflects the economic factors driving the 2009 PJM load forecast.

The review team determined that the forecasted peak demand in 2023, based on the 2013 PJM load forecasts, would be 22,072 MW. Of that amount, PSE&G accounts for 52 percent of the electricity demand, JCPL for 32 percent, AE for 14 percent, and RECO for about 2 percent. The distribution of energy demand in New Jersey is displayed in Table 8-3.

In addition to actual customer demand for electricity, total demand must include any reductions in demand—typically EE and DSM programs, and stand-by capacity used as a reserve. As discussed above, the PJM demand estimates are net of any conservation efforts and therefore could not be isolated from the total to explicitly show their contribution to total demand. The RTO establishes the magnitude of its reserve margin, which for 2023 is set at 15.6 percent of peak demand, based on RFC Standard BAL-502-RFC-02-Resource Planning Reserve Requirements (NERC 2011-TN3177), which calls for an 11-year resource adequacy projection. Therefore, the 2023 system reserve margin for New Jersey, based on the forecast 2023 summer peak demand, would be about 3,443 MW, for a total New Jersey demand for electricity in 2023 of 25,515 MW. Table 8-4 displays the calculations behind this determination.

Table 8-4. Total Electricity Needed in New Jersey in 2023

		2023 (MW)
Summer Peak Load Demand		22,072
2023 Reserve Margin	15.6%	3,443
Total Electric Capacity Required in 2023		25,515

Source: PJM 2013-TN2038.

8.3 Power Supply

The review team assumed for this analysis that the electricity in New Jersey is provided by the power generated in New Jersey, without consideration of any power imported into or exported from New Jersey. New Jersey power supply is negatively affected by the likely increase in deactivation and retirement of generation resources due to the increased cost of environmental emissions. However, the New Jersey power supply is also positively affected by the recent expansion of planned natural gas generating units due to the exploitation of Marcellus Shale gas reserves.

The review team identified the generation resources for New Jersey using data obtained from the 2013 PJM Load Forecast Report (PJM 2013-TN2038). Generation resources include existing generation, planned generation (new generation and increases in capacity to existing generation), and bilateral contracts for unit-specific capacity resources.

The existing and planned PJM power supply portfolio consists of nuclear, fossil, renewable, demand, EE resources, and others. Table 8-5 was developed from available PJM data from PJM's 2007 through 2012 annual RTEP reports (PJM 2008-TN3025; PJM 2009-TN3026; PJM 2010-TN3027; PJM 2011-TN3028; PJM 2012-TN3129; PJM 2013-TN3130) and shows a breakdown of New Jersey's generation resources by fuel type that qualified for the RPM base residual auction through 2012, the last year of the most recent RTEP report. The megawatt values in the table reflect the summer installed capacity rating of the units in the region. Figure 8-7 presents a graphical representation of the data in Table 8-5.

Table 8-5. New Jersey Electricity Supply by Fuel (MW)

Fuel	2007	2008	2009	2010	2011	2012
Natural Gas	6,731	9,411	9,620	9,756	9,526	9,631
Nuclear	3,984	4,108	4,108	4,108	4,108	4,108
Oil	366	384	373	148	171	148
Solid Waste	104	120	122	142	125	146
Solar	0	0	0	2	14	43
Hydro	405	405	405	405	405	405
Coal	2,062	2,062	2,087	2,036	1,967	1,979
Diesel/Kerosene	3,139	543	542	630	630	630
Other Gas	19	0	0	0	0	0
TOTAL	**16,810**	**17,033**	**17,257**	**17,227**	**16,946**	**17,090**

Sources: PJM 2008-TN3025; PJM 2009-TN3026; PJM 2010-TN3027; PJM 2011-TN3028; PJM 2012-TN3129; PJM 2013-TN3130.

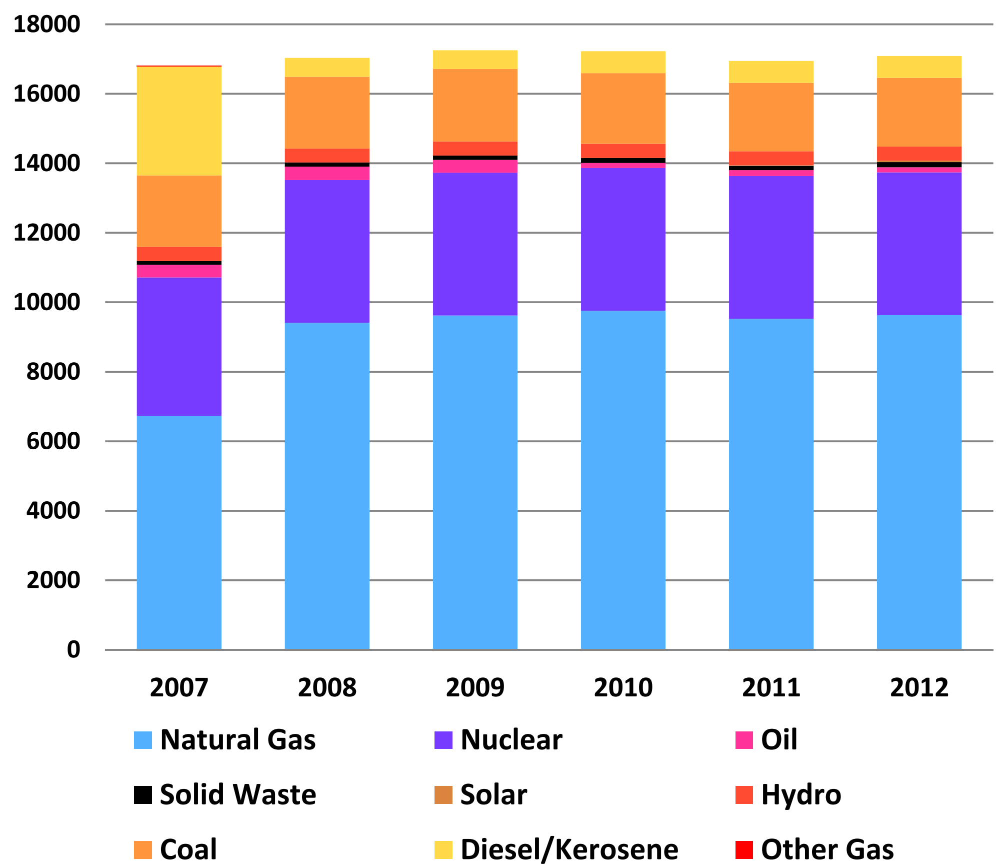

Figure 8-7. Generation Resources by Fuel Type, 2007–2012 (Sources: Annual state summaries from the PJM Regional Transmission Expansion Plan reports covering 2007–2012, including PJM 2008-TN3025; PJM 2009-TN3026; PJM 2010-TN3027; PJM 2011-TN3028; PJM 2012-TN3129; PJM 2013-TN3130)

The current portfolio of New Jersey is only moderately diversified; its generating resources consist largely of fossil fuels. Since 2008, over half of the new generating resources in New Jersey have been natural gas units. The year 2007 is viewed as an outlier with natural gas-fired generation around two-thirds of its 2008–2012 levels. Between 2008 and 2012, all of the major fuel types show relatively constant contributions, with natural gas at 9,400 to 9,700 MW, nuclear at a constant 4,108 MW, and coal at about 2,000 MW. The total varied by no more than about 400 MW from its lowest reported level (2011) to its highest (2009) during the same period. While the total share of all fossil fuel generators has declined steadily since 2008 (down 2.6 percent between 2008 and 2012), by 2012 carbon-based fuels still accounted for about 73 percent of all generating capacity (PJM 2012-TN3130) .

Information from 2012 on the deactivation and retirement of generation resources shows an increased number of retirements of fossil and nuclear units. PJM expects almost 3,000 MW of existing New Jersey generating capacity will be retired by 2019, based on the following:

- The 637-MW Oyster Creek Nuclear Power Plant, a baseload resource, will be decommissioned starting in 2019.
- PJM anticipates another 2,300 MW of New Jersey generation deactivations through 2015, composed of natural gas, oil, kerosene, coal, and landfill gas resources.
- Older fossil-fueled plants are coming under increasing economic pressure because of their age, lower prices for natural gas, and stricter environmental regulations. Fossil-fueled power plants will require millions of dollars of pollution control modifications, which may force some units to shut.

New Jersey's Long-Term Capacity Agreement Pilot Program includes three new combined-cycle natural gas-fired generation projects totaling 1,949 MW (not completed due to litigation). The initial increase in capacity from natural gas that occurred between 2007 and 2008 (2,680 MW) coincides with the first commercial expansion of the Marcellus Shale natural gas fields in northern Pennsylvania and throughout New Jersey. Further exploitation of the Marcellus resource was hindered by the lack of infrastructure, which prevented the transportation of natural gas from the fields to end users.

However, the review team believes the 2012 capacity estimates may be low, based on new trends in natural gas generation. Fitch, a major energy credit rating service, identified seven major gas pipeline projects (5,711 MMf^3/d) and two major liquefied natural gas pipeline projects (240,000 bbl/d) under development in the Marcellus Shale region (NGI 2012-TN3135). In Pennsylvania alone, plans for 7,351 MW of new natural gas generating capacity have been submitted to PJM, despite the current lack of gas transportation infrastructure (NGI 2013-TN3172). None of these projects are reflected in the PJM forecast. Once they are built, there is every indication that these pipelines will fuel a near-term emphasis on natural gas generation (NGI 2012-TN3135).

The PJM 2012 power supply within New Jersey was 17,090 MW, increasing to 18,946 MW by 2023 (Table 8-6). The available New Jersey power supply described in this section is compared to the PJM load forecast, as described in Section 8.2. This comparison, performed in Section

8.4, identifies a need for the baseload capacity that could be provided by a new nuclear power plant at the PSEG Site.

Table 8-6. New Jersey Capacity 2023

	Capacity (MW)
2012 Installed Capacity	17,090
Capacity Additions	3,082
Retirements	1,226
Forecast 2023 Capacity	18,946

8.4 Assessment of Need for Power

A new nuclear power plant at the PSEG Site would serve the New Jersey market and address a portion of the projected capacity needed in New Jersey. PSEG plans for a new nuclear power plant at the PSEG Site to become operational in 2021 and operate as a merchant baseload plant producing up to roughly 2,200 MW.

PJM has the overall responsibility of establishing and maintaining the integrity of electricity supply within the PJM RTO. PJM is responsible for determining the load forecast and calculating the PJM Reserve Requirement, based on the industry and Federal guidelines and standards for reliability established by NERC and RFC. Table 8-7 compares the forecast peak demand for electricity available within New Jersey in 2023 (from Table 8-4) with the total peak capacity expected to be available in 2023 (from Table 8-6). Demand includes a 15.6 percent reserve margin, as defined by RFC, over the 2023 forecasted summer peak. Table 8-7 shows the need for additional peak capacity within New Jersey in 2023 would be almost three times the expected output of a new nuclear power plant at the PSEG Site. Consequently, the review team determined that unless a new generation plant is constructed, New Jersey will be short on capacity to meet the summer peak load and reserve margin requirements in 2023, and therefore would need to continue to rely on imports (PJM 2013-TN2038).

Table 8-7. Need for Power in New Jersey in 2023

	Percent	Megawatts
Summer Peak Demand		22,072
2023 IRM	15.6	3,443
Total Electric Capacity Required		25,515
Expected Available Generating Capacity		18,946
Expected Need for Power		6,569

Source: PJM 2013-TN2038.

8.5 Conclusion

A new nuclear power plant at the PSEG Site would operate as a merchant baseload facility producing up to 2,200 MW by 2021. It would alleviate more than half of the capacity deficit in New Jersey in 2023. Consequently, the review team concludes there is a justified need for a new nuclear power plant based on a comparison of forecasted demand and supply.

From a peak power perspective, a new nuclear power plant at the PSEG Site would contribute up to 2,200 MW of electricity to the State of New Jersey, alleviating about a third of the gap between forecasted demand and forecasted supply in 2023. Therefore, from a strictly demand-minus-supply standpoint, the review team determined there was a reasonable expectation of need for the additional baseload generating capacity of a new nuclear power plant 2 years after the commencement of full operations (2023).

The principal benefit of a nuclear power plant is the electricity it generates, but the applicant referenced several additional purposes in its stated purpose and need for a new nuclear power plant at the PSEG Site. Based on the applicant's stated purpose and need, the review team concludes a new nuclear power plant would have the potential to do the following:

- Meet NJEMP Goal 1 of reducing the price of electricity for all consumers by lowering the locational marginal price of electricity by displacing more expensive producers during the bid process
- Meet NJEMP Goal 2:
  - Increase the diversity of New Jersey's generation portfolio.
  - Reduce local air pollution emissions by displacing fossil-fueled generation in New Jersey (this also supports New Jersey's Global Warming Response Act, (NJPL 2007, Ch112-TN4305), goals for the reduction of greenhouse gas emissions in New Jersey to 80 percent below 2006 levels by 2050).
  - Reduce New Jersey's dependence on imported power by displacing imports with cheaper and cleaner in-state generation.
  - Help increase the New Jersey economy by producing local jobs, expanding the state's tax base, and providing energy for infrastructure and industrial development.
- Reduce potential for transmission congestion.
- Reduce local emissions from fossil-fueled generation from generators of imported electricity.
- Increase grid stability and reliability in the PJM and Eastern Mid-Atlantic Zone by increasing PJM's reserve margin.

These ancillary benefits are discussed in Section 10.6.

The NRC staff emphasizes that these need for power projections are based on PJM forecasts that meet the sufficiency criteria set forth in NUREG–1555 (NRC 2000-TN614). These criteria state that for a forecast to be reliable, it must be (1) systematic, (2) comprehensive, (3) subject to confirmation, and (4) responsive to forecasting uncertainty.

Based on the review team's independent analysis, the sufficiency of the forecasts on which it is based, the foreseeable additions to generation capacity that will affect the market area, and the consistency of the applicant's stated purpose and need relative to the State of New Jersey's identified energy goals, the NRC staff finds its conclusions regarding the need for the proposed two units to be consistent with the conclusions of the applicant in its ER and determined there is a reasonable need for power in the market area that could be partially, if not entirely, met by building and operating a new baseload nuclear power plant at the PSEG Site.

9.0 ENVIRONMENTAL IMPACTS OF ALTERNATIVES

This chapter describes alternatives to the proposed U.S. Nuclear Regulatory Commission (NRC) action for an early site permit (ESP) for the PSEG Power, LLC, and PSEG Nuclear, LLC (PSEG), site in New Jersey and the U.S. Army Corps of Engineers (USACE) action for Department of the Army (DA) permits. This chapter also discusses the environmental impacts of alternatives to the proposed NRC and USACE actions. Section 9.1 discusses the no-action alternative. Section 9.2 addresses alternative energy sources. Section 9.3 reviews the PSEG region of interest (ROI) evaluated in the site-selection process, its alternative site-selection process, and issues common or generic to all of the alternative sites and summarizes the environmental impacts for the proposed and alternative sites. Section 9.4 examines plant design alternatives.

The need to compare the proposed action with alternatives arises from the requirement in Section 102(2)(c)(iii) of the National Environmental Policy Act of 1969, as amended (NEPA; 42 USC 4321 et seq. -TN661), that environmental impact statements (EISs) include an analysis of alternatives to the proposed action. The NRC implements this requirement through regulations in Title 10 of the *Code of Federal Regulations* (CFR) Part 51 (TN250) and its Environmental Standard Review Plan (ESRP) (NRC 2000-TN614). Furthermore, Subpart A of 10 CFR Part 52 (TN251) sets forth the NRC regulations related to ESPs.

In this EIS, the environmental impacts of the alternatives are evaluated using the NRC three-level standard of significance—SMALL, MODERATE, or LARGE—developed using Council on Environmental Quality (CEQ) guidelines (40 CFR Part 1508-TN428) and set forth in the footnotes to Table B-1 of 10 CFR Part 51, Subpart A, Appendix B (TN250). The issues evaluated in this chapter are the same as those addressed in the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*, NUREG–1437 (GEIS) (NRC 2013-TN2654).

Although NUREG–1437 (NRC 2013-TN2654) was developed for license renewal, it provides useful information for this review and is referenced throughout this chapter. Additional guidance on conducting environmental reviews is provided in *Interim Staff Guidance on Environmental Issues Associated with New Reactors* (NRC 2014-TN3767).

As part of the evaluation of permit applications subject to Section 404 of the Clean Water Act (CWA; 33 USC 1251 et seq. -TN662), the USACE must define the overall project purpose in addition to the basic project purpose. The overall project purpose establishes the scope of the alternatives analysis and is used for evaluating practicable alternatives under the U.S. Environmental Protection Agency (EPA) CWA Section 404(b)(1) Guidelines for Specification of Disposal Sites for Dredged or Fill Material (40 CFR Part 230-TN427), hereafter the 404(b)(1) Guidelines. In accordance with the 404(b)(1) Guidelines and the USACE headquarters guidance (USACE 1989-TN2365), the overall project purpose must be specific enough to define the applicant's needs but not so narrow and restrictive as to preclude a proper evaluation of alternatives. The USACE is responsible for controlling every aspect of the 404(b)(1) Guidelines analysis. In this regard, defining the overall project purpose is the sole responsibility of the USACE. While generally focusing on the applicant's statement, the USACE will, in all cases, exercise independent judgment in defining the purpose and need for the project from the

perspective of both the applicant's alternatives and the public (33 CFR Part 325, Appendix B(9)(c)(4) [TN425]; see also 33 CFR Part 230 [TN2273]).

Section 230.10(a) of the 404(b)(1) Guidelines (40 CFR Part 230-TN427) requires that "no discharge of dredged or fill material shall be permitted if there is a practicable alternative to the proposed discharge which would have less adverse impact on the aquatic ecosystem, so long as the alternative does not have other significant adverse environmental consequences." Section 230.10(a)(2) of the 404(b)(1) Guidelines states that "an alternative is practicable if it is available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purposes. If it is otherwise a practicable alternative, an area not presently owned by the applicant which could reasonably be obtained, used, expanded, or managed in order to fulfill the basic purpose of the proposed activity may be considered." Thus, this analysis is necessary to determine which alternative is the least environmentally damaging practicable alternative (LEDPA) that meets the project purpose and need.

Where the activity associated with a discharge is proposed for a special aquatic site (as defined in 40 CFR Part 230, Subpart E [TN427]) and does not require access or proximity to or siting within these types of areas to fulfill its basic project purpose (i.e., the project is not "water dependent"), practicable alternatives that avoid special aquatic sites are presumed to be available, unless clearly demonstrated otherwise (40 CFR 230.10(a)(3) [TN427]). See Section 1.3.2 for the USACE determination of the basic purpose and overall purpose to be used for the USACE alternatives analysis for this project.

Even if an applicant's preferred alternative is determined to be the LEDPA that meets the project purpose, the USACE must determine whether the LEDPA is contrary to the public interest. The USACE Public Interest Review (PIR), described at 33 CFR 320.4 (TN424), directs the USACE to consider several factors in a balancing process. A permit will not be issued for a practicable alternative that is not the LEDPA, nor will a permit be issued for an activity that is determined to be contrary to the public interest. In considering both the LEDPA and the PIR, the USACE must consider compliance with other applicable substantive laws such as the Endangered Species Act of 1973, as amended (16 USC 1531 et seq. -TN1010), and the National Historic Preservation Act of 1966, as amended (NHPA; 54 USC 300101 et seq. -TN4157), and consult with other Federal agencies. The USACE also must follow procedural laws such as NEPA (42 USC 4321 et seq. -TN661) and other applicable laws described in 33 CFR 320.3 (TN424).

Because the USACE is a cooperating agency with the NRC in this environmental review and for development of this EIS, both the USACE and the NRC have provided information to the maximum extent practicable in this EIS that the USACE will use in its evaluation of the project, including the evaluation of alternatives. While the USACE concurs as part of the review team with the qualitative designation of impact levels for terrestrial or aquatic resource areas for this EIS, in so far as waters of the United States are concerned, the USACE must conduct a quantitative comparison of impacts on waters of the United States as part of the LEDPA analysis.

The NRC determination as to whether an alternative site is environmentally preferable to the proposed PSEG Site is independent of the USACE determination of a LEDPA pursuant to the Section 404(b)(1) Guidelines at 40 CFR Part 230 (TN427). The USACE will conclude its analysis of both offsite and onsite alternatives in a regulatory permit decision document issued for the PSEG ESP application.

9.1 No-Action Alternative

For purposes of an application for an ESP, the no-action alternative refers to a scenario in which the NRC would deny the ESP request. Likewise, the USACE could also take no action or deny any request for a DA permit. Upon such a denial by the NRC or the USACE, the construction and operation of a new nuclear power plant at the proposed location on the PSEG Site in accordance with the 10 CFR Part 52 (TN251) process referencing an approved ESP would not occur.

Under the no-action alternative the NRC would not issue the ESP. There are no environmental impacts associated with not issuing the ESP, and the impacts predicted in this EIS would not occur.

In this context, the no-action alternative would accomplish none of the benefits intended by the ESP process, which would include (1) early resolution of siting issues prior to large investments of financial capital and human resources in new plant design and construction, (2) early resolution of issues related to the environmental impacts of construction and operation of new nuclear generation units that fall within the plant parameters, (3) the ability to bank sites on which nuclear plants might be located, and (4) the facilitation of future decisions about whether to construct new nuclear power generation facilities.

If other generating sources were built, either at another site or using a different energy source, the environmental impacts associated with these other sources would eventually occur. As discussed in Chapter 8, PJM Interconnection, LLC (PJM), has regulatory responsibilities in New Jersey to provide electrical service in its service area, and there is a demonstrated need for power. It is reasonable to assume that PJM and the power generation companies in the region will act to meet the need for power. This needed power could be provided and supported through a number of energy alternatives and alternative sites, which are discussed in Sections 9.2 and 9.3, respectively.

9.2 Energy Alternatives

The purpose and need for the NRC proposed action (i.e., ESP issuance) as identified in Section 1.3.1 of this EIS is to provide for early resolution of site safety and environmental issues, which provides stability in the licensing process. The PSEG objective in seeking an ESP is to identify a site where it can, by 2021, provide 2,200-MW(e) of baseload power generation for sale within the relevant service area (RSA), which is the State of New Jersey. This section examines the potential environmental impacts associated with alternatives to building a new baseload nuclear generating facility. Section 9.2.1 discusses energy alternatives not requiring new generating capacity. Section 9.2.2 discusses energy alternatives requiring new generating capacity, while Section 9.2.3 discusses those alternatives from Section 9.2.2

that appear capable of meeting the need for power as a discrete energy source. A combination of alternatives is discussed in Section 9.2.4. Section 9.2.5 compares the environmental impacts from new nuclear, coal-fired, and natural-gas-fired generating units, as well as a combination of energy sources, at the PSEG Site.

For analysis of energy alternatives, PSEG assumed a bounding electrical output target value of 2,200-MW(e) with a capacity factor of 90 percent[(1)] (PSEG 2015-TN4280). The NRC staff and USACE staff (collectively referred to as the review team) also used this level of output in the analysis of energy alternatives.

9.2.1 Alternatives Not Requiring New Generation Capacity

Four alternatives to the proposed action that do not require PSEG to construct new generating capacity include taking some or all of the following actions:

- purchase the needed electric power from other suppliers,
- reactivate retired power plants,
- extend the operating life of existing power plants, and/or
- implement conservation or demand-side management (DSM) programs.

Each of the above four alternatives is discussed in greater detail in the following sections.

9.2.1.1 Purchased Power

As discussed in Chapter 8, a shortfall in peak load resources is projected in New Jersey for 2023, as well as a shortfall in baseload capacity in New Jersey in the same time frame. In addition, the potential for further power exports from New Jersey to New York City and to Long Island could increase the demand for in-state generating capacity. As discussed in Chapter 8, PJM anticipates that New Jersey will continue to rely upon imported-energy transmission capability to replace retired in-state generating capacity and to meet growth in the demand for peak power.

In a letter dated March 11, 2013 (PSEG 2013-TN2464), PSEG provided a detailed analysis of the potential to use imported power as an alternative to building new nuclear capacity at the PSEG Site. The analysis was based on publicly available information in reports and analyses prepared by PJM. These reports indicate that there will not be surplus capacity available from nearby portions of PJM or from the New York Independent System Operator region (which borders on PJM). The reports also indicate that there is not likely to be excess transmission capacity available to New Jersey in the time frame when the new units would become operational. In addition, purchasing power from other utilities or power generators that are outside New Jersey would have undesirable consequences (such as higher costs and potential reliability issues) and would be inconsistent with the goals of the New Jersey Energy Master Plan (New Jersey 2011-TN2115) to (1) promote a diverse portfolio of new, clean, in-state energy generation and (2) drive down the cost of energy for all customers. Based on the

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

preceding discussion, the review team concludes that the option of purchasing electric power from other suppliers outside New Jersey is not a reasonable alternative to providing new baseload power generation.

9.2.1.2 Reactivating Retired Power Plants or Extending Operating Life

Regarding reactivation, retired generating plants—predominantly fossil-fuel-fired plants that could be reactivated—would ordinarily require extensive refurbishment prior to their reactivation. Such plants would typically be old enough that refurbishment would be very costly, and the refurbished plants would likely be viewed as new sources, subject to the current-day complement of regulatory controls on air emissions and waste management. PSEG estimates that about 3,000 MW(e) of existing electrical generating capacity in New Jersey is projected for retirement by 2019 (PSEG 2015-TN4280).

PSEG has retired several fossil-fuel-fired units in the past several years, and plans to retire several more. Hudson Unit 3 (129 MW(e)) was retired in 2003 due to generator damage, and Hudson Unit 1 (383 MW(e)) was retired in 2011. Burlington Units 101 through 105 (260 MW(e) total) were retired in 2004, and their turbine generators were subsequently sold. In 2005, the Kearny Unit 7 and Unit 8 steam plants (150 MW(e) each) were retired. Kearny Units 10 and 11 (122 MW(e) and 128 MW(e), respectively) were retired in 2012, and Unit 9 (21 MW(e)) was retired in 2013. Bergen Unit 3 (21 MW(e)), Burlington Unit 8 (21 MW(e)), Mercer Unit 3 (115 MW(e)), National Park Unit 1 (21 MW(e)), and Sewaren Units 1 through 4 and Unit 6 (558 MW(e) total) are scheduled for retirement in 2015. There are no plans to return any of these retired coal-fired units to service (PSEG 2015-TN4280). Based on the cost and difficulty of refurbishing old fossil-fuel-fired units to meet current environmental regulations, the review team concludes that reactivation of such units is not a reasonable alternative.

In November 1974, PSEG was granted a permit by the NRC for the construction of a second unit at the Hope Creek station (i.e., Hope Creek Unit 2); however, construction of this second unit was abandoned in 1981 for economic reasons and because of a reduced demand for power at that time (PSEG 2015-TN4280). The containment structure and the reactor vessel planned for use at the Hope Creek Unit 2 were subsequently dismantled and distributed for salvage; furthermore, according to PSEG the proposed location for Hope Creek Unit 2 is not suitable for the construction of a new nuclear reactor unit for the following reasons (PSEG 2015-TN4280):

- Significant portions of the Hope Creek Unit 2 turbine building are currently used for maintenance and administrative office space and laydown support for the operating Hope Creek Unit 1.
- The structural components of the Hope Creek Unit 2 reactor building currently provide flood and missile protection for Hope Creek Unit 1. Alteration of the Hope Creek Unit 2 reactor building to accommodate a new reactor could impact these protective functions, thereby adversely impacting the operation of Hope Creek Unit 1.
- Constructing a new-generation reactor design at the Hope Creek Unit 2 location is not feasible given the high likelihood that the existing Hope Creek Unit 2 footprint would not physically be able to accommodate any of the standardized reactor designs.

- Construction activities associated with the completion of the Hope Creek Unit 2 would impact operation of Hope Creek Unit 1 due to the above described inter-reliance of structures and overall proximity of heavy construction (e.g., cranes and ultra-heavy modules) to critical Hope Creek Unit 1 structures, systems, and components.

Based upon the above discussion, the review team concludes that the reactivation of the construction permit for Hope Creek Unit 2, as well as the possible use of the Hope Creek Unit 2 site for the construction of a new reactor unit, would not be reasonable alternatives to the construction and operation of a new nuclear power-generating plant at another location.

Nuclear power facilities are initially licensed by the NRC for a period of 40 years. Operating licenses issued by the NRC can be renewed for up to 20 years, and the NRC regulations do not preclude multiple renewals. PSEG currently operates the Hope Creek Generating Station Unit 1 and the Salem Generating Station Units 1 and 2 under licenses issued by the NRC. In August 2009, PSEG submitted applications to the NRC for license renewal for all three of these units, and in June and July 2011, the NRC issued its approval of the extension of the operating licenses for the two Salem units and the Hope Creek unit, respectively (NRC 2011-TN2108; NRC 2011-TN2109). The operating licenses for these units now expire between 2036 (Salem Unit 1) and 2046 (Hope Creek). Therefore, continuing power generation from these units has already been considered in the need for power analysis during the time frame being addressed for alternatives.

The environmental impacts of continued operation of a nuclear power plant are significantly smaller than those of constructing a new plant. However, continued operation of an existing nuclear plant does not provide additional generating capacity nor is it a feasible alternative to proposed new power-generating plants.

While all four of the operating nuclear plants in New Jersey have been approved by the NRC for license renewal, decommissioning activities are planned for Oyster Creek Nuclear Power Plant (637 MW(e)), beginning in 2019 (Exelon 2013-TN2521).

Older, existing fossil-fuel-fired plants—predominately coal-fired and natural-gas-fired plants—that are nearing the end of their useful lives are likely to need refurbishing to extend plant life and to meet applicable environmental requirements. However, such refurbishment activities are costly, and the typical fate of an aged fossil-fuel-fired plant is retirement as described in the discussion of reactivation above.

The review team concludes that the environmental impacts of any life extension, refurbishment, and/or reactivation scenarios would be bounded by alternatives involving new coal-fired or natural-gas-fired facilities (see Section 9.2.3). Given both the costs of refurbishment and the environmental impacts of operating such facilities, the review team concludes that extending the operational life of older, existing plants or reactivating retired plants would not be a reasonable alternative to providing new baseload power-generation capacity with new nuclear units.

9.2.1.3 Energy Efficiency and Demand-Side Management

DSM programs consist of planning, implementing, and monitoring activities that enable and encourage consumers to reduce and/or modify their levels and patterns of electricity use. By reducing customer demand for energy through energy efficiency, conservation, and load management, the need for additional generation capacity can be reduced, postponed, or even eliminated. In addition, energy conservation measures in New Jersey also include distributed generation programs that are designed to encourage end users to supply some of their own electrical needs through the use of renewable technologies such as solar photovoltaic (PV) power-generating systems.

The New Jersey Clean Energy Program is a statewide initiative that offers financial incentives, programs, and services for New Jersey residents, business owners, and local governments to help them save energy, money, and the environment (NJBPU 2012-TN2106). The Clean Energy Program supports technologies that conserve electricity and natural gas, and it also promotes increased energy efficiency and the use of clean, renewable sources of energy such as solar, wind, geothermal, and sustainable biomass. The program establishes a set of objectives and measures to track progress in reducing energy use while promoting energy efficiency. The program provides financial incentives and services to residential customers, businesses, schools, and municipalities that install energy-efficient and renewable energy technologies.

Public Service Electric and Gas Company (PSE&G) already offers several conservation and DSM programs to its customers to reduce peak electricity demands and daily power consumption, including residential programs in whole house efficiency, programmable thermostat installation, and multifamily housing and industrial/commercial programs in small business direct installation, large business best practices and technology demonstration, hospital efficiency, municipal/local/State government direct installation, data center efficiency, building commissioning operation and maintenance, and technology demonstration (PSEG 2015-TN4280).

The need for power discussion in Chapter 8 takes planned energy efficiency, conservation, and DSM programs into account. As discussed in Chapter 8 of this EIS, the State of New Jersey took account of conservation and DSM programs in preparing its report, *New Jersey Energy Master Plan* (New Jersey 2011-TN2115). In this report, the State of New Jersey determined that there was a need for additional baseload power in the PSEG RSA, even taking into account conservation and DSM programs. The review team concluded in Chapter 8 that there is a justified need for power in the PSEG RSA, which covers the same area as the ROI, even with the successful implementation of conservation and DSM programs. Because PSEG Power only owns generating plants, it does not directly offer energy efficiency, conservation, and DSM programs. The review team concludes that such programs are not a reasonable alternative to the proposed action.

9.2.1.4 Conclusions

Based on the preceding discussion, as well as information and discussions provided in the need for power analysis in Chapter 8, the review team concludes that the options of purchasing

electric power from other suppliers, reactivating retired power plants, extending the operating life of existing power plants, conservation and DSM programs, or any combination of these are already fully used in the capacity projections for the PSEG RSA (New Jersey 2011-TN2115) and that additional efforts do not present reasonable alternatives to providing new baseload power-generation capacity. The review team therefore concludes that alternatives not requiring new generation capacity are not reasonable alternatives to providing new baseload power generation in amounts sufficient to satisfy the project purpose and need.

9.2.2 Alternatives Requiring New Generation Capacity

This section discusses energy alternatives involving new generating capacity, the review team conclusions about the feasibility of each alternative, and the basis for the review team conclusions. Consistent with the NRC guidance in ESRP 9.2.2 (NRC 2000-TN614), a reasonable set of energy alternatives to the construction and operation of one or more new nuclear units for baseload power generation at the PSEG Site should be limited to analysis of discrete power-generation sources, or a combination of sources, that are capable of generating baseload power and are developed, proven, and available in the relevant region. The current mix of baseload power-generation options in the State of New Jersey is one indicator of the feasible choices for power-generation technology within the State. The energy generation profile for New Jersey in 2011 was as follows: nuclear (24 percent), natural gas (56 percent), coal (12 percent), renewables (2.5 percent), and oil (4.7 percent) (PJM 2012-TN3129).

Furthermore, in accordance with NUREG–1555 (NRC 2000-TN614), the basic criteria for a viable alternative energy source include (1) use of the energy source is consistent with national energy policy goals for energy use and (2) Federal, State, and local regulations do not prohibit or restrict the use of the energy source. Additional criteria listed in NUREG–1555 (NRC 2000-TN614) include the following:

- The energy technology should be developed, proven, and available in the relevant region.
- The energy source should provide power generation equivalent to the power level output of the applicant's proposed project (which, in this case, is 2,200 MW(e) baseload power with a capacity factor of 90 percent).
- The power should be available within the time frame needed for the proposed project.
- No unusual environmental impacts or exceptional costs are associated with the energy source that would make it impractical.

This section discusses the environmental impacts of energy alternatives to the proposed action that would include the construction of new facilities to meet the demand for power-generating capacity. The three primary energy sources for generating electric power in the United States in 2012 were coal, natural gas, and nuclear energy (DOE/EIA 2013-TN2593), which combined to generate roughly 87 percent of the electricity in this country. Coal-fired plants remain the primary source of baseload generation in the United States (DOE/EIA 2013-TN2590). Natural-gas combined-cycle power-generation plants are often used as intermediate generation sources, but they are also used as baseload generation sources (SSI 2010-TN1405). Each year, the Energy Information Administration (EIA), a component of the U.S. Department of Energy (DOE), issues an annual energy outlook. In the *Annual Energy Outlook 2013*

(DOE/EIA 2013-TN2590), the EIA reference case projects that the total electrical generating capacity additions between 2012 and 2040 will use the following fuels in the approximate percentages indicated: natural gas[(1)] (67 percent), renewables (29 percent), and nuclear (4 percent). During this same period, coal- and petroleum-fired capacities will both decrease. The EIA projections include baseload, intermittent, and peaking units and are based on the assumption that providers of new generating capacity would seek to minimize cost while meeting applicable environmental requirements.

New Jersey has a renewable energy portfolio implemented through Renewable Portfolio Standard (RPS) regulations that consist of a set of State policies designed to increase the generation of electricity from renewable sources. These policies require or encourage electricity producers to supply a certain minimum share of their electricity from renewable sources (DOE/EIA 2012-TN2090). The New Jersey RPS requires each supplier/provider serving retail customers in the state to procure 22.5 percent of the electricity it sells in New Jersey from qualifying renewables by 2021. In addition, the standard contains a separate solar-specific provision that requires suppliers/providers to procure at least 3.47 percent of sales from qualifying solar electric generation facilities by 2021 (NCSU 2012-TN2095).

The 22.5 percent RPS target includes Class I and Class II types of renewable energy. Class I renewable energy includes electricity derived from solar energy, wind energy, wave or tidal action, geothermal energy, landfill gas (LFG), anaerobic digestion, fuel cells using renewable fuels, and—with written permission from New Jersey—certain other forms of sustainable biomass. Class I also includes hydroelectric facilities with capacities of 3 MW or less. Class II renewable energy includes electricity derived from hydroelectric facilities with capacities greater than 3 MW but less than 30 MW and from resource-recovery facilities such as municipal solid-waste facilities (NCSU 2012-TN2095).

New nuclear units at the PSEG Site would be baseload generation units. Any feasible alternative to the new units would need to generate baseload power consistent with the purpose and need for the project. In evaluating alternative energy technologies, PSEG used the technologies discussed in NUREG–1437, Revision 0 (i.e., the GEIS for license renewal (NRC 1996-TN288]). The review team reviewed the information submitted in the PSEG Environmental Report (ER) (PSEG 2015-TN4280) and also conducted an independent review as documented in this section.

9.2.2.1 Wind Power Generation

As discussed above, electricity derived from wind energy is included in the New Jersey renewable energy portfolio. As of August 2012, New Jersey had 9 MW(e) of wind energy projects online, and an additional 1,416 MW(e) were in the queue; however, no such projects were located in or planned for Salem County or the adjacent counties (AWEA 2012-TN2076). Nevertheless, adequate wind resources exist in New Jersey and its surrounding offshore areas to make wind powered electricity generation a potentially attractive alternative. About

(1) Includes the projections for “combined cycle,” “combustion turbine/diesel,” and “distributed generation (natural gas).”

1,440 MW(e) of offshore wind projects are under consideration and/or design within the PJM generation interconnection queues (PSEG 2012-TN2114).

The largest operating wind farm in the world is the 9,000-ac Alta Wind Energy Center in California, which has a total capacity of 1,320 MW (CEC 2015-TN4265). The second largest wind farm in the United States is the Roscoe Wind Farm situated on 100,000 ac in Texas. The Roscoe Wind Farm has an installed capacity of 781.5 MW and uses 627 wind turbines, each with a capacity between 1.0 and 1.5 MW (Power Technology 2010-TN2112).

A utility-scale land-based wind-power-generation plant in open flat terrain would generally require about 60 ac per megawatt of installed capacity to prevent interference and shadowing among and between the wind turbine units, although much of this land could be used for other compatible purposes such as farming or ranching (AWEA 2009-TN2075). Wind turbines typically operate at a capacity factor of 25 to 40 percent compared to 90 to 95 percent for a baseload plant such as a nuclear plant (AWEA 2009-TN2074). The capacity factor of the Alta Wind Energy Center is estimated to be 30 percent (CEAP 2012-TN2077). Higher capacity factors for wind turbines are typically associated with wind farms built offshore, where winds are steadier. There are no offshore wind farms in the United States at this time.

With modern wind turbine designs of about 2 MW per turbine, about 3,300 wind turbines would be required to produce the same energy as the PSEG target of 2,200 MW(e) at a 90 percent capacity factor, assuming a wind energy capacity factor of 30 percent. The review team estimates that about 396,000 ac (about 620 mi^2) would be required for these 3,300 turbines, assuming 60 ac per installed megawatt.

Offshore wind farms can have higher capacity factors and use larger turbines. For example, the Cape Wind Energy Project will use 130 wind turbines rated at 3.6 MW(e) each for an electrical generation capacity of 468 MW(e). The project is expected to deliver, on average, 1,600 GWh per year to the grid (including consideration of line losses from the turbines to shore), for an average effective capacity factor of 39 percent (DOI 2009-TN2527). The project will occupy an area of about 25 mi^2 (16,000 ac), or roughly 120 ac per turbine (or about 34 ac per installed megawatt).

Using similar 3.6-MW wind turbine designs, almost 1,400 wind turbines would be necessary to produce the same energy as the PSEG target of 2,200 MW(e) at a 90 percent capacity factor, assuming a wind energy capacity factor of 40 percent. The review team estimates that about 165,000 ac (about 260 mi^2) would be required for these turbines, assuming 120 ac per turbine.

To improve the availability and reliability of wind energy for use as a baseload supply, some form of backup power or energy storage would be needed to supply power during periods when the wind is not blowing. Backup power would likely be in the form of gas turbines, which can respond quickly to demand. Energy storage could involve batteries, compressed air energy storage (CAES), or, as discussed in Section 9.2.2.4, pumped storage.

A CAES plant consists of motor-driven air compressors that use off-peak electricity to compress air and pump it into a suitable geological repository such as an underground salt cavern, a mine, or a porous rock formation. During periods of low electricity generation by the wind farm, the

stored energy is recovered by releasing the compressed air through a combustion turbine to generate electricity (NPCC 2010-TN2107). CAES is not a new technology. A 290-MW plant near Bremen, Germany, began operating in 1978, and a 110-MW plant located in McIntosh, Alabama, has been operating since 1991. Both facilities use salt caverns for compressed air storage (Succar and Williams 2008-TN2122). The largest CAES facility under consideration in the United States is the 2,700-MW Norton Energy Storage facility in Ohio, which, if built, would store compressed air in 600 ac of underground limestone mines (FirstEnergy 2009-TN2102; OPSB 2011-TN2111). However, there does not appear to be any timetable for the development of the Norton project at this time.

Alternatively, the power company could install 1,100 2-MW(e) wind turbines to match the planned output of the nuclear units and also build and maintain a backup power source (e.g., a natural-gas plant) to provide power when the wind farm is not operating at full capacity. This would involve a smaller commitment of land (about 132,000 ac) for the wind turbines. But it would also involve the very expensive proposition of building two power plants: the wind turbines and the natural-gas plant.

Wind turbines typically have a service life of at least 20 years (DOE/EERE 2008-TN2078); nevertheless, waste generation from wind power technology would be minimal. Some construction-related debris could be generated during construction activities.

DOE predicts that there will be substantial water savings, especially in the western United States, as wind power production increases (DOE/EERE 2008-TN2078). While there are no water discharges for wind turbines, erosion and sedimentation, which could be managed, could occur and affect land and water resources. Depending on the number and amount of stream and wetland crossings needed for the interconnecting transmission lines, aquatic resources could also be affected.

Bird and bat collisions with wind turbines are a documented concern (DOE/EERE 2008-TN2078); hence, wind energy developers should consider migration areas and nesting locations when sites for wind energy facilities are selected. However, relative to other human causes of avian mortality, wind energy impacts are minimal. Bird fatalities from anthropogenic causes range from 100 million to 1 billion annually, and it has been estimated that for every 10,000 birds killed by human activity, less than one death is caused by wind turbines (DOE/EERE 2008-TN2078). A study by the National Research Council concluded that wind energy generation is responsible for 0.003 percent of human-caused avian mortality (National Research Council 2007-TN2105). Additionally, mortalities as a result of collisions with wind turbines occur most frequently with migrating bats, and studies indicate that this is not a significant source of population declines (Erickson et al. 2002-TN771). Estimates of temporary construction impacts from turbines, service roads, and other infrastructure range from 0.5 to 2.5 ac per turbine; estimates of permanent habitat spatial displacement range from 0.75 to 1.0 ac per turbine (Strickland and Johnson 2006-TN2116). Indirect impacts can include loss and fragmentation of wildlife habitat and the presence of turbines causing reduced productivity and a local reduction in biological diversity. For example, a grassland songbird study on Buffalo Ridge in Minnesota found species displacement of 600 to 800 ft from wind turbines (Strickland and Johnson 2006-TN2116).

The workforce needed to install and maintain wind turbines at a wind farm is a small fraction of that for fossil-fuel or nuclear power options. Transporting the large wind turbine components can result in temporary disruptions to local traffic. Individuals with turbines on their properties might see an increase in their property values because of the lease payments paid by the wind project owner. Lease payments tend to be in the range of $2,000 to $5,000 per turbine per year, either through fixed payments or as a small share of the electric power revenue (DOE/EERE 2008-TN2078).

Turbine noise might be considered obtrusive in some instances. However, to reasonably ensure that sound levels are acceptable and nonintrusive, standard setbacks from residences and other buildings are frequently used (DOE/EERE 2008-TN2078). While the optimal areas for siting wind turbines tend to be those with lower population densities, such areas are also often prized for their natural beauty, unimpaired by human activity.

Wind turbines can be highly visible because of their height and locations (e.g., ridgelines, open plains, and near offshore). The aesthetic impacts associated with a large number of wind turbines could be significant.

Impacts on cultural resources and historical properties for wind farms would depend on the amount of land disturbed for wind turbines, access roads, and transmission line corridors. Lands that are acquired to support wind power generation would also likely need an inventory of field cultural resources, identification and recording of existing historic and archaeological resources, and possible mitigation of the adverse effect from ground-disturbing actions.

Based on the information provided above, the review team concludes that a wind energy facility at the PSEG Site or elsewhere within the PSEG ROI would not currently be a reasonable alternative to construction of a 2,200-MW(e) nuclear power generation facility that would be operated as a baseload plant. The primary reason for this conclusion is the intermittent nature of wind power generation, which makes it unsuited, by itself, to produce baseload power. However, because it is a proven generating technology available in New Jersey, it will be considered by the review team in the combination of energy alternatives in Section 9.2.4.

9.2.2.2 Oil-Fired Power Generation

Oil-fired generation is more expensive than the nuclear, natural-gas-fired, or coal-fired generation options. In addition, future increases in oil prices are expected to make oil-fired generation increasingly more expensive. The high cost of oil has resulted in a decline in its use for electricity generation. The reference case in the EIA *Annual Energy Outlook 2013* projects that electric power production using petroleum will decrease by around 10 percent from 2012 to 2040 (DOE/EIA 2013-TN2593). In the 1996 version of NUREG–1437, the NRC staff estimated that construction of a 1,000-MW(e) oil-fired plant would require about 120 ac of land (NRC 1996-TN288). Operation of an oil-fired power plant would have air emissions that would be similar to those of a comparably sized coal-fired plant (NRC 1996-TN288).

For the aforementioned economic and environmental reasons, the review team concludes that an oil-fired power plant would not be a reasonable alternative to construction of a 2,200-MW(e) nuclear power generation facility that would be operated as a baseload plant.

9.2.2.3 Solar Power

Electricity derived from solar power has a special place in the New Jersey renewable energy portfolio. New Jersey currently ranks second to California in installed solar capacity in the United States, and New Jersey has adopted an aggressive stance on supporting the use of solar energy for electric power generation. As of September 2011, the installed solar capacity of commercial and residential solar projects in New Jersey was about 306 MW(e) and 73 MW(e), respectively, and almost one-half of the New Jersey solar PV capacity was installed between 2010 and 2011 (New Jersey 2011-TN2115). About 1,780 MW(e) of solar projects are either under consideration/design or are being installed in New Jersey (PSEG 2012-TN2114). In July 2009, the New Jersey Board of Public Utilities approved a request from PSE&G to invest more than $500 million through 2013 to install, own, and operate up to 80 MW(e) of solar PV cells in the state. The proposed installation includes the world's largest use of solar panels on utility poles; about 200,000 PV panels on utility poles would generate a total of 40 MW(e) from solar energy (PSEG 2015-TN4280).

In addition to solar PVs, solar energy can be converted to electricity using solar thermal technologies that use concentrating devices to create elevated temperatures suitable for power production (also known as concentrating solar power [CSP]). In solar thermal technology, heat energy from the sun is captured and transferred to a fluid that is subsequently used to create steam for use in turbine generators. Because this is a thermoelectric technology, it requires a cooling system similar to that used at a nuclear or fossil-fuel power plant. These types of solar thermal technologies are currently less costly than solar PVs for bulk power production. The largest operational solar thermal plant is the 310-MW(e) Solar Energy Generating System located on about 1,500 ac in the Mojave Desert in southern California (NextEra 2012-TN1400). The land-use requirement for this plant in southern California is about 5 ac/MW. Thus, about 11,000 ac would be needed for a hypothetical solar thermal power plant with the same capacity (2,200-MW(e)) as the new units at the PSEG Site, assuming 5 ac/MW(e) and not accounting for any site-specific differences in solar insolation between the two locations. To increase their utility as sources of baseload power, solar thermal facilities can also be equipped with thermal storage or auxiliary boilers that allow production of electricity during periods when the sun is not shining (NPCC 2006-TN1408). However, the use of CSP in New Jersey is unlikely. The DOE considers select areas in seven states (Arizona, California, Colorado, Nevada, New Mexico, Texas, and Utah) to be suitable for the development of CSP (NREL 2011-TN4224).

In solar PV systems, sunlight incident on special PV materials results in the production of direct current electricity, which can then be converted into alternating current power. Solar insolation has a low energy density relative to other common energy sources. The average annual solar insolation in Atlantic City, New Jersey—a city for which data are available—is 4.7 kWh/m^2/d for fixed plate solar collectors oriented at an angle approximately equivalent to the latitude of the receiving location (NREL 2012-TN2096). Storage such as with batteries would be required for constant PV energy output during periods when the sun is not shining. Alternatively, PSEG could build a backup power plant (e.g., natural gas) to provide power for those times when the solar panels are producing less than full power. In addition, interference on solar cells that are obscured by dirt or snow reduces their net electrical output. DOE reports that capacity factors for solar PV facilities range from 0.14 to 0.33, with the higher value in the range resulting from solar panels that track the sun, and a favorable location (e.g., Phoenix, Arizona) (NREL 2011-

TN4224). Because of the low solar insolation value and the low capacity factor, a large total acreage is needed to gather an appreciable amount of energy. Typical solar-to-electric power plants require 5 to 10 ac for every megawatt of generating capacity (TSECO 2008-TN2118). For the PSEG target capacity of 2,200 MW(e), the review team estimates the land requirements would be between 11,000 and 22,000 ac. The associated land-use and ecological impacts could include fragmentation and loss of wildlife habitat, reduced productivity, and local reduction in biological diversity. However, the solar panels would produce, on average, less than a third of the power of the nuclear power plant because solar PV facilities have a much lower capacity factor.

Based on the information provided above, the review team concludes that a solar energy facility at the PSEG Site or elsewhere within the PSEG ROI would not be a reasonable alternative to construction of a 2,200-MW(e) nuclear power generation facility that would be operated as a baseload plant. The primary reason for this conclusion is the intermittent nature of solar power generation, which makes it unsuited, by itself, to produce baseload power. However, because it is a proven generating technology available in New Jersey, it will be considered by the review team in the combination of energy alternatives in Section 9.2.4.

9.2.2.4 Hydropower and Hydrokinetic Energy

Four technology variants of hydroelectric power-generation technologies are applicable to water resources in New Jersey: impoundment, diversion, pumped storage, and hydrokinetic.

Impoundment technology (also called dam-and-release) is the most common type of hydroelectric technology in the United States, and it consists of a dam that stores water in its associated reservoir. Electrical energy is produced in turbine generators when water is released from the reservoir and flows through these turbines. Impoundment facilities affect large amounts of land behind the dam to create reservoirs, but they can provide substantial amounts of baseload power at capacity factors greater than 90 percent.

Diversion technology (also called run-of-the-river) channels a portion of the water in a river through a canal or penstock, and it may or may not require the use of a dam or other impoundment. Turbine generators are used to convert the flow of water into electrical energy. The power-generating capacities of diversion facilities fluctuate with the flow of water in the river, and the operation of such facilities is typically constrained so as not to create undue stress on the aquatic ecosystems that are present.

A pumped storage facility stores energy by pumping water from a lower reservoir into a reservoir at a higher elevation during off-peak periods when the demand for electrical energy is low; then, during periods of higher electrical demand, the water is released through turbine generators back into the lower reservoir.

Hydrokinetic energy projects generate electricity from waves or from the flow of water in ocean currents or tides or inland waterways. Hydrokinetic technologies capture wave energy from floating or submerged devices, oscillating water columns, overtopping devices, or attenuators. Hydrokinetic devices for use with currents in ocean or inland waterways use axial or cross-flow turbines or reciprocating mechanisms to generate electric power. In addition, hydrokinetic

systems involving thermodynamic cycles that are under development would use the temperature differential within a water body (such as the ocean) or hybrid combinations of the above mechanisms to generate electrical energy (DOE 2012-TN2085).

All of the above hydropower technologies are technically plausible for development in New Jersey; however, the characteristics of rivers in the state, the topography, and the existing land uses limit the development of impoundment facilities and diversion facilities. The highest elevation in the State of New Jersey is 1,803 ft above sea level, and the lowest point is at sea level (i.e., the Atlantic Ocean). The mean elevation of the state is about 250 ft (USCB 2012-TN2119). In the 1996 version of NUREG–1437, the NRC staff estimated that land requirements for impoundment hydroelectric power are about 1 million ac per 1,000 MW(e) (NRC 1996-TN288). For the PSEG target capacity of 2,200 MW(e) for the desired net electrical output, land requirements would thus be 2.2 million ac. Although diversion hydroelectric facilities avoid concerns for excessive land use and widespread habitat alteration, their productivity is directly affected by a number of factors; for example, seasonal low-flow conditions and sustenance requirements of the river aquatic ecosystems can lead to temporary or extended interruptions in power production.

The EIA reference case in the *Annual Energy Outlook 2013* projects that U.S. electricity production from hydropower plants will remain essentially stable through the year 2040 (DOE/EIA 2013-TN2591). EIA reports that in 2010, conventional hydroelectric power in New Jersey had a collective net summer capacity of only 4 MW and generated 18,119 MWh of power (DOE 2012-TN2524).

The most recent comprehensive state-by-state study of potential impoundment and diversion hydropower resources in the United States was published by DOE in 2006 (Hall et al. 2006-TN2092). The 2006 study was a follow-on examination of a 2004 study that evaluated potential water energy resources to identify which of those resources could be feasibly developed. The 2006 study attempted to determine the realistic hydropower potential of those resources by focusing more closely on the low-head resources (i.e., elevation changes of 30 ft or less) and low-power resources. The development model included consideration of working flow restrictions that were equivalent to half the stream flow rate at the site or sufficient flow to produce an average of 30 MW, whichever was less. The study found that a potential total of 63 MW (annual average) was feasible in the State of New Jersey from such water resources.

There is one pumped energy storage facility in New Jersey (the Yards Creek facility in Warren County), and it is used for peaking power generation. The combined capacity of the three Yards Creek units is 400 MW(e) (PSEG 2015-TN4280). The Federal Energy Regulatory Commission (FERC) has also issued a preliminary permit to Reliable Storage 2, LLC, for a feasibility study of additional pumped storage in New Jersey (FERC Docket No. P-14114). The proposed Rockaway Pumped Storage facility in Morris County would take water from the inactive Mount Hope mine at depths up to 2,500 ft below ground level and pump it into a to-be-constructed aboveground reservoir. Electrical power would be generated by turbine generators when the water is released from the proposed reservoir back into the underground mine. The total proposed capacity of the Rockaway facility would be 1,000 MW(e) (FERC 2011-TN2099).

No hydrokinetic power facilities that generate significant amounts of power are currently in operation in New Jersey; however, FERC has issued several preliminary permits for feasibility studies of possible hydrokinetic energy facilities in New Jersey. The two largest of these potential facilities are being considered by Natural Currents Energy Services, LLC. One such facility would be installed on the Beach Thorofare in Atlantic City (FERC 2012-TN2100) and the other on the Ingram Thorofare in Cape May County (FERC 2012-TN2101). Each of these potential facilities would install between 10 and 30 hydrokinetic tidal units, each with a generating capacity of 100 kW(e); thus, the total combined output of the two facilities would be between 2 and 6 MW(e). However, these facilities are presently in the conceptual planning stage, no firm plans have yet been developed for their full construction or operation, and no FERC permits have been issued beyond the preliminary feasibility study stage.

Because of the relatively low amount of undeveloped hydropower resource in New Jersey and the large land-use and related environmental and ecological resource impacts associated with siting hydroelectric facilities large enough to produce 2,200 MW(e), and the limited progress in developing hydrokinetic resources, the review team concludes that hydropower, including energy from ocean/tidal/wave energy, within the PSEG ROI is not a reasonable alternative to a new nuclear power generation facility operated as a baseload plant at the PSEG Site.

9.2.2.5 Geothermal Energy

Geothermal energy has an average capacity factor of 90 percent or more and can be used for baseload power; however, the development of geothermal generating facilities is only likely to occur in limited geographical areas because of the limited availability of the resource (NRC 2013-TN2654). Geothermal plants are most likely to be sited in the western continental United States, Alaska, and Hawaii, where hydrothermal reservoirs are prevalent (DOE 2008-TN1409). Maps available from the National Renewable Energy Laboratory (NREL) show that no geothermal power generation is planned for any state east of the Mississippi River according to data supplied to NREL by the Geothermal Energy Association (NREL 2012-TN2097). Furthermore, no hydrogeothermal sites with temperatures greater than 90°C have been identified in the State of New Jersey, nor are any favorable deep geothermal resources (i.e., with elevated temperatures at depths of 1 to 3 km) located beneath New Jersey (NREL 2012-TN2097).

Geothermal systems have a relatively small footprint and minimal emissions; however, a study led by the Massachusetts Institute of Technology concluded that a $300 to $400 million investment over 15 years would be needed to make early-generation enhanced geothermal system power plant installations competitive in the evolving U.S. electricity supply markets (MIT 2006-TN1410).

For these reasons, the review team concludes that a geothermal energy facility at the PSEG Site or elsewhere in the PSEG ROI would not currently be a reasonable alternative to construction of a 2,200-MW(e) nuclear power generation facility operated as a baseload plant.

9.2.2.6 Wood Waste

A wood-burning facility could provide baseload power and operate with a high annual capacity factor and with thermal efficiency similar to a coal plant (EPA 2007-TN2660; NREL 1993-TN2661). The fuels required for a wood-waste facility are variable and site-specific. A significant impediment to the use of wood waste to generate electricity is the high cost of fuel delivery and high construction cost per megawatt of generating capacity. The largest wood-waste power plants are only 75 MW(e) in size (DOE/EERE 2004-TN2086). Estimates in the 1996 version of NUREG–1437 suggest that the overall level of construction impacts per megawatt of installed capacity would be about the same as that for a coal-fired plant, although facilities using wood waste for fuel would be built at smaller scales (NRC 1996-TN288). Similar to coal-fired plants, wood-waste plants require large areas for fuel storage and processing and involve the same type of combustion and pollution-control equipment.

Based on the quantities of biomass reported by NREL (2005-TN2094), PSEG estimates that up to about 240 MW(e) from biomass such as wood waste, forest residues, and agricultural crop residues could potentially be developed in New Jersey. Of that 240 MW(e), about 155 MW(e) could be produced by urban wood residues and secondary mill residues (PSEG 2012-TN2113). Biomass already provides a baseload capacity of 30 MW(e) in New Jersey (PSEG 2015-TN4280).

Because of uncertainties associated with obtaining sufficient wood and wood waste to fuel a baseload power plant, the ecological impacts of large-scale timber cutting (e.g., soil erosion and loss of wildlife habitat), and the relatively small size of wood power-generation plants, the review team concludes that wood waste would not be a reasonable alternative to a 2,200-MW(e) nuclear power generation facility operated as a baseload plant.

9.2.2.7 Municipal Solid Waste and Methane from Landfills

Municipal solid-waste (MSW) combustors incinerate waste and can use the resulting heat to produce steam, hot water, or electricity. The combustion process reduces the volume of waste, as well as the need for new solid-waste landfills. MSW combustors use three basic types of technologies: mass burn, modular, and refuse-derived fuel. Mass-burning technologies are most commonly used in the United States. This group of technologies processes raw MSW with little or no sizing, shredding, or separation before combustion. More than 20 percent of the U.S. MSW incinerators use refuse-derived fuel, where (in contrast to mass burning, in which the MSW is introduced “as is” into the combustion chamber) the facilities are equipped to recover recyclables (e.g., metals, cans, and glass) followed by shredding the combustible fraction into fluff for incineration (EPA 2013-TN2121).

MSW combustors generate sulfur dioxide (SO_2) and nitrogen oxides (NO_x) emissions, as well as an ash residue that is buried in landfills. The ash residue is composed of bottom ash and fly ash, as is the case with coal combustion.

In New Jersey, 116 MW(e) of baseload capacity and 23 MW(e) of peaking capacity are currently available from MSW facilities (PSEG 2015-TN4280). In a report prepared for the State of New Jersey, Rutgers University estimated that additional electricity production from incineration of MSW could amount to as much as about 840 MW(e) if all of the practicably recoverable waste were to be burned (Brennan et al. 2007-TN2528).

The combustion of methane gas collected from natural decay processes in landfills is another source of energy for the production of electric power. While the composition of LFG varies depending on the type of waste in the landfill, the primary component is combustible methane. The LFG is collected in a process that involves the use of recovery wells and gas collection systems that are constructed in the landfill. Because LFG is produced continuously, facilities that burn LFGs can have a capacity factor greater than 90 percent and can thus be relied upon as sources of baseload power. PSEG estimates that about 70 MW(e) can potentially be produced in New Jersey from LFG and from wastewater treatment facilities, which also generate methane (PSEG 2015-TN4280).

Currently in New Jersey, a baseload capacity of 31 MW(e) and an additional 20 MW(e) of peaking capacity are available from facilities burning methane from landfills (PSEG 2015-TN4280).

Given the small size and output of existing plants, the review team concludes that generating electricity from either MSW or methane derived from landfills or wastewater treatment plants would not be a reasonable alternative to a 2,200-MW(e) nuclear power generation facility operated as a baseload plant within the PSEG ROI.

9.2.2.8 Other Biomass-Derived Fuels

In addition to wood waste and MSW as fuels, several other biomass-derived fuels are available for fueling electric generators, including crops grown specifically for use as feedstocks in combustion facilities (i.e., energy crops such as switchgrass), agricultural residues such as corn stover, crops converted into a liquid fuel such as ethanol, and crops (including wood waste) used in gasification processes.

Biomass-derived fuels would typically be used as fuel for combustion processes that create electric power by steam generators and turbines in a manner similar to coal-fired power plants. Construction of any combustion-based biomass plant would have environmental impacts similar to those for a coal-fired plant, although facilities using energy crops and agricultural residues for fuel would be built on a smaller scale. Similar to coal-fired plants, biomass-fired plants require areas for fuel storage, processing, and waste (i.e., ash) disposal. The major operating waste from biomass-fired plants would be the fly ash and bottom ash that result from the combustion of the carbonaceous fuels. Biomass-derived fuels would generate fewer criteria pollutants per unit of energy than coal. Significant impacts to land use could be associated with energy crops due to the large acreage required to grow these crops. If these crops were to be irrigated, then significant impacts to water use and/or water quality could also occur.

Co-firing biomass fuels with coal is possible when low-cost biomass resources are available. Co-firing is the most economic option for the near future to introduce new biomass power generation. These projects require small capital investments per unit of power-generation capacity. Co-firing systems range in size from 1 to 30 MW(e) of biopower capacity (DOE 2008-TN1416).

The review team concludes that given the relatively small average output of biomass power-generation facilities and the lack of maturity of technologies such as crop gasification, biomass-

derived fuels do not offer a reasonable alternative to a 2,200-MW(e) nuclear power generation facility operated as a baseload plant within the PSEG ROI.

9.2.2.9 Fuel Cells

Fuel cells work without combustion and its associated environmental side effects. Power is produced electrochemically by passing a hydrogen-rich fuel over an anode, air over a cathode, and then separating the two with an electrolyte. The only by-products are heat, water, and carbon dioxide (CO_2). The hydrogen fuel can come from a variety of hydrocarbon resources by subjecting them to steam under pressure. Natural gas is typically used as the source of hydrogen.

Phosphoric acid fuel cells are generally considered first-generation technology. Higher-temperature second-generation fuel cells achieve higher fuel-to-electricity and thermal efficiencies. The higher temperatures contribute to improved efficiencies and give the second-generation fuel cells the capability to generate steam for cogeneration and combined-cycle operations.

During the past three decades, significant efforts have been made to develop more practical and affordable fuel cell designs for stationary power applications, but progress has been slow. The cost of fuel cell power systems must be reduced before they can be competitive with conventional technologies (DOE 2008-TN1417). DOE has an initiative called the Solid State Energy Conversion Alliance (SECA) with the goal of developing large (i.e., 250 MW or greater) fuel cell power systems, including those based on coal-derived fuels. Another goal of SECA is to cut the costs of electricity generated via fuel cells to $700 per kilowatt (electrical) (DOE 2011-TN2083). However, it is not clear whether DOE will achieve these goals and, if so, when the associated fuel cells might reach commercial operations.

The review team concludes that, at the present time, fuel cells are not economically or technologically competitive with other alternatives for baseload electricity generation. Future gains in cost competitiveness for fuel cells compared to other fuels are speculative.

For the preceding reasons, the staff concludes that a fuel cell energy facility located at the PSEG Site or elsewhere within the PSEG ROI would not currently be a reasonable alternative to construction of a 2,200-MW(e) nuclear power generation facility operated as a baseload plant.

9.2.2.10 Coal

Coal-fired generation is a proven baseload generating technology that is currently in use in New Jersey. In 2011, coal generated about 12 percent of the utility-generated electricity in New Jersey (PJM 2012-TN3129). This contribution to generation was down from over 17 percent in 2000, primarily because of a significant increase in generation using natural gas. While building a new coal-fired power plant could be challenging[(1)] (e.g., meeting evolving air emissions

(1) The review team is aware that the governor of New Jersey has announced a policy of no new coal-fired power plants (New Jersey 2011-TN2115). While the policy does not have the force of law, it further reduces the likelihood a new coal plant could be built. However, because a new coal plant is not prohibited by law, the review team included a coal-fired alternative in its analysis.

standards), the review team considers it to be a feasible option to meet the need for new baseload capacity that was discussed in Chapter 8.

9.2.2.11 Natural Gas

Natural-gas-fired generation is a proven generating technology that is currently in use in New Jersey. In 2011, natural gas generated about 55 percent of the utility-generated electricity in New Jersey (PJM 2012-TN3129). This contribution to generation was up from around 28 percent in 2000. While natural gas has traditionally been used as an intermediate or peaking power source, more recently it has been used increasingly as a baseload source, often displacing coal-fired generating plants (DOE/EIA 2013-TN2590). The review team considers natural gas to be a feasible option to meet the need for new baseload capacity that was discussed in Chapter 8.

9.2.3 Feasible Discrete New Generating Alternatives

The discussion in Sections 9.2.3.1 and 9.2.3.2 is limited to a reasonable range of the individual energy alternatives that appear to be viable for new baseload generation: coal-fired and natural-gas combined-cycle generation. The impacts discussed in these sections are estimates based on current technology. Section 9.2.2 also addresses other generation technologies that have demonstrated commercial acceptance but may be limited in application, total capacity, or technical feasibility when analyzed based on the need to supply reliable, baseload capacity.

To assess the environmental impacts of each of the competitive energy alternatives, the review team assumed that (1) the new power-generation facilities would be located at the PSEG Site for the coal-fired and natural-gas-fired alternatives, (2) the same cooling approach (i.e., closed-cycle cooling) as in the type envisioned by PSEG for new nuclear units at the PSEG Site would be used for plant cooling, and (3) the new causeway to be constructed for access to the PSEG Site would be needed for any new coal-fired or natural-gas-fired alternatives that might be constructed and operated at the site.

9.2.3.1 Coal-Fired Power Generation

For the coal-fired power-generation alternative, the review team assumed construction and operation of four supercritical pulverized coal-fired units, each with a total net capacity of about 580 MW(e). A capacity factor of 85 percent was assumed. The coal-fired units were assumed to have an operating life of 40 years. The above assumptions are consistent with the ER submitted as part of the PSEG ESP application (PSEG 2015-TN4280), except that the review team assumed a somewhat lower capacity factor for coal, and slightly larger units in order to generate the same amount of electricity annually as the proposed project. The review team estimates of coal consumption, coal combustion technology, air emissions, water consumption, and waste product generation are based on *Cost and Performance Baseline for Fossil Energy Plants, Volume 1: Bituminous Coal and Natural Gas to Electricity* (NETL 2010-TN1423).

The review team also considered an integrated gasification combined-cycle (IGCC) coal-fired plant. IGCC is an emerging technology for generating electricity with coal that combines modern coal gasification technology with both gas turbine and steam turbine power generation. This technology is cleaner than conventional pulverized coal plants because major pollutants

can be removed from the gas stream before combustion. The IGCC alternative also generates less solid waste than the pulverized coal-fired alternative. The largest solid-waste stream produced by IGCC installations is slag—a glassy, black, sand-like material—that is potentially a marketable by-product. The other large-volume by-product produced by IGCC plants is sulfur, which is extracted during the gasification process and which can also be marketed rather than disposed of as waste. IGCC units do not produce ash or scrubber wastes.

In spite of the preceding advantages, the review team concludes that, at present, a new IGCC plant is not a reasonable alternative to a 2,200 MW(e) nuclear power generation facility for the following reasons: (1) IGCC plants are more expensive than comparable pulverized coal plants (NETL 2010-TN1423), (2) the existing IGCC plants in the United States have considerably smaller capacities than the assumed 2,200-MW(e) nuclear plant,[(1)] (3) the system reliability of existing IGCC plants has been lower than pulverized coal plants, and (4) a lack of overall plant performance warranties for IGCC plants has hindered commercial financing (NPCC 2005-TN1406). For these reasons, IGCC plants are not considered further in this EIS.

For the coal-fired alternative, the review team assumed that coal for fuel and limestone (calcium carbonate) for the pollution abatement system would be delivered to the plant by barge. The review team estimates that the hypothetical coal-fired plant would consume about 6.5 million tons per year (tpy) of pulverized Illinois No. 6 bituminous coal. Slaked lime or limestone would be used in the flue-gas scrubbing process for control of SO_2 emissions and would be injected as a slurry into the hot effluent combustion gases to remove entrained SO_2. The limestone-based scrubbing solution reacts with SO_2 to form calcium sulfite or calcium sulfate, which precipitates and is removed from the process as sludge for dewatering and then sold to industry for use in the manufacture of wallboard or other industrial products. The review team estimates that about 641,000 tpy of limestone would be used for flue-gas desulfurization, generating about 997,000 tpy of spent limestone (i.e., calcium sulfite or calcium sulfate) waste.

Air Quality

The impacts on air quality from coal-fired generation would vary considerably from those of nuclear generation because of emissions of SO_2, NO_x, carbon monoxide, particulate matter (PM), volatile organic compounds, and hazardous air pollutants such as mercury and lead. The review team assumes that fugitive dust emissions from construction activities would be mitigated using best management practices (BMPs), similar to mitigation discussed in Chapter 4 for building a new nuclear plant at the PSEG Site. Such emissions would be temporary.

The review team assumed a plant design that would minimize air emissions through a combination of boiler and combustion technology and post-combustion pollutant removal. Nevertheless, these emissions estimates are not necessarily representative of those allowable under applicable regulatory air permits. Salem County is in nonattainment of the 8-hour ozone National Ambient Air Quality Standards (NAAQSs). One or more of the emission estimates

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(1) The review team is aware that Duke Energy placed a 618-MW(e) integrated gasification combined cycle (IGCC) plant into service in June 2013 (Duke 2013-TN2662) and that Mississippi Power is building an IGCC plant in Kemper County, Mississippi, with a planned output of 582 MW(e) and a planned commercial operations date in the first half of 2016 (MPC 2015-TN4155).

presented below exceeds the threshold value of 100 tpy; therefore, a new coal-fired plant having these emissions would qualify as a major source that must obtain a Title V operating permit. A final air permit for building the coal-fired power plant would likely require the lowest achievable emission rate (LAER) for ozone precursor (NO_x), along with offsets[(1)] (NJAC 7:27-TN3290), and the best available control technology (BACT) for other pollutants (SO_2 and PM). The review team's estimate of the approximate emissions from the coal-fired generation alternative is as follows:[(2)]

- SO_2 = 6,460 tpy;
- NO_x = 5,270 tpy;
- PM = 980 tpy; and
- mercury = 0.085 tpy.

The review team estimates that the coal-fired plant would also have CO_2 emissions of 15.3 million tpy that could affect climate change.

The acid rain requirements of the Clean Air Act, as amended (42 USC 7401 et seq. -TN1141), capped U.S. SO_2 emissions from power plants. PSEG would need to obtain sufficient pollution credits either from a set-aside pool or purchases on the open market to cover annual emissions from the plant.

A new coal-fired power-generation plant at the PSEG Site would need a Nonattainment New Source Review (NSR) permit for NO_x and a Prevention of Significant Deterioration (PSD) permit for SO_2 and PM as building permits and a Title V operating permit under the Clean Air Act (42 USC 7401 et seq. -TN1141). The plant would need to comply with the new source performance standards for such plants in 40 CFR Part 60 (TN1020), Subpart Da. The standards establish emission limits for PM and opacity (40 CFR 60.42Da), SO_2 (40 CFR 60.43Da), and NO_x (40 CFR 60.44Da) (40 CFR Part 60-TN1020).

Historically, CO_2, an unavoidable by-product of combustion of carbonaceous fuels, has not been regulated as a pollutant. However, regulations are now under development for CO_2 and other greenhouse gases (GHGs). In response to the Consolidated Appropriations Act of 2008 (Public Law 110-161, 121 Stat. 1844-TN1485), EPA promulgated final mandatory GHG reporting regulations in October 2009, effective in December 2009 (74 FR 56260-TN1024). The rules are primarily applicable to large facility sources of CO_2 equivalent (CO_2e) (those emitting 25,000 metric tons or more per year). New utility-scale coal-fired power plants would be subject to those regulations.

A new coal-fired generation plant would qualify as a major generator of GHGs under the "Tailoring Rule" recently promulgated by EPA (75 FR 31514-TN1404). Beginning January 2,

(1) The minimum offset ratio varies, depending on the distance between the facility and the location of the emission reductions being proposed as emission offsets: 1.3 to 1 for 0−100 mi; 2.6 to 1 for 100−250 mi; and 5.2 to 1 for 250−500 mi.

(2) Based on 6,460,000 tpy of bituminous coal and combustion controls using overfire air nozzles in combination with low-NO_x burners and selective catalytic reduction, limestone-based flue-gas desulfurization, and conventional particulate capture technology.

2011, permits issued to major sources of GHG under the PSD or Title V Federal permit programs must contain provisions requiring the use of BACT to limit the emissions of GHGs if those sources would be subject to PSD or Title V permitting requirements because of their non-GHG pollutant emission potentials and if their estimated GHG emissions are at least 75,000 tons CO_2e per year. The amount of GHGs, mostly CO_2, released per unit of power produced would depend on the quality of the fuel, the firing conditions, and overall firing efficiency of the boiler. On August 3, 2015, the EPA set the final standard to limit CO_2 emissions from new coal-fired power plants (EPA 2015-TN4336). However, even with the application of this new standard, the emissions from a coal-fired power plant will still be far greater than those from a comparably sized nuclear power plant. Meeting permit limitations for GHG emissions may require installation of carbon capture and sequestration (CCS) devices on any new coal-fired power plant, which could add substantial power penalties. The relative efficiency penalty for adding CO_2 capture ranges from 21 to 29 percent on average, meaning that a new coal plant would have to be much larger than the proposed nuclear power plant to provide a comparable amount of power (NETL 2010-TN1423). In addition, once extracted the CO_2 would have to be piped either to a permanent sequestration site, or for use in enhanced oil recovery. Regardless of end use, the construction of a CO_2 pipeline would have the potential to increase the impacts on resources such as, but not limited to, terrestrial and aquatic ecology, socioeconomics, and cultural and historic resources. Because the exact location of such sequestration is beyond the scope of this analysis the magnitude of the impacts could not be quantified by the NRC staff. The NRC staff concludes that complying with the new CO_2 regulations would increase the cumulative impacts because the coal-fired power plant would be larger and because of the construction of the CO_2 pipeline.

The EPA has various regulatory requirements for visibility protection in 40 CFR Part 51, Subpart P (TN1090), including a specific requirement for review of any new major stationary source in an area designated as in attainment or unclassified for criteria pollutants under the Clean Air Act (42 USC 7401 et seq. –TN1141) (40 CFR 51.307(a) [TN1090]). NAAQSs for criteria pollutants are specified in 40 CFR Part 50 (TN1089). Salem County, in which the PSEG Site is located, is in attainment for all criteria pollutants except ozone, which is in nonattainment with the 8-hour ozone NAAQSs. New Castle County, Delaware, located across the Delaware River from the PSEG Site and in which the northernmost portions of Artificial Island are located, is in attainment for all criteria pollutants except 8-hour ozone. Effective September 4, 2014, New Castle County was redesignated from a nonattainment area to a maintenance area for PM with aerodynamic diameters less than or equal to 2.5 μm (i.e., $PM_{2.5}$). See Section 2.9.2 for additional details.

Section 169A of the Clean Air Act (42 USC 7401 et seq. -TN1141) establishes a national goal of preventing future impairment of visibility and remedying existing impairment in mandatory Class I Federal areas when impairment is from air pollution caused by human activities. In addition, EPA regulations provide that for each mandatory Class I Federal area located within a state, the state must establish goals that provide for reasonable progress toward achieving natural visibility conditions. The reasonable progress goals must provide for an improvement in visibility on the most impaired days over the period of the implementation plan and make sure there is no degradation in visibility for the least-impaired days over the same period [40 CFR 51.308(d)(1) (TN1090)]. If a new coal-fired power-generation station were to be located close to

a mandatory Class I area, additional requirements for air-pollution control could be imposed. The Federal Class I area nearest to the PSEG Site is the Brigantine Wilderness Area at the Edwin B. Forsythe National Wildlife Refuge, about 60 mi to the east.

New Jersey is one of 28 states in the eastern half of the United States whose stationary sources of criteria pollutants are subject to revised emission limits for SO_2 and NO_x under the Cross-State Air Pollution Rule (CSAPR). New Jersey stationary sources of SO_2 and NO_x would be subject to this rule, as well as complementary regulatory controls developed at the State level. On July 6, 2011, EPA announced the finalization of CSAPR (EPA 2015-TN4307), previously referred to as the Transport Rule, as a response to previous court decisions and as a replacement to the EPA's 2005 Clean Air Interstate Rule (CAIR). A number of court actions have impacted implementation of CSAPR, including an August 2012 D.C. Circuit decision vacating CSAPR. On April 29, 2014, the U.S. Supreme Court issued an opinion reversing the D.C. Circuit decision. CSAPR took effect starting January 1, 2015, for SO_2 and annual NO_X and May 1, 2015, for ozone season NO_X (EPA 2015–TN4307). Fossil-fuel power plants in New Jersey would be subject to CSAPR and would be required to reduce emissions of SO_2 and NO_x to help reduce downwind ambient concentrations of fine particulates ($PM_{2.5}$) and ozone. However, the review team recognizes that the environmental impacts of air emissions from the coal-fired plant would be significantly greater than those from a new nuclear power plant at the PSEG Site, even after application of CSAPR, because the operational emissions from the new nuclear power plant would be much less than from a coal-fired plant even with the required reductions under CSAPR.

The coal-fired electric utility steam-generating units would be subject to EPA National Emission Standards for Hazardous Air Pollutants (40 CFR Part 63, Subpart B [TN1403]). EPA determined that coal-fired and oil-fired electric utility steam-generating units are significant emitters of the following hazardous air pollutants (HAPs): arsenic, beryllium, cadmium, chromium, dioxins, hydrogen chloride, hydrogen fluoride, lead, manganese, and mercury (65 FR 79825-TN2536). EPA concluded that mercury is the HAP of greatest concern and that (1) a link exists between coal combustion and mercury emissions, (2) electric utility steam-generating units are the largest domestic source of mercury emissions, and (3) certain segments of the U.S. population (e.g., the developing fetus and subsistence fish-eating populations) are believed to be at potential risk of adverse health effects resulting from mercury exposures caused by the consumption of contaminated fish (65 FR 79825-TN2536). On March 28, 2013, EPA finalized updates to emission standards, including mercury, for power plants under the Mercury and Air Toxics Standards (EPA 2013-TN2537). This rule became effective on April 24, 2013. However, the review team recognizes that the environmental impacts of air emissions from the coal-fired plant would be significantly greater than those from a new nuclear power plant at the PSEG Site, even after application of any new mercury emissions standards.

NUREG–1437 (NRC 2013-TN2654) indicates that air-quality impacts from a coal-fired power plant can be significant. NUREG–1437 also provides estimates of CO_2 and other emissions (NRC 2013-TN2654). Adverse human health effects, such as cancer and emphysema, have been associated with the by-products of coal combustion.

Overall, the review team concludes that air-quality impacts from construction and operation of the new coal-fired power generation at the PSEG Site, despite the availability of LAER/BACT,

would be MODERATE. The impacts would be clearly noticeable, but would not destabilize air quality.

Waste Management

Coal combustion generates waste in the form of ash, and equipment for controlling air pollution generates additional ash, spent selective catalytic reduction (SCR) catalyst, and scrubber sludge. The review team estimates that the coal-fired units would generate a total of about 625,000 tpy of ash, which would include 500,000 tpy of fly ash and 125,000 tpy of bottom ash (NETL 2010-TN1423). Bottom ash refers to the portion of the unburned matter in coal 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. The fly ash is typically removed from the stack gases using fabric filters and/or wet scrubbers. Significant quantities of the fly ash may be recycled for use in commodity products such as concrete, thus reducing the total landfill volume.

Effective 6 months after publication of the final rule signed by the EPA administrator on December 19, 2014, coal combustion residuals (CCRs) from electric utilities will be regulated as solid waste under Subtitle D of the Resource Conservation and Recovery Act of 1976, as amended (42 USC 6901 et seq. -TN1281). The minimum criteria for new CCR units include location restrictions; design and operating criteria; groundwater monitoring and corrective action; closure requirements and post-closure care; and requirements for recordkeeping, notification, and Internet posting. Different criteria apply to landfills and surface impoundments.

Waste impacts on groundwater and surface water could extend beyond the operating life of the plant if leachate runoff from the waste-storage area occurs. Disposal of the waste could noticeably affect land use (because of the acreage needed for waste) and groundwater quality, but with appropriate management and monitoring, it would not destabilize any resources. After closure of the waste site and revegetation, the land could be available for some other uses. The disposal location could be either on or off the site. If the disposal location is off the site, the review team assumes that the waste would be transported by barge in a manner similar to the delivery of coal for fuel and limestone for the pollution abatement system. Construction-related debris would be generated during plant construction activities and would be disposed of in approved landfills.

For the reasons stated above, the review team concludes that the impacts from waste generated at a coal-fired plant would be MODERATE. The impacts would be clearly noticeable but would not destabilize any important resource.

Human Health

Adverse human health effects such as cancer and emphysema have been associated with the by-products of coal combustion. Coal-fired power generation also introduces worker risks from coal and limestone mining, worker and public risk from coal and lime/limestone transportation, worker and public risk from disposal of coal combustion waste, and worker and public risk from inhalation of stack emissions. In addition, the discharges of uranium and thorium from coal-fired power plants can potentially produce radiological doses in excess of those arising from nuclear power plant operations (Gabbard 1993-TN1144).

Regulatory agencies, including EPA and State agencies, base air emission standards and requirements on human health impacts. These agencies also impose site-specific emission limits as needed to protect human health. Given the regulatory oversight exercised by EPA and State agencies, the review team concludes that the human health impacts from radiological doses, inhaled toxins, and criteria pollutants (including particulates and nitrogen oxides) generated from coal-fired generation would be SMALL; furthermore, similar to the findings of the traffic accident analysis in Chapter 4 for a new nuclear plant, transportation of personnel and construction materials for a new coal-fired plant would result in minor impacts limited mainly to those from traffic associated with the construction workforce traveling to and from the PSEG Site.

Other Impacts

Based on the 1996 version of NUREG–1437 (NRC 1996-TN288), at least 1,700 ac of land would need to be converted to industrial use for a 1,000-MW(e) coal-fired plant on the PSEG Site for the power block, infrastructure and support facilities, coal and limestone storage and handling, and landfill disposal of ash and spent scrubber sorbent (as much as 3,900 ac for four 580-MW(e) coal units). Land-use changes would occur in an undetermined offsite coal-mining area to supply coal for the plant. In the 1996 version of NUREG–1437 (NRC 1996-TN288), the staff estimated that about 22,000 ac would be needed for coal mining and waste disposal to support a 1,000-MW(e) coal-fired plant over its operating life (51,000 ac for four 580-MW(e) coal units). Based on the considerable amount of land affected for the site, mining, and waste disposal, as well as the new causeway, the review team concludes that land-use impacts would be MODERATE. The impacts would alter noticeably, but would not destabilize, any important attributes of land uses on the site or in offsite areas.

The amount of water used and the impacts on water quality from constructing and operating a coal-fired plant at the PSEG Site would be comparable to those associated with building a new nuclear power plant. Water consumption due to evaporative cooling would also be comparable to that of a new nuclear power plant. The source of the cooling water would be the Delaware River. All liquid discharges would be regulated by the New Jersey Department of Environmental Protection, Division of Water Quality, through a National Pollutant Discharge Elimination System (NPDES) permit. Indirectly, water quality could be affected by acids and mercury from air emissions. However, these emissions are regulated to minimize impacts. Some erosion and sedimentation would likely occur during construction of new facilities. These impacts would be similar to those for a new nuclear plant, which would be minor, as discussed in Sections 4.2 and 5.2. Overall, the review team concludes that the surface-water and groundwater impacts would be SMALL.

The coal-fired power-generation alternative would introduce ecological impacts from construction and new incremental impacts from operations. The impacts would be similar to those of constructing and operating new nuclear units at the PSEG Site. The impacts could include terrestrial and aquatic functional loss, habitat fragmentation and/or loss, reduced productivity, and a local reduction in biological diversity. The impacts could occur at the PSEG Site and at the sites used for coal and limestone mining. Stack emissions and disposal of waste products could affect aquatic and terrestrial resources. Additional impacts on threatened and endangered terrestrial species could result from ash disposal and mining activities if the

locations of such activities overlap with habitat for such protected species. Overall, the review team concludes that the terrestrial and wetland ecological impacts would be SMALL to MODERATE, primarily because of the potential disturbance to habitat associated with the new causeway and because of the potential impacts associated with disposal of ash and the large area of land affected by mining activities. Impacts to aquatic ecosystems would be similar to those for building and operating a new nuclear plant at the PSEG Site, which are SMALL provided there is compliance with BMPs required for Federal and State permitting.

The review team estimates that the four 580-MW(e) coal-fired units would require a peak workforce of about 2,000 construction workers, and about 250 workers would be needed to operate the facility (NRC 2012-TN1976). Socioeconomic impacts would be associated with these workforces in proportion to those expected for the proposed PSEG Site's socioeconomic impacts. The construction workers would be predominantly temporary, and the review team expects that most of the socioeconomic impacts (physical, demography, economy/taxes, and infrastructure/community services) would be similar to those for a new nuclear plant, as discussed in Sections 4.4 and 5.4. Impacts in the following categories could be different for a coal-fired plant than for a new nuclear plant: noise from plant operations and potential impacts to air quality, transportation, and traffic associated with transporting coal, limestone, and wastes.

Coal-fired power generation would introduce mechanical sources of noise that would likely be audible at offsite locations. Sources contributing to the noise produced by plant operation are classified as continuous or intermittent. Continuous sources include the mechanical equipment associated with normal plant operations. Intermittent sources include the equipment related to coal handling, solid-waste disposal, transportation related to deliveries (coal and lime/limestone) and removal (primarily top and bottom ash wastes), use of outdoor alarms and loudspeakers, and commuting of plant employees. The review team concludes that the impacts of noise on residents in the vicinity of the facility would be SMALL given the large distances to such residents from the proposed PSEG Site.

Beyond the impacts related to coal combustion, which are discussed above, the transportation and handling of coal can lead to particulate emissions along the transport route and in the vicinity of the plant. Transportation-related impacts of coal transportation would be most noticeable if the coal were to be transported by rail. The use of barges to transport coal and limestone would minimize any associated air-quality impacts because—unlike rail—the barges operate at some distance from residential areas. In addition, the relatively remote location of the site would minimize the impacts associated with coal handling at the site. The review team therefore concludes that the physical impacts on air quality would be SMALL.

Similarly, traffic impacts from transporting coal and ash would also be minimized by the use of barges. As a result, the remaining traffic impacts—deliveries and commuting—would be similar to those for a new nuclear plant, as analyzed in Sections 4.4 and 5.4.

Overall, the socioeconomic impacts from a coal plant at the PSEG site would range from LARGE (beneficial) to MODERATE (adverse).

<u>Beneficial Impacts</u>. Construction and operation of a series of coal-fired generating units at the PSEG Site would produce beneficial economic impacts ranging from SMALL (for all economic

categories within the 50-mi region other than the host county) to MODERATE (for tax revenues collected by the State of New Jersey) and LARGE (for economic impacts, primarily tax revenues, in Salem County during construction and operation).

Adverse Impacts. For the entire 50-mi region, construction and operations would produce SMALL adverse impacts for all physical impact categories, demographic categories, and community and infrastructure categories except for traffic impacts (MODERATE) during peak employment during construction and for heavy vehicle transportation of coal and limestone delivery; waste removal and ash management activities; and aesthetic impacts (MODERATE) related to recreational enjoyment of the viewshed, primarily during operation.

As discussed in Section 2.6.2, there are no environmental pathways by which the identified minority or low-income populations within the 50-mi radius surrounding the proposed PSEG Site (region) would be likely to suffer disproportionately high and adverse environmental impacts. The impacts to nearby populations of building and operating the coal-fired units would be similar to those from building and operating a new nuclear power plant. Therefore, the review team concludes that there are no pathways for disproportionately high and adverse impacts on minority or low-income populations.

The impacts on cultural resources and historical properties of a new coal-fired plant located at the PSEG Site would be similar to the impacts of a new nuclear power plant, as discussed in Sections 4.6 and 5.6. Because Artificial Island is man-made and therefore not anticipated to contain intact historic and cultural resources, no direct impacts would be anticipated within onsite areas. Other lands, if located off Artificial Island, that would be acquired to support the plant would require cultural resource studies, and possible mitigation of the adverse effects from ground-disturbing actions. The studies would likely be needed for all areas of potential disturbance offsite, such as mining and waste-disposal sites, and along associated corridors where new construction would occur (e.g., access roads). Visual effects from the cooling system (i.e., cooling towers) to historic and cultural resources would be anticipated from a new coal plant on Artificial Island. The review team concludes that the impacts on historic and cultural resources could range from SMALL to MODERATE, similar to the impacts of the proposed action.

The construction and operational impacts of four 580-MW(e) coal-fired power-generation units at the PSEG Site are summarized in Table 9-1.

Table 9-1. Summary of Environmental Impacts of Coal-Fired Power Generation at the PSEG Site

Impact Category	Impact Level	Comment
Land Use	MODERATE	As much as 3,900 ac would be needed for power block; coal-handling, storage, and transportation facilities; infrastructure facilities; and cooling water facilities. Coal-mining and waste-disposal activities would require an additional 51,000 ac off the site. Additional land would be required for the new causeway.
Surface Water	SMALL	Impacts would be comparable to the impacts for building and operating a new nuclear power plant located at the PSEG Site. Impacts might also be associated with offsite locations where coal and/or limestone are mined.

Table 9-1. (continued)

Impact Category	Impact Level	Comment
Groundwater	SMALL	Impacts would be comparable to the impacts for building and operating a new nuclear power plant located at the PSEG Site.
Terrestrial Ecology	SMALL to MODERATE	Impacts could include functional loss, habitat fragmentation and/or loss, reduced productivity, and a local reduction in biological diversity. Impacts could occur at the PSEG Site and vicinity, along the new causeway and transmission lines, and at the sites used for coal and limestone mining. Disposal of ash could affect the terrestrial environments. Additional impacts on threatened and endangered species could result from ash disposal and mining activities. Impacts on wetlands could occur within the project footprint and/or along the new causeway and transmission lines.
Aquatic Ecology	SMALL	Impacts to aquatic resources would be comparable to the impacts for building and operating a new nuclear power plant located at the PSEG Site. Impacts could also occur along the new causeway and transmission lines and at the sites used for coal and limestone mining and ash disposal. However, use of best management practices required for Federal and State permitting would minimize effects to aquatic habitats.
Socioeconomics	LARGE (beneficial) to MODERATE (adverse)	**Beneficial Impacts:** Construction and operation of a series of coal-fired generating units at the PSEG Site would produce beneficial economic impacts ranging from SMALL (for all economic categories within the 50-mi region other than the host county) to MODERATE (for tax revenues collected by the State of New Jersey) and LARGE (for economic impacts, primarily tax revenues, in the host county during construction and operation). **Adverse Impacts:** For the entire 50-mi region, construction and operations would produce SMALL adverse impacts for all physical impact categories, demographic categories, and community and infrastructure categories except for traffic impacts (MODERATE) during peak employment during construction and for heavy vehicle transportation of coal and limestone, other large deliveries, waste removal, ash management activities, and aesthetic impacts (MODERATE) related to recreational enjoyment of the viewshed, primarily during operation.
Environmental Justice	None[(a)]	There are no pathways for disproportionately high and adverse impacts on minority or low-income populations.
Historic and Cultural Resources	SMALL to MODERATE	Most potential impacts could likely be effectively managed. Most of the facility and infrastructure would be built in previously disturbed areas. Impacts may also be associated with locations where coal and/or limestone are mined and/or along the new causeway. Visual impacts could be noticeable.
Air Quality	MODERATE	SO_2 − 6,460 tpy NO_x − 5,270 tpy PM − 980 tpy Mercury − 0.085 tpy CO_2 − 15.3 million tpy Small amounts of hazardous air pollutants.
Human Health	SMALL	Regulatory controls and oversight are assumed to be protective of human health.
Waste Management	MODERATE	Total volume of combustion wastes would exceed 1.5 million tpy (i.e., 625,000 tpy ash and 997,000 tpy spent limestone/sorbent waste).

(a) The entry “None” for Environmental Justice does not mean there are no adverse impacts to minority or low-income populations from the proposed action. Rather, “None” means that, while there may be adverse impacts, those impacts do not affect minority or low-income populations in any disproportionate manner, relative to the general population.

9.2.3.2 Natural-Gas-Fired Power Generation

For the natural-gas power-generation alternative, the review team assumed construction and operation of a natural-gas-fired plant at the PSEG Site. The review team assumed that the plant would use combined-cycle combustion turbines. Four such units were assumed, each with a net capacity of 580 MW(e). A capacity factor of 85 percent was assumed. The natural-gas-fired units were assumed to have an operating life of 40 years. The above assumptions are consistent with the ER submitted as part of the PSEG ESP application (PSEG 2015-TN4280), except that the review team assumed a somewhat lower capacity factor for natural gas, and slightly larger units in order to generate the same amount of electricity annually as the proposed project. The review team estimates of natural-gas consumption, combined-cycle technology, air emissions, water consumption, and waste product generation are based on the DOE report *Cost and Performance Baseline for Fossil Energy Plants, Volume 1: Bituminous Coal and Natural Gas to Electricity* (NETL 2010-TN1423). The review team estimated that the natural-gas-fired plant would use about 114 billion standard ft^3 of gas per year.

Air Quality

Natural gas is a relatively clean-burning fuel. When compared with a coal-fired plant, a natural-gas-fired plant would release similar types of emissions but in lower emitted quantities. The review team assumes that fugitive dust emissions from construction activities would be mitigated using BMPs, similar to mitigation discussed in Chapter 4 for building new nuclear reactor units at the PSEG Site. Such emissions would be temporary and limited in magnitude and are anticipated to be SMALL.

The review team assumed a plant design that would minimize air emissions through a combination of combustion technology and post-combustion pollutant removal. Nevertheless, these emissions estimates are not necessarily representative of what would be allowed under applicable regulatory air permits. Salem County is in nonattainment of the 8-hour ozone NAAQSs. One or more of the emission estimates below exceeds the threshold value of 100 tpy; therefore, a new natural-gas-fired plant having these emissions would qualify as a major source that must obtain a Title V operating permit. A final air permit for building the natural-gas-fired power plant would likely require the LAER for ozone precursor (NO_x), along with offsets[(1)] (NJAC 7:27-TN3290), and the BACT for PM and SO_2.[(2)] A natural-gas-fired plant equipped with appropriate combustion and post-combustion pollution-control technology would have approximately the following emissions:[(3)]

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(1) The minimum offset ratio varies, depending on the distance between the facility and the location of the emission reductions being proposed as emission offsets: 1.3 to 1 for 0−100 mi; 2.6 to 1 for 100−250 mi; and 5.2 to 1 for 250−500 mi.

(2) Sulfur dioxide emissions exceed the significant emission rate of 40 tpy under the Prevention of Significant Deterioration regulations (40 CFR 51.166 [TN1090]) and thus require control by the best available control technology.

(3) Emissions are based on 114 billion standard cubic feet per year of natural gas burned in advanced Class F combustion turbine generators using dry low-NO_x burners and catalytic control for NO_x at a 90 percent reduction rate (NETL 2010-TN1423). The SO_2 emissions are based on the amounts of sulfur compounds that are permitted in pipeline natural gas. The PM value was provided by PSEG based on data obtained from its Linden, New Jersey, natural-gas-fired combined-cycle plant, scaled to a net output of 2,200 MW(e) (PSEG 2012-TN2113).

- SO_2 = 97 tpy;
- NO_x = 530 tpy; and
- PM = 660 tpy.

The review team estimates that the natural-gas-fired power plant would also have CO_2 emissions of 7.0 million tpy that could affect climate change. On August 3, 2015, EPA set the final standard to limit CO_2 emissions from new stationary combustion turbines (such as natural gas combined cycle technology) (EPA 2015-TN4336). However, the staff's emissions estimate of 7.0 million tpy was already below the new standard and would, therefore, be unchanged under the new rule.

A new natural-gas-fired power-generation plant would likely need a Nonattainment NSR permit for NO_x and a PSD permit for PM as building permits and a Title V operating permit under the Clean Air Act (42 USC 7401 et seq. -TN1141). A new natural-gas-fired combined-cycle plant would also be subject to the new source performance standards specified in 40 CFR Part 60, Subpart KKKK (TN1020). These regulations establish emission limits for SO_2 and NO_x.

EPA has various regulatory requirements for visibility protection in 40 CFR Part 51, Subpart P (TN1090), including a specific requirement for review of any new major stationary source in an area designated as in attainment or unclassified for criteria pollutants under the Clean Air Act (42 USC 7401 et seq. –TN1141) (40 CFR 51.307(a) [TN1090]). Salem County, in which the PSEG Site is located, is in attainment for all criteria pollutants except ozone, which is in nonattainment with the 8-hour ozone NAAQSs. New Castle County, Delaware, located across the Delaware River from the PSEG Site and in which the northernmost portions of Artificial Island are located, is in attainment for all criteria pollutants except 8-hour ozone. Effective September 4, 2014, New Castle County was redesignated from a nonattainment area to a maintenance area for $PM_{2.5}$. (See Section 2.9.2 for additional details.)

Section 169A of the Clean Air Act (42 USC 7401 et seq. -TN1141) establishes a national goal of preventing future impairment of visibility and remedying existing impairment in mandatory Class I Federal areas when impairment is from air pollution caused by human activities. In addition, EPA regulations provide that for each mandatory Class I Federal area located within a State, the State regulatory agencies must establish goals that provide for reasonable progress toward achieving natural visibility conditions. The reasonable progress goals must provide for an improvement in visibility for the most impaired days over the period of the implementation plan and make sure there is no degradation in visibility for the least-impaired days over the same period (40 CFR 51.308(d)(1) [TN1090]). If a new natural-gas-fired power-generation plant were to be located close to a mandatory Class I area, additional requirements for air-pollution control could be imposed. The Federal Class I area nearest to the PSEG Site is the Brigantine Wilderness Area at the Edwin B. Forsythe National Wildlife Refuge, about 60 mi to the east.

New Jersey is one of 28 states in the eastern half of the United States whose stationary sources of criteria pollutants are subject to revised emission limits for SO_2 and NO_x under CSAPR. New Jersey stationary sources of SO_2 and NO_x would be subject to this rule, as well as complementary regulatory controls developed at the State level. On July 6, 2011, EPA announced the finalization of CSAPR (EPA 2015-TN4307), previously referred to as the Transport Rule, as a response to previous court decisions and as a replacement to the EPA's

2005 CAIR. A number of court actions have impacted implementation of CSAPR, including an August 2012 D.C. Circuit decision vacating CSAPR. On April 29, 2014, the U.S. Supreme Court issued an opinion reversing the D.C. Circuit decision. CSAPR took effect starting January 1, 2015, for SO_2 and annual NO_X and May 1, 2015, for ozone season NO_X (EPA 2015–TN4307). Fossil-fuel power plants in New Jersey would be subject to CSAPR and would be required to reduce emissions of SO_2 and NO_x to help reduce downwind ambient concentrations of fine particulates ($PM_{2.5}$) and ozone. However, the review team recognizes that the environmental impacts of air emissions from the natural-gas-fired plant would be significantly greater than those from a new nuclear power plant at the PSEG Site, even after application of CSAPR, because the operational emissions from the new nuclear power plant would be much less than from a natural-gas-fired plant, even with the required reductions under CSAPR.

The combustion turbine portion of the combined-cycle units would be subject to EPA National Emission Standards for Hazardous Air Pollutants for Stationary Combustion Turbines (40 CFR Part 63, Subpart YYYY [TN1403]), if the site is a major source of hazardous air pollutants. Major sources have the potential to emit 10 tpy or more of any single hazardous air pollutant or 25 tpy or more of any combination of hazardous air pollutants (40 CFR 63.6585(b) [TN1403]).

Historically, CO_2, an unavoidable by-product of combustion of carbonaceous fuels, has not been regulated as a pollutant. However, regulations are now under development for CO_2 and other GHGs. In response to the Consolidated Appropriations Act of 2008 (Public Law 110-161, 121 Stat. 1844-TN1485), EPA promulgated final mandatory GHG reporting regulations in October 2009, effective in December 2009 (74 FR 56260-TN1024). The rules are primarily applicable to large-facility sources of CO_2e (those emitting 25,000 metric tons or more per year). New utility-scale gas-fired power plants would be subject to those regulations.

A new gas-fired generation plant would qualify as a major generator of GHGs under the "Tailoring Rule" recently promulgated by EPA (75 FR 31514-TN1404). Beginning January 2, 2011, permits issued to major sources of GHGs under the PSD or Title V Federal permit programs must contain provisions requiring the use of BACT to limit the emissions of GHGs if those sources would be subject to PSD or Title V permitting requirements because of their non-GHG pollutant emission potentials and if their estimated GHG emissions are at least 75,000 tons CO_2e per year. Meeting permit limitations for GHG emissions may require installation of CCS devices on any new natural-gas-fired power plant, which could reduce power output. However, the review team recognizes that the environmental impacts of air emissions from the natural-gas-fired power plant would be significantly greater than those of a new nuclear power plant at the PSEG Site, even after application of any new GHG emissions standards.

The impacts of emissions from a natural-gas-fired power-generation plant would be clearly noticeable but would not be sufficient to destabilize air resources. Overall, the review team concludes that air-quality impacts resulting from construction and operation of new natural-gas-fired power generation at the PSEG Site would be SMALL to MODERATE; SMALL for criteria pollutants and MODERATE for GHGs.

Waste Management

In the 1996 version of NUREG–1437, the NRC staff concluded that waste generation from natural-gas-fired technology would be minimal (NRC 1996-TN288). The only significant waste generated at a natural-gas-fired power plant would be spent SCR catalyst, which is used to control NO_x emissions. The spent catalyst would be regenerated or disposed of offsite. Other than spent SCR catalyst, waste generation at an operating natural-gas-fired plant would be largely limited to typical operations and maintenance waste. Construction-related debris would be generated during construction activities. Overall, the review team concludes that waste impacts from natural-gas-fired power generation would be SMALL.

Human Health

Natural-gas-fired power generation introduces public risk from inhalation of gaseous emissions. The risk may be attributable to NO_x emissions that contribute to ozone formation, which in turn contributes to health risk. Regulatory agencies, including EPA and State agencies, base air emission standards and requirements on human health impacts. These agencies also impose site-specific emission limits as needed to protect human health. Given the regulatory oversight exercised by EPA and State agencies, the review team concludes that the human health impacts from natural-gas-fired power generation, including traffic accident impacts from the transportation of personnel and construction materials, would be SMALL.

Other Impacts

The natural-gas-fired power-generating plant would require at least 110 ac for the power block and support facilities for a 1,000-MW(e) plant (NRC 1996-TN288) (as much as 250 ac for four 580-MW(e) gas units). Construction of a natural-gas supply pipeline to the PSEG Site would require about 60 ac, assuming 10 mi of pipeline length with a 50-ft right-of-way (ROW). Thus, the total land-use commitment, not including natural-gas wells and collection stations, would be at least 310 ac. A small amount of additional land would also be required for natural-gas wells and collection stations. Due to the proximity of the PSEG Site to existing natural-gas infrastructure, these impacts would be minimized. Overall, the review team concludes that the land-use impacts from new natural-gas-fired power generation would be MODERATE due mainly to the impacts from the new causeway.

The amount of water used and the impacts on water quality from constructing and operating a natural-gas-fired plant at the PSEG Site would be comparable to those associated with building a new nuclear power plant. The impacts on water quality from sedimentation during construction of a natural-gas-fired plant were characterized in the 1996 version of NUREG–1437 as SMALL (NRC 1996-TN288). The NRC staff also noted in the 1996 version of NUREG–1437 that the impacts on water quality from the operation of a natural-gas-fired combined-cycle plant would be similar to, or less than, the impacts from other power-generating technologies (NRC 1996-TN288). The source of the cooling water would be the Delaware River. Overall, the review team concludes that impacts to surface water and groundwater would be SMALL.

A natural-gas-fired plant at the PSEG Site would have fewer ecological impacts than a new nuclear power plant because less land would be affected. Constructing a new underground gas

pipeline to the site would result in permanent loss of some terrestrial and aquatic function and conversion and fragmentation of habitat; however, because the distance to connect to natural-gas distribution systems would be minimal, no important ecological attributes would be noticeably altered. Impacts on threatened and endangered species would be similar to the impacts from a new nuclear power plant or a new coal-fired facility located at the PSEG Site. Overall, the review team concludes that terrestrial and wetland impacts would be SMALL to MODERATE when considering the potential impacts associated with the new causeway. Impacts to aquatic ecosystems would be similar to those for building and operating a new nuclear plant at the PSEG Site, which are SMALL, provided there is compliance with BMPs required for Federal and State permitting.

Socioeconomic impacts would result from the roughly 1,200 construction workers and 150 workers needed to operate the natural-gas-fired facility (NRC 2012-TN1976). These workforce numbers are smaller than those for a new nuclear plant. The construction workers would be predominantly temporary, and the review team expects that most of the socioeconomic impacts (physical, demography, economy/taxes, and infrastructure/community services) would be similar to those for a new nuclear plant as discussed in Sections 4.4 and 5.4. Impacts in the following categories could be different for a natural-gas-fired plant than for a new nuclear plant: physical impacts to the local roadway network, traffic, and recreation. All three of these issues are associated with construction traffic.

The construction workforce for the natural-gas-fired plant would be less than one-third the size of the workforce for a new nuclear plant. In addition, a natural-gas-fired plant would require fewer shipments of construction materials, and the components for a natural-gas plant would weigh less than those for a new nuclear plant. Physical impacts to the local roadway network may be reduced to SMALL. Furthermore, the temporary and intermittent nature of the 1,200 construction workers on the roads surrounding the PSEG Site would not lead to noticeable impacts to traffic and recreation. The review team therefore concludes that these impacts would be SMALL. For beneficial impacts, the review team determined all impact areas would be SMALL for a natural-gas-fired plant, with the exception of the property tax revenues to the host county of Salem, New Jersey, which would be MODERATE during operations.

As described in Section 2.6.2, there are no environmental pathways by which the identified minority or low-income populations within the region would be likely to suffer disproportionately high and adverse environmental impacts. Therefore, the review team concludes that there are no pathways for disproportionately high and adverse impacts on minority or low-income populations.

The impacts on cultural resources and historical properties for a natural-gas-fired plant located at the PSEG Site would be similar to the impacts for a new nuclear power plant, as discussed in Sections 4.6 and 5.6. Because Artificial Island is human-made and therefore not anticipated to contain intact historic and cultural resources, no direct impacts would be anticipated within onsite areas. Other lands, if located off Artificial Island, that would be acquired to support the plant would require cultural resource studies, and possible mitigation of the adverse effects from ground-disturbing actions. The studies would likely be needed for all areas of potential disturbance offsite such as gas wells, collection stations, and waste-disposal sites; and along associated corridors where new construction would occur (e.g., roads and any new pipelines).

Visual effects from the cooling system (i.e., cooling towers) to historic and cultural resources would be anticipated from a new natural-gas-fired power generation on Artificial Island. The review team concludes that the impacts on historic and cultural resources could range from SMALL to MODERATE, similar to the impacts of the proposed action.

The impacts of natural-gas-fired power generation at the PSEG Site are summarized in Table 9-2.

Table 9-2. Summary of Environmental Impacts of Natural-Gas-Fired Power Generation

Impact Category	Impact Level	Comment
Land Use	MODERATE	Up to 310 ac would be needed for power block, cooling towers, and support systems and connection to an existing natural-gas supply pipeline. Additional land would be needed for infrastructure and other facilities, including the new causeway.
Surface Water	SMALL	Impacts would be comparable to the impacts for building and operating a new nuclear power plant located at the PSEG Site. Impacts might also be associated with offsite locations where natural gas is extracted/obtained.
Groundwater	SMALL	Impacts would be comparable to the impacts for building and operating a new nuclear power plant located at the PSEG Site.
Terrestrial Ecology	SMALL to MODERATE	Constructing a new underground gas pipeline to the site would result in permanent loss of some terrestrial function and conversion and fragmentation of habitat. Impacts on threatened and endangered species would be similar to the impacts from new nuclear generating units. Most impacts from pipeline construction would be temporary. Impacts on wetlands could occur within the project footprint and/or along the new causeway and transmission lines.
Aquatic Ecology	SMALL	Impacts would be comparable to the impacts for building and operating a new nuclear power plant located at the PSEG Site. Impacts could also occur along the new causeway and transmission lines and at the sites used for natural-gas extraction. Constructing a new underground gas pipeline to the site would result in loss of some aquatic function and disturbance to aquatic habitats; however, use of best management practices required for Federal and State permitting would minimize effects.
Socioeconomics	MODERATE (beneficial) to SMALL (adverse)	**Beneficial Impacts**: Construction and operation of a series of natural-gas generating units at the PSEG Site would produce beneficial economic impacts ranging from SMALL (for all economic categories within the 50-mi region other than the host county) to MODERATE (for property tax revenues in the host county during operation). **Adverse Impacts**: For the entire 50-mi region, construction and operations would produce SMALL adverse impacts for all impact categories.
Environmental Justice	None[(a)]	There are no pathways for disproportionately high and adverse impacts on minority or low-income populations.
Historic and Cultural Resources	SMALL to MODERATE	Most potential impacts could likely be effectively managed. Most of the facility and infrastructure would be built in previously disturbed areas. Visual impacts could be noticeable.

Table 9-2. (continued)

Impact Category	Impact Level	Comment
Air Quality	SMALL to MODERATE	SO_2 − 97 tpy NO_x − 530 tpy PM − 660 tpy CO_2 − 7.0 million tpy Small amounts of hazardous air pollutants.
Human Health	SMALL	Regulatory controls and oversight are assumed to be protective of human health.
Waste Management	SMALL	The only significant waste would be from spent selective catalytic reduction catalyst used for control of emissions of NO_x.

(a) The entry "None" for Environmental Justice does not mean there are no adverse impacts to minority or low-income populations from the proposed action. Rather, "None" means that, while there may be adverse impacts, those impacts do not affect minority or low-income populations in any disproportionate manner, relative to the general population.

9.2.4 Combination of Alternatives

Individual alternatives to the construction of new nuclear units at the PSEG Site might not be sufficient on their own to generate the PSEG target value of 2,200 MW(e) because of limited availability of resources or lack of cost-effective opportunities. Nevertheless, it is conceivable that a combination of alternatives might be cost effective. Because there are many possible combinations of alternatives, it would not be reasonable to examine every possible combination of alternatives in an EIS. Doing so would be counter to CEQ guidance that an EIS should be analytic rather than encyclopedic, should be kept concise, and should be no longer than absolutely necessary to comply with NEPA (42 USC 4321 et seq. -TN661) and CEQ regulations (40 CFR Part 1502-TN2123). Given that the PSEG objective is for a new baseload generation facility, a fossil-fuel energy source, most likely natural gas or coal, would need to be a significant contributor to any reasonable alternative energy combination.

In developing a combination of energy alternatives for other combined license applications, the review team has typically relied on data from the power company's integrated resource plan and/or data from the most recent EIA *Annual Energy Outlook*. However, because of the regulatory structure for power companies in New Jersey, PSEG does not publish an integrated resource plan. The review team also found that the *Annual Energy Outlook 2013* (DOE/EIA 2013-TN2591) predictions for growth in renewable sources in the region that includes New Jersey are less than the growth that would be necessary to meet the RPS for New Jersey (NJBPU 2011-TN2526). Compliance with the RPS will require greater growth in renewable sources (or considerable compliance payments) beyond the growth predicted by the Annual Energy Outlook. Because of this situation, the review team has relied on the information in the latest annual report for the New Jersey RPS, the New Jersey Energy Master Plan (New Jersey 2011-TN2115), and other public information to develop the combination of energy alternatives.

In Chapter 8 the review team concluded that there is a sufficient need for power by 2023 to justify building and operating one or more nuclear units with a total capacity of up to 2,200 MW(e). The analysis on which the review team's conclusion is based considered planned

new generation sources. For example, construction has begun on two natural-gas combined-cycle projects in New Jersey with a total capacity of 1,405 MW(e) (Platts 2014-TN4153; Power Technology 2015-TN4154). In concluding that the need for the new nuclear power plant existed, the review team assumed the construction and operation of these planned natural-gas units. Therefore, the combination of alternative energy sources would involve the addition of generating sources beyond what is already planned.

The review team considered whether 2,200 MW(e) could be provided by wind and solar, each with a backup power source; a combination of sources including biomass, municipal solid waste, and geothermal; and natural gas. EIA estimates that through 2040 the combination of wind, solar, and biomass will provide most of the growth in renewable electricity generation in the United States (DOE/EIA 2013-TN2590). Wind or solar energy sources without a backup power source are not considered here for baseload purposes, but that does not preclude their development; in fact, there is great interest in developing such renewable energy resources. The consumption of natural gas by the facility in the combination of alternatives case can be offset by the production of energy from wind and solar resources when available; however, a combination of alternatives would still necessitate the installation of natural-gas power facilities to ensure that power is available as a baseload power source when wind and solar sources cannot meet the demand.

The review team considered a spectrum of energy alternatives that were reasonable for the PSEG ROI and, for the purpose of analysis, developed a combination of alternatives case that comprises solar and wind power, biomass (including MSW and methane from landfills), and natural-gas-fired power generation. Additional savings from energy-efficiency and conservation programs were not included in the combination of energy alternatives because the State of New Jersey is already pursuing a very aggressive goal for these programs, which the review team assumes will have already implemented those activities that would be cost effective.

The review team assessed the environmental impacts of a combination of natural-gas-fired combined-cycle power-generating units with a total capacity of 1,400 MW(e) at the PSEG Site using closed-cycle cooling and the following additional contributions from within or near the PSEG ROI: 560 MW(e) from solar, 890 MW(e) from wind, and 800 MW(e) from biomass sources.(1) These contributions were derived based on the expected percentage contributions to new generation from these resources considering sources such as the Annual Energy Outlook 2013 (DOE/EIA 2013-TN2590), the New Jersey Energy Master Plan (New Jersey 2011-TN2115), and the New Jersey RPS (NJBPU 2011-TN2526). The solar and wind sources would be backed up by the natural-gas-powered generation. The review team believes that the preceding contributions are reasonable and representative for the PSEG ROI given the publicly available information in the cited Federal and State sources. The contributions of the generating sources used in the combination of energy alternatives reflect the review team analyses in Sections 9.2.2 and 9.2.3.

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(1) Because there is limited landfill gas (LFG) available, the review team assumes that the biomass is composed of 100 MW(e) of LFG (with emissions similar to a natural gas combined-cycle plant) and 700 MW(e) of a combination of biomass (such as wood waste) and municipal solid waste, with emissions similar to a coal plant. These assumptions were used to estimate the emissions of this portion of the combination of energy alternatives.

As described in Section 9.2.2.3, a capacity factor of 0.14 to 0.33 for solar PV power operation is reasonable. The capacity factor in New Jersey would fall somewhere between that of Boston (as high as 24 percent) and Miami (as high as 26 percent) if panels with two-axis tracking are used (NREL 2011-TN4224). Assuming a 0.25 capacity factor, the 560 MW(e) from solar energy would generate on average 1,230 GWh of electricity annually. Land use required for this installed capacity would be between 2,800 and 5,600 ac. Additional transmission lines might be needed to connect the locations of the PV panels to those areas in New Jersey with the largest load growth rate.

As described in Section 9.2.2.1**,** a capacity factor of 0.25 to 0.40 for wind power generation is reasonable. The higher the capacity factor, the less area would be necessary to support the wind turbine facilities. Offshore wind generally provides for the highest capacity factors and so the review team assumed the development of offshore wind resources. Assuming a 0.40 capacity factor, the 890 MW(e) from wind energy would generate on average 3,110 GWh of electricity annually. An offshore wind farm of this installed capacity would occupy about 48 mi^2 (30,400 ac) based on an extrapolation from the Cape Wind project, a 468 MW(e) project that will occupy about 25 mi^2 (DOI 2009-TN2527). Optimal locations for obtaining offshore wind energy along the New Jersey shoreline may require lengthy new transmission lines to deliver the power to those areas with the highest demand for electricity.

For the remainder of the energy sources that make up the combination of alternatives (biomass, MSW, and LFG), the review team assumed a capacity factor of 0.85, which is consistent with the fossil energy combustion alternatives discussed in Sections 9.2.3.1 and 9.2.3.2. While land would necessarily be used to host these facilities and, in the cases of biomass and MSW, additional land would be needed for storage of fuel materials, combustion residue (such as fly ash), and landfills, the review team did not attempt to quantify the additional land used. In addition there could be attendant environmental effects on air, water, ecology, socioeconomics, waste, cultural resources and historical properties, and human health; these were discussed earlier for each of the other power sources.

The review team assumed that the 1,400-MW(e) natural-gas-fired portion of the combination of alternatives would be built at the PSEG Site in a manner similar to the 2,320-MW(e) natural-gas-fired alternative discussed in Section 9.2.3.2. Consequently, the environmental effects for building this portion of the combination of alternatives would be scaled to be about 60 percent of the natural-gas-fired alternative. However, the natural-gas plant would operate at a lower capacity factor than that assumed in Section 9.2.3.2 because it would reduce its output when the wind and solar resources were generating electricity. It would only operate at full capacity when wind and solar generation dropped to zero. Based on the capacity factors of 25 percent and 40 percent assumed for solar and wind, respectively, the natural-gas plant would operate at an average capacity factor of about 58 percent.

The review team estimates that the combination of alternatives would also have CO_2 emissions of 7.75 million tpy that could affect climate change. On August 3, 2015, EPA set the final standard to limit CO2 emissions from new stationary combustion turbines (e.g., natural gas combined cycle technology) (EPA 2015-TN4336). However, the new rule applies to only fossil-fueled power plants and would, therefore, not apply to power generated by biomass, landfill gas, or municipal solid waste. In addition, the staff's emissions estimate for the natural-gas-fired

power plant was already below the new standard. Therefore, the staff's estimate of the CO2 emissions from the combination of energy alternatives would be unchanged under the new rule.

Overall, the review team concludes that the impacts to land use would be MODERATE, based on the impacts of the natural-gas plant, the solar facilities, the biomass facilities, and their respective transmission lines. On the same basis, the impacts to terrestrial ecological resources and air quality would be similar to those for the natural-gas plant from Section 9.2.3.2, which were SMALL to MODERATE. The impacts to surface water and groundwater, aquatic ecosystems, human health, and waste are also expected to be similar to those for the natural-gas plant from Section 9.2.3.2, which were SMALL[(1)]. The impacts to socioeconomic resources are expected to range from MODERATE (adverse) to MODERATE (beneficial). The MODERATE (adverse) impacts to socioeconomic resources are related to traffic impacts associated with moving large wind turbine components during construction and aesthetic impacts associated with the large number of wind turbines. Similar to the situation for a natural-gas-fired plant, there are no environmental pathways by which the identified minority or low-income populations within the region would be likely to suffer disproportionately high and adverse environmental impacts. Therefore, the review team concludes that there are no pathways for disproportionately high and adverse impacts on minority or low-income populations.

The impacts on cultural resources and historical properties for the natural-gas-fired plant located at the PSEG Site would be similar to the impacts for a new nuclear power plant, as discussed in Sections 4.6 and 5.6. Because Artificial Island is human-made and therefore not anticipated to contain intact historic and cultural resources, no direct impacts would be anticipated within onsite areas. Other lands, if located off Artificial Island, that would be acquired to support the plant or other portions of the combination of alternatives (e.g., solar) would require cultural resource studies, and possible mitigation of the adverse effects from ground-disturbing actions. The studies would likely be needed for all areas of potential disturbance offsite such as wind and solar facilities, gas wells, collection stations, and waste-disposal sites; and along associated corridors where new construction would occur (e.g., roads and any new pipelines). Visual effects from the cooling system (i.e., cooling towers) to historic and cultural resources would be anticipated from the new natural-gas-fired power generation on Artificial Island. The review team concludes that the impacts on historic and cultural resources could range from SMALL to MODERATE.

The review team believes that the preceding contributions are representative of a combination of energy sources that could be considered for comparison with a new nuclear power plant and together form a reasonable combination alternative. A summary of the review team characterization of the environmental impacts associated with the construction and operation of the preceding combination of energy alternatives is shown in Table 9-3.

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(1) Impacts to aquatic resources could be greater than SMALL because of the installation of almost 900 MW(e) of offshore wind turbines. However, due to uncertainty in specific technology design, the review team concludes that there is insufficient information to definitively assign a higher impact category.

Table 9-3. Summary of Environmental Impacts of a Combination of Power Sources

Impact Category	Impact	Comment
Land Use	MODERATE	A natural-gas-fired plant would have land-use impacts for the power block, new causeway, cooling towers, support systems, and connection to a natural-gas pipeline. Solar, wind, and biomass facilities and their associated transmission lines would also have land-use impacts because of the large footprints required for these facilities. Offshore wind development could potentially impede navigation.
Surface Water	SMALL	Impacts would be somewhat less than the impacts for building and operating a new nuclear power plant.
Groundwater	SMALL	Impacts would be somewhat less than the impacts for building and operating a new nuclear power plant.
Terrestrial Ecology	SMALL to MODERATE	Impacts could occur both on and off the site and could include wildlife habitat loss and fragmentation, reduced productivity, and local reductions in biological diversity comparable to the impacts associated with a new nuclear plant but with a potential for greater habitat loss due to increases in land use for solar facilities. Wind energy facilities could result in increased avian and bat mortality.
Aquatic Ecology	SMALL	Impacts from the natural gas portion of the combination would be similar to those discussed in Section 9.2.3.2. The construction of offshore wind energy facilities could result in impacts to aquatic resources.
Socioeconomics	MODERATE (beneficial) to MODERATE (adverse)	**Beneficial Impacts**: Construction and operation of a series of natural-gas generating units at the PSEG Site and solar, wind, and biomass units elsewhere would produce beneficial economic impacts ranging from SMALL (for all economic categories within the 50-mi region other than the host county) to MODERATE (for economic impacts, primarily tax revenues, in the host county during construction and operation). **Adverse Impacts**: For the entire 50-mi region, construction and operations would produce SMALL adverse impacts for all physical impact categories, demographic categories, and community and infrastructure categories except for traffic impacts, which would be MODERATE during movement of large wind turbine components during construction, and aesthetic impacts, which would be MODERATE based on the large number of wind turbines.
Environmental Justice	None[(a)]	There are few minority populations and/or low-income populations near the PSEG Site; impacts to such populations would likely be minimal. The potential for impacts from solar, wind, and biomass facilities should be manageable based on likely locations and distributed nature of the resources. Beneficial impacts from property tax revenues might result in beneficial impacts.
Historic and Cultural Resources	SMALL to MODERATE	Most potential impacts could likely be effectively managed. Most of the facility and infrastructure would be built in previously disturbed areas. Visual impacts could be noticeable. Potential offsite impacts from solar, wind, and biomass facilities could likely be effectively managed. Important site-specific resources could be affected by transmission lines, but these could likely be effectively managed.

Table 9-3. (continued)

Impact Category	Impact	Comment
Air Quality	SMALL to MODERATE	Emissions from the natural-gas-fired plant and the biomass facilities would be roughly as follows. SO_2 = 1,980 tpy NO_x = 1,820 tpy PM = 294 tpy CO_2 = 7.75 million tpy Small amounts of hazardous air pollutants.
Human Health	SMALL	Regulatory controls and oversight are assumed to be protective of human health.
Waste Management	SMALL	The only significant quantities of waste would be from the spent SCR catalyst used in the natural-gas-fired plant for the control of NO_x emissions and from the ash associated with biomass and municipal solid-waste sources of energy.

(a) The entry "None" for Environmental Justice does not mean there are no adverse impacts to minority or low-income populations from the proposed action. Rather, "None" means that, while there may be adverse impacts, those impacts do not affect minority or low-income populations in any disproportionate manner, relative to the general population.

The review team also considered whether some other combination of energy alternatives would be more advantageous under a different set of assumptions.

If the contribution from solar energy were doubled, it would require the addition (compared to 2010) of 1,120 MW of solar panels by 2021, which would generate on average 2,460 GWh of electricity annually. The natural-gas plant for the combination alternative would still be sized at 1,400 MW in order to back up the solar and wind sources. But it would generate 5,830 GWh annually, operating at a capacity factor of 48 percent, with an associated reduction in emissions. But the emissions would still be significant, equivalent on average to the operation of a roughly 700-MW natural-gas plant. At the same time, the additional 560 MW of solar panels would occupy roughly an additional 2,800 to 5,600 ac. So while emissions would decrease somewhat, land-use impacts would increase and there would be no clear advantage to this option.

If the contribution from wind energy were doubled, it would require the addition (compared to 2010) of 1,780 MW of wind turbines by 2021, which would generate on average 6,220 GWh of electricity annually. The natural-gas plant for the combination alternative would still be sized at 1,400 MW in order to back up the solar and wind sources. But it would generate 3,950 GWh annually, operating at a capacity factor of 32 percent, with an associated reduction in emissions. But the emissions would still be significant, equivalent on average to the operation of a roughly 450-MW natural-gas plant. At the same time, the additional 890 MW of offshore wind turbines would occupy roughly an additional 30,400 ac. So while emissions would decrease, impacts to ecological resources from the construction and operation of the wind turbines, as discussed in Section 9.2.2.1, would increase and there would be no clear advantage to this option.

Increasing the contributions of LFG/biomass/MSW would lead to an equivalent reduction in the size of the natural-gas plant that would be needed. However, the land-use and emissions impacts of these other sources are equal to or greater than the impacts of the natural-gas plant. So increasing the contribution of these sources would offer no advantage other than an

increased reliance on renewable resources. However, the review team also notes that there may not be additional capacity available from these limited resources.

9.2.5 Summary Comparison of Alternatives

Table 9-4 contains a summary of the review team's environmental impact characterizations for building and operating new nuclear, coal-fired, and natural-gas-fired power-generating units, as well as a combination of energy alternatives, at the PSEG Site or within the PSEG ROI. The nuclear power impacts summarized in the table are evaluated in Chapters 4 and 5 for construction and preconstruction activities and operational impacts. The impacts of fossil-fuel alternatives summarized in the table are evaluated in Section 9.2.2 and the combination of alternatives in Section 9.2.4. For the combination of alternatives shown in Table 9-4, the review team assumes the siting of natural-gas-fired combined-cycle units at the PSEG Site and the siting of other alternative power-generating facilities elsewhere within or near the PSEG ROI. Closed-cycle cooling with natural draft or mechanical draft cooling towers (NDCTs or MDCTs) is assumed for all thermal plants.

The review team reviewed the available information on the environmental impacts of power-generation alternatives compared to building a new nuclear power plant at the PSEG Site. Based on this review, the review team concludes that, from an environmental perspective, none of the viable energy alternatives is environmentally preferable to building new baseload nuclear power-generating units at the PSEG Site.

Because of current concerns related to GHG emissions, it is appropriate to specifically discuss the differences among the alternative energy sources regarding CO_2 emissions. The CO_2 emissions for a new nuclear plant and for the energy generation alternatives are discussed in Sections 5.7.1, 9.2.3.1, 9.2.3.2, and 9.2.4. Table 9-5 summarizes the CO_2 emission estimates for a 40-year period for the alternatives considered by the review team to be viable for baseload power generation. These estimates are limited to the emissions from power generation and do not include CO_2 emissions for workforce transportation, building, uranium fuel cycle, or decommissioning. Among the reasonable energy generation alternatives, the CO_2 emissions for nuclear power are a small fraction of the emissions of the other viable energy generation alternatives. Even when the transportation emissions attributable to the nuclear workforce and the fuel cycle emissions are added in, which would increase the emissions for plant operations over a 40-year period to about 11,000,000 MT CO_2e, this number is still significantly lower than the emissions for the plant operations portion of the other reasonable energy generation alternatives.

On June 3, 2010, EPA issued a rule (75 FR 31514-TN1404) tailoring the applicability criteria that determine which stationary sources and modifications to existing projects become subject to permitting requirements for GHG emissions under the PSD and Title V programs of the Clean Air Act (42 USC 7401 et seq. –TN1141). According to the source permitting program, if the source (1) is otherwise subject to PSD (for another regulated NSR pollutant) and (2) has a GHG potential to emit that is equal to or greater than 75,000 tons CO_2e per year (i.e., adjusting for different global warming potentials for different GHGs), then the source would be subject to BACT. In addition, on August 3, 2015, the EPA set the final standard to limit CO_2 emissions from new coal-fired power plants (EPA 2015-TN4336). The use of BACT has the potential to

Table 9-4. Summary of Environmental Impacts (Impact Category Level) of Constructing and Operating New Nuclear, Coal-Fired, and Natural-Gas-Fired Power-Generating Units and a Combination of Alternatives[(a)]

Impact Category	Nuclear[(b)]	Coal	Natural Gas	Combination of Alternatives[(c)]
Land Use	SMALL to MODERATE	MODERATE	MODERATE	MODERATE
Surface Water	SMALL	SMALL	SMALL	SMALL
Groundwater	SMALL	SMALL	SMALL	SMALL
Terrestrial Ecology	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE
Aquatic Ecology	SMALL	SMALL	SMALL	SMALL
Socioeconomics	LARGE (beneficial) to MODERATE (adverse)	LARGE (beneficial) to MODERATE (adverse)	MODERATE (beneficial) to SMALL (adverse)	MODERATE (beneficial) to MODERATE (adverse)
Environmental Justice	None[(d)]	None[(d)]	None[(d)]	None[(d)]
Historic and Cultural Resources	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE	SMALL to MODERATE
Air Quality	SMALL	MODERATE	SMALL to MODERATE	SMALL to MODERATE
Human Health	SMALL	SMALL	SMALL	SMALL
Waste Management	SMALL	MODERATE	SMALL	SMALL

(a) Each alternative has an electrical output equivalent to a new 2,200-MW(e) nuclear plant operating at a capacity factor of 90 percent.
(b) The impact levels for a new nuclear plant are those discussed in Chapters 4 and 5 and do not include the cumulative impacts discussed in Chapter 7.
(c) The combination of alternatives includes gas-fired combined-cycle units (1,400 MW total), solar (560 MW), wind (890 MW), and biomass (800 MW).
(d) The entry "None" for Environmental Justice does not mean there are no adverse impacts to minority or low-income populations from the proposed action. Rather, "None" means that, while there may be adverse impacts, those impacts do not affect minority or low-income populations in any disproportionate manner, relative to the general population.

Table 9-5. Comparison of Carbon Dioxide Emissions for Energy Alternatives

Generation Type	Years	CO_2 Emissions (metric tons)[(a)]
Nuclear Power[(b)]	40	362,000
Coal-Fired Generation[(c)]	40	556,000,000
Natural-Gas-Fired Generation[(d)]	40	255,000,000
Combination of Alternatives[(e)]	40	282,000,000

(a) Nuclear power emissions are in units of metric tons of CO_2 equivalent, whereas the other energy alternatives emissions estimates are in units of metric tons of CO_2. If nuclear power emissions were represented in metric tons of CO_2, the value would be slightly less, because the other greenhouse gas emissions would not be included.
(b) From Section 5.7.1.2 for two units operational emissions, not including CO_2 emissions for workforce transportation.
(c) From Section 9.2.3.1.
(d) From Section 9.2.3.2.
(e) From Section 9.2.4.

reduce the amount of GHGs emitted from stationary source facilities. Implementation of these rules could reduce the amount of GHGs from the values indicated in Table 9-5 for coal, natural gas, and other alternative energy sources that would otherwise have appreciable uncontrolled GHG emissions. The GHG emissions from the production of electricity from a nuclear power source are primarily from the fuel cycle and such emissions could be reduced further if the electricity from the assumed fossil-fuel source powering the fuel cycle is subject to BACT controls. GHG emissions from the production of electrical energy from a nuclear power source are orders of magnitude less than those from the reasonable alternative energy sources discussed here. Accordingly, the comparative relationship between the energy sources listed in Table 9-5 would not change meaningfully, even if possible reductions to the GHG emissions from the nuclear fuel cycle are ignored, because GHG emissions from the other energy source alternatives would not be sufficiently reduced to make them environmentally preferable to the proposed project.

The CO_2 emissions associated with generation alternatives such as wind power, solar power, and hydropower would be associated with workforce transportation, construction, and decommissioning of the facilities. Because these power-generation alternatives do not involve combustion, the review team considers the GHG emissions to be minor and concludes that the GHG emissions would have a minimal cumulative impact. Other energy generation alternatives involving combustion of oil, wood waste, municipal solid waste, or biomass-derived fuels would produce CO_2 emissions from combustion, workforce transportation, plant construction, and plant decommissioning. It is likely that the CO_2 emissions from the combustion process for these alternatives would dominate the other CO_2 emissions associated with the generation alternative. It is also likely that the CO_2 emissions from these alternatives would be of the same order of magnitude as the emissions for the fossil-fuel alternatives considered in Sections 9.2.3.1, 9.2.3.2, and 9.2.4. However, because the review team determined that these alternatives do not meet the need for baseload power generation, the review team has not evaluated their CO_2 emissions quantitatively. Insofar as some of these alternatives, such as biomass, are considered in the combination of alternatives discussed in Section 9.2.4, they would increase the total CO_2 emissions beyond the numbers shown in Table 9-5; however, the review team considers the small fraction contributed by these technologies in comparison to the contributions of the natural-gas component for the combination of alternatives case to have a minimal further cumulative impact that does not warrant a more precise analysis.

As discussed in Chapter 8, the review team concludes that the need for additional baseload power generation has been demonstrated. Also, as discussed previously in this chapter, the review team concludes that the viable alternatives to the proposed action would all involve the use of fossil fuels (coal or natural gas). Consequently, the review team concludes that the construction and operation of a new nuclear power plant at the PSEG Site would result in the lowest level of emissions of GHGs among the viable alternatives.

9.3 Alternative Sites

The NRC regulations require that the EIS prepared in conjunction with an application for an ESP include an evaluation of alternatives to the proposed action (10 CFR Part 51-TN250). The consideration of alternative sites is one portion of the review of alternatives. The NRC guidance in Section 9.3 of the ESRP (NRC 2000-TN614) regarding the site-selection process calls for the

identification of an ROI followed by successive screenings of candidate areas, potential sites, candidate sites, and the proposed site. Section 9.3.1 of this EIS presents a discussion of the PSEG site-selection process, which includes identification of the ROI for possible siting of a new nuclear power plant. This discussion is followed by the review team evaluation of the PSEG site-selection process (Section 9.3.1.3).

The specific resources and components that could be affected by the incremental effects of the proposed action and other actions in the same geographic area are assessed. For the purposes of this alternative sites evaluation, the impacts evaluated include NRC-authorized construction and operation and other cumulative impacts including preconstruction activities. Sections 9.3.2 through 9.3.5 provide a site-specific description of the environmental impacts of locating a new nuclear power plant at each alternative site based on issues such as land use, air quality, water resources, terrestrial and aquatic ecology, socioeconomics and environmental justice, and cultural resources and historical properties. Section 9.3.6, which summarizes the impacts of the proposed action and alternative sites, contains a table with the NRC staff characterization of the impacts at the alternative sites in comparison to the impacts at the proposed site to determine whether there are any alternative sites that are environmentally preferable or obviously superior to the PSEG Site.

9.3.1 Alternative Site-Selection Process

The review team evaluation of the PSEG alternative site-selection process began with an evaluation of the PSEG-stated ROI. Within that ROI, the review team evaluated the results of the application of screening criteria applied sequentially to establish candidate areas, potential sites, and finally candidate sites, leading to the selection of a proposed site and alternative sites. The process that PSEG used to select its proposed site and alternative sites is described in the following sections.

9.3.1.1 Selection of Region of Interest

In general, the ROI is the geographic area considered in searching for candidate sites (NRC 2000-TN614). The ROI is typically the state in which the proposed site is located or the relevant service area for the proposed plant (NRC 2000-TN614).

PSEG selected the State of New Jersey as its ROI primarily because (1) the PSEG parent company, Public Service Enterprise Group, is headquartered in New Jersey and has power plants and offices located throughout the state and (2) one of the Public Service Enterprise Group's principal subsidiaries is PSE&G, a regulated public utility company engaged in the transmission and distribution of natural gas and electricity and whose electric service area is limited to the State of New Jersey and extends throughout much of the state. Furthermore, PSEG concluded that the selection of the State of New Jersey as the ROI provides a good diversity of environmental and geographic conditions for potential power plant sites and that any reasonable expansion of the ROI outside the State of New Jersey would not significantly improve that diversity (PSEG 2015-TN4280).

The PSEG ER states that locating new nuclear units in New Jersey would allow Public Service Enterprise Group to make effective use of its existing resources in the state to supply the anticipated electrical output to important load centers via existing transmission lines (PSEG 2015-4280).

The ROI consists of about 8,700 mi^2 in 21 counties within the State of New Jersey. Major water features within the ROI that could serve as sources of cooling water include the Delaware River, the Hudson River, and the Atlantic Ocean. In addition to numerous state highways and routes, major transportation routes within the ROI include Interstate Routes 78, 80, 95, 280, 287, and 295; the New Jersey Turnpike; the Garden State Parkway; and the Atlantic City Expressway. Rail and water transportation infrastructures also exist throughout the ROI.

9.3.1.2 Selection of Candidate Areas and Potential Sites

The PSEG site-selection process is described in the PSEG ER (PSEG 2015-TN4280) and in greater detail in the PSEG *Alternative Site Evaluation Study* (PSEG 2010-TN257). PSEG also provided additional details on the process of identifying and selecting potential sites in a Request for Additional Information (RAI) response (PSEG 2012-TN2113). The following discussion summarizes the PSEG site-selection process.

Candidate Areas

As the initial step of the site-selection process, PSEG identified candidate areas within the ROI by constructing digitized geographic information system (GIS) maps of the entire ROI and then applying exclusionary criteria to eliminate areas considered to be unsuitable for siting a nuclear power plant. The exclusionary criteria applied by PSEG covered those factors that might make the licensing, permitting, or development of a new nuclear power plant impractical.

PSEG exclusionary criteria included distances to primary highways, railroad or barge transportation, transmission lines or 500-kV substations, and water sources capable of supplying 35,000 gpm. Any areas located more than 20 mi from such resources were eliminated. In addition, areas were eliminated if their population densities were greater than 500 people/mi^2, including a 3-mi buffer zone around such densely populated areas. The exclusionary criteria also provided for the elimination of designated parks, preserves, and recreation areas and active military bases (PSEG 2010-TN257).

The principal criteria that affected the identification of candidate areas within the ROI were population density and the presence of designated lands. These two criteria eliminated significant portions of the ROI. It should be noted that application of the criteria for distance to highways and/or to rail/barge transportation did not eliminate any areas from the ROI, and the criteria for distance to transmission lines/substations and/or water sources eliminated only a small part of the ROI (PSEG 2015-TN4280).

PSEG application of exclusion criteria to the ROI resulted in the identification of seven candidate areas scattered throughout the State of New Jersey.

Potential Sites

PSEG next searched within the seven candidate areas to identify locations for potential sites suitable for siting a new nuclear power plant. Topographical maps and aerial photographs of each candidate area were examined to identify locations that would provide sufficient land for the suitable arrangement of a new nuclear power plant and other required facilities and a reasonable site boundary. The principal considerations at this step included (1) reasonably flat

terrain and undeveloped land of sufficient size to accommodate a new nuclear power plant and (2) avoiding any of the following: urban areas; residential developments; public institutions; designated parks, preserves, and recreational areas; listed historic sites; extensive wetland or floodplain areas; public drinking water intakes; protected groundwater resources; and airports (PSEG 2012-TN2113).

Locations that were identified as satisfying the above conditions were subjected to further examination to identify specific parcels of land with the following attributes: site topography of no more than 5 percent slope across the area; minimal contact with wetlands, floodplains, individual residences, and hazardous material pipelines; location as close as possible to water, transmission, and transportation resources; and location as far as possible from the other environmental features identified in Item 2 listed in the preceding paragraph.

Preliminary block-type plant footprint layouts were developed and overlaid on each parcel of land that appeared to satisfy the above criteria. These footprint layouts were used to determine whether sufficient land was available to develop a new nuclear plant at that location. In addition to the block-type plant footprint, conceptual offsite corridors were identified and examined for the nearest suitable water supply, transmission line, rail line, and primary road. An attempt was made to locate these conceptual corridors to avoid the same types of sensitive environmental features that are described above for the identification of potential sites. The locations that survived this part of the process were designated by PSEG as preliminary potential sites.

These preliminary potential sites and their associated offsite corridors were then evaluated as to how well they satisfied the aforementioned siting attributes (e.g., site topography of no more than 5 percent slope across the area). The site in each candidate area that was determined to best satisfy the siting criteria was carried forward to become a potential site. An effort was made by PSEG to identify at least 1 potential site in each of the seven candidate areas, and 11 such potential sites were so identified. In each case, the potential sites that were retained for further evaluation included the most favorable site identified in each of the candidate areas (PSEG 2012-TN2113).

Candidate Sites

Candidate sites are those sites within the ROI that are considered to be among the best sites that can be reasonably identified and made available for the siting of a new nuclear power plant. PSEG subjected the 11 potential sites to evaluation in greater detail to identify possible candidate sites. PSEG collected more detailed information on environmental and technical conditions at each of the potential sites.

The primary criteria used by PSEG for the selection of candidate sites included consideration of whether a potential site had any significant environmental or other issues that would make it impractical or undesirable for licensing, permitting, or development with a new nuclear power plant. PSEG considered the following issues in its evaluation:

- **Environmental acceptability.** The potential sites were reviewed with regard to major environmental issues such as proximity to designated lands or waters and potential encroachment on sensitive land uses.

- **Nuclear licensing.** The potential sites were reviewed with regard to major nuclear licensing issues such as proximity to capable faults, proximity to hazardous land uses, and proximity to population centers.
- **Engineering.** The potential sites were reviewed with regard to major engineering issues such as the length and difficulty of required water, transmission, and rail connections; cooling water pumping head; and ability to deliver large components to the site.

PSEG identified the number of environmental concerns for each site during this screening; however, this evaluation was combined with a qualitative assessment of the level of environmental impact and the necessary activities or considerations that would be required to mitigate or avoid such impacts. The focus of the evaluation was therefore on the environmental suitability of the potential sites. Any issues that were identified were considered to be significant if they introduced the potential for adverse environmental impact or schedule delays (such as those associated with environmental/regulatory permitting or nuclear licensing). Other issues were considered to be significant if they involved environmental conditions that introduced overall regulatory uncertainty by raising the possibility of unusual and restrictive licensing or permitting conditions and/or increased project costs by requiring unusual and costly site-development efforts or impact mitigation measures.

PSEG's evaluation identified significant issues at each of the 11 potential sites; however, these issues did not by themselves indicate a site would not be feasible for the licensing, permitting, or development of a new nuclear power plant at that site. Rather, the evaluation highlighted those issues that would make it more difficult, more costly, and/or more complicated to construct a new nuclear power plant at that particular site. As applied in the PSEG siting study, the extent of these issues was an important factor in determining the overall desirability of a site.

Based on the more detailed evaluation of the 11 potential sites, 5 of these sites were found to have fewer significant negative issues than the other 6 sites. Furthermore, the PSEG qualitative evaluation of the significant issues at these five sites indicated that all of the identified issues appeared to be manageable and could reasonably be expected to be resolved. In addition, each of these five sites was found to possess multiple highly desirable characteristics (PSEG 2010-TN257).

On the basis of these evaluations, the six sites with significantly more negative issues were eliminated from further consideration, and the following five sites were retained as candidate sites for further study (see Figure 9-1):

- Site 4-1 in Hunterdon County, New Jersey
- Site 7-1 in Salem County, New Jersey
- Site 7-2 in Salem County, New Jersey
- Site 7-3 in Cumberland County, New Jersey
- Site 7-4 (also called the proposed site or the PSEG Site, which is located at the existing Salem-Hope Creek site) in Salem County, New Jersey

Proposed and Alternative Sites

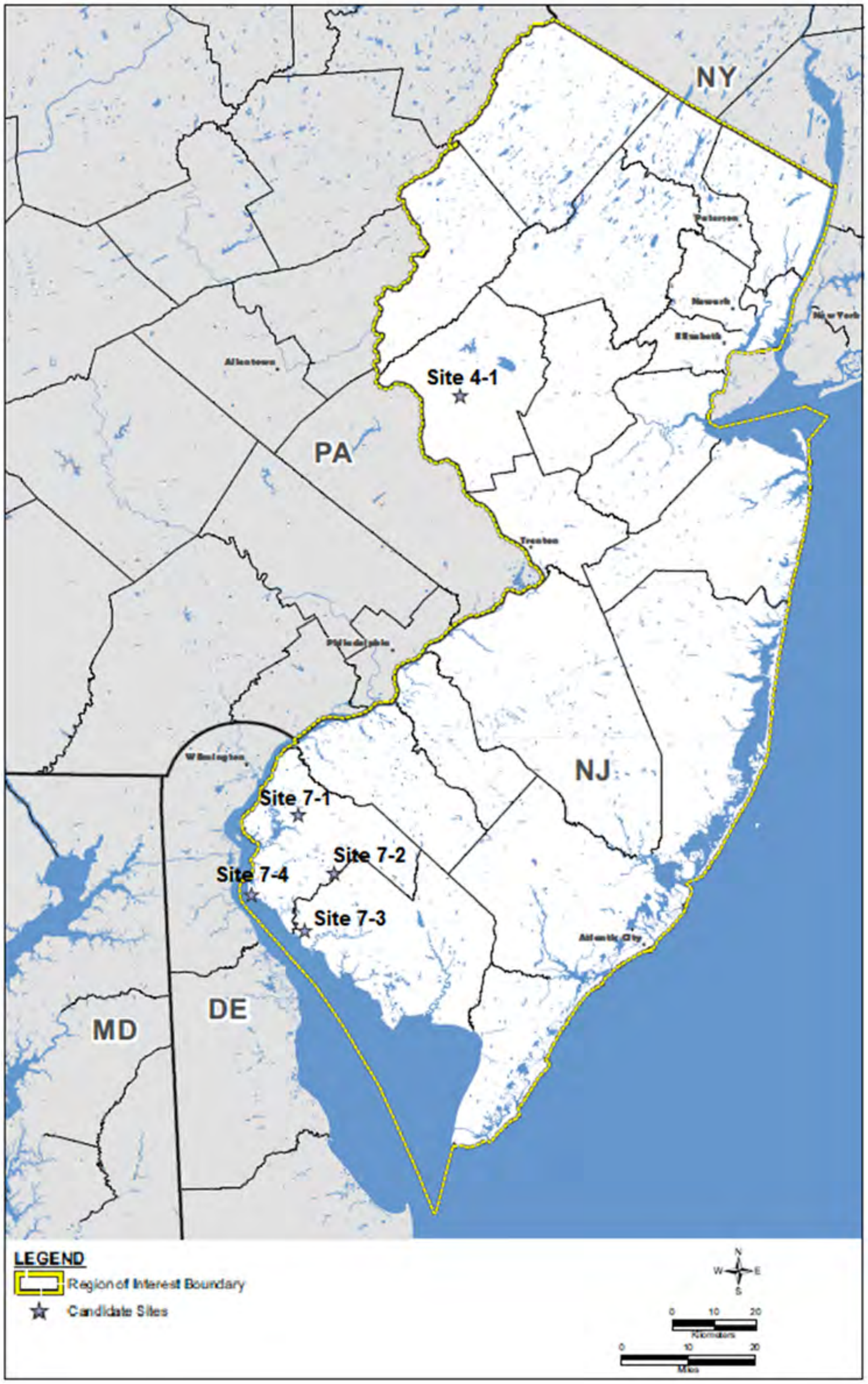


Figure 9-1. Map Showing the Locations of PSEG Alternative Sites (Source: Modified from PSEG 2015-TN4280)

To identify the proposed and alternative sites, PSEG evaluated each of the five candidate sites against more specific criteria from both technical and environmental perspectives. A numerical scoring system was used as the basis for comparing the candidate sites. To support the numerical scores, various investigations and assessments of the candidate sites were performed, including environmental and permitting evaluations, transmission evaluations, field reconnaissance, and refinement of the previously developed preliminary site layouts. These more detailed evaluations included the aspects (PSEG 2015-TN4280) described below.

- **Environmental and Permitting Conditions.** Factors related to environmental acceptability and permitting issues were evaluated in more detail than previously for the potential sites. Information on zoning and land-use planning—including maps showing the property parcels on and near each of the candidate sites—was collected. Reviews were conducted of applicable State and local regulations concerning air quality; ambient noise; water withdrawal; land use; and other environmental, regulatory, and permitting issues. Site-specific information on threatened and endangered species and cultural resources was obtained from appropriate State and Federal government agencies.
- **Transmission Interconnection and Stability.** The feasibility of obtaining transmission interconnection for each of the candidate sites was evaluated through modeling of thermal overloads and was expressed as a cost of network upgrades that might be required for the mitigation of such overloads. The risk of transmission upgrades being required to maintain system stability was evaluated qualitatively.
- **Field Reconnaissance.** Field reconnaissance site visits were conducted and were intended to supplement and confirm the information collected from maps, aerial photographs, and other publicly available sources. The observations from the field reconnaissance focused on issues such as the condition of wetlands and other natural habitats, recent residential developments, transportation routes, and constructability characteristics.
- **Refinement of Site Layouts.** Based on the information collected through the environmental evaluations and field reconnaissance, the preliminary site layouts developed during the prior identification of "potential sites" were revised to make the best use of existing property parcels and reduce impacts on environmentally sensitive areas.

The information collected was used to generate numerical scores for each of the candidate sites. The numerical scores covered 40 individual site characteristics related to three categories: environmental acceptability (15 characteristics), nuclear licensing (11 characteristics), and engineering/cost factors (14 characteristics). An importance weighting factor was assigned to each site characteristic. The weighted scores for each candidate site were obtained by multiplying each unweighted score by its importance weighting factor and then summing the weighted scores for each characteristic. The resulting numerical scores are shown in Table 9-6, in which the candidate sites have been ranked from the highest weighted score to the lowest weighted score (PSEG 2010-TN257). (It should be noted that the maximum possible weighted score under the PSEG method would be 1,465.)

To evaluate the impact of the importance weighting factors, the candidate sites were also ranked according to their total unweighted score. The ranking of the sites by their unweighted scores is also shown in Table 9-6. It should be noted that the maximum possible unweighted

score under the PSEG method would be 200. The data in Table 9-6 show that the importance weighting factors did not have a significant impact on the rankings of the five candidate sites. That is, the candidate sites have the same overall ranking regardless of whether the total weighted or the total unweighted scores are used, with the exception that Sites 7-1 and 7-2 would have been tied if the unweighted scores had been used to rank the sites.

Table 9-6. Rankings of the Candidate Sites Based on Total Numerical Scores

Site	Total Unweighted Score	Total Weighted Score
7-4	138	1,014
7-3	124	904
7-2	120	886
7-1	120	875
4-1	108	772

Note: Higher numerical scores are better.

Source: PSEG 2010-TN257.

The total weighted numerical scores in Table 9-6 indicate that Site 7-4 has the highest ranking, followed in order by Site 7-3, Site 7-2, Site 7-1, and Site 4-1.

As a further check on the results of the site evaluations, the numerical scores were subtotaled within each of three categories of site characteristics: environmental acceptability (including issues related to ecology, land use, and socioeconomics), nuclear licensing (including issues related to demographics, emergency planning, seismicity, and site security), and engineering/cost (including issues related to site development, transmission, transportation, and water supply). The results are shown in Table 9-7 (PSEG 2010-TN257).

Table 9-7. Weighted Numerical Scores for the Candidate Sites Based on Three Categories of Site Characteristics

Site	Environmental Acceptability	Nuclear Licensing	Engineering/Cost
7-4	***361***	***300***	***353***
7-3	258	***305***	341
7-2	***260***	289	337
7-1	256	262	***357***
4-1	196	286	290

Note: Higher numerical scores are better. Both the highest score and the second highest score in each column are shown in bolded italicized font.

Source: PSEG 2010-TN257.

Based on the results summarized in Table 9-6 and Table 9-7, PSEG identified Site 7-4 as the most favorable candidate site in regard to the issues considered in the numerical scoring. As can be seen in Table 9-6, Site 7-4 is the highest ranked site based on both the weighted and unweighted overall scoring. In addition, as shown in Table 9-7, Site 7-4 is the highest ranked site in the environmental acceptability category and is the second highest ranked site for both the nuclear licensing category and the engineering/cost category. None of the other candidate sites ranked among the top two sites in all three categories.

In addition to the numerical scores described above for the candidate sites, PSEG considered the additional technical and business considerations and synergies of collocating a new nuclear facility with the existing Salem and Hope Creek nuclear units at Site 7-4. According to PSEG, these synergies include the following factors:

- abundant existing site-specific data, information, and regulatory knowledge;
- significant community and key stakeholder support in Lower Alloways Creek Township and in Salem County, New Jersey;
- existing emergency management infrastructure and support agreements with the states of New Jersey and Delaware and with Salem and Cumberland Counties in New Jersey and New Castle County in Delaware;
- economic and operational synergies with existing operations at the Salem and Hope Creek nuclear units;
- security considerations, such as the opportunity for an integrated security strategy and protected area and preexisting agreements for mutual aid, support, and response;
- jobs creation in areas of New Jersey currently experiencing low per capita income and high unemployment;
- limited risk of substantial population growth near the proposed site; and
- minimal community and regional disruptions associated with necessary infrastructure improvements such as the new transmission lines, new pipelines, and new access road and rail systems.

In consideration of all of the above elements, PSEG evaluated business and other qualitative factors along with the numerical scores of each candidate site in making its final site selection. Site 7-4 (i.e., the existing PSEG site in Salem County, New Jersey) was selected by PSEG as the proposed site for the ESP application because it was the highest ranked site and because it has additional benefits related to the existing infrastructure, community support, emergency response, and operational synergies (PSEG 2015-TN4280). The other four candidate sites are considered to be alternative sites.

9.3.1.3 Review Team Evaluation of the PSEG Site-Selection Process

Review Team Findings

The review team evaluated the PSEG method for selecting the ROI; identifying candidate areas; and evaluating potential sites, candidate sites, and alternative sites. The results of the review team evaluation are presented in this section.

PSEG chose the entire State of New Jersey for the PSEG ROI, an area that is larger than, and completely encompasses, PSEG's traditional service territory. The designated ROI is consistent with the guidance in the NRC ESRP (NRC 2000-TN614). The review team concludes that the ROI used in the PSEG ESP application is reasonable for consideration and analysis of potential sites. The areal extent of the ROI is sufficiently expansive to ensure that an

adequate slate of potential sites could be found. The review team also finds that the PSEG basis for defining the ROI did not arbitrarily exclude desirable candidate locations.

PSEG next identified candidate areas within the ROI. PSEG used exclusionary criteria based on distances to primary highways, railroad or barge transportation, transmission lines or 500-kV substations, and water supply, as well as exclusionary criteria for areas with high population densities and areas designated as parks, preserves, recreation areas, and active military bases. The review team concludes that the approach used by PSEG to identify its seven candidate areas within the State of New Jersey is consistent with that described in the ESRP (NRC 2000-TN614); therefore, the review team concludes that the method used by PSEG to identify candidate areas is reasonable.

To identify potential sites, PSEG used topographical maps and aerial photographs to determine where suitable land area for siting a new nuclear plant would be available within each of the candidate areas (i.e., inclusionary criteria). PSEG developed preliminary plant footprint layouts for this purpose. PSEG also considered other required conditions at each site, including ground slope and proximity to water supply, transmission, and transportation resources. For each location under consideration, PSEG developed conceptual offsite corridors for water supply pipelines, transmission corridors, rail lines, and primary roads. In addition, PSEG gave consideration to the proximity of each site to floodplains, wetlands, residences, and other sensitive land features. In all, PSEG identified 11 potential sites, including at least 1 such site in each of the 7 candidate areas. The review team notes that the 11 potential sites identified by PSEG cover a wide geographic area and range of environmental conditions. The approach used by PSEG in identifying potential sites is consistent with that described in the ESRP (NRC 2000-TN614); therefore, the review team concludes that the PSEG process for identifying potential sites is reasonable.

PSEG reviewed the 11 potential sites in more detail to narrow the list to a group of candidate sites. This portion of the PSEG review included subjecting the 11 sites to more detailed evaluation including obtaining more detailed information on the environmental and technical conditions at each site. While the focus of the PSEG evaluation was on the environmental suitability of the sites, other factors in the PSEG evaluation included consideration of major nuclear licensing issues and major engineering issues related to cost or difficulty of constructing and operating a new nuclear plant at the site.

In this step of its site-selection process, PSEG eliminated 6 of the 11 potential sites; 5 of these sites were eliminated for a variety of reasons, including the observation that the water supply pipeline and/or the transmission lines would have to cross a state park or other sensitive areas. According to the PSEG siting study (PSEG 2010-TN257), one of the potential sites was eliminated due to consideration that, among other factors, two population centers of greater than 25,000 people are located within 10 mi. The PSEG siting study also found that 5 of the 11 potential sites had 40 percent fewer identified issues than the other 6 sites; hence, these 5 sites were identified by PSEG as candidate sites. While the PSEG evaluation and ranking of the potential sites included consideration of factors other than environmental acceptability, the review team found that none of the sites that were eliminated had fewer environmental issues than the sites that were retained, while all of the eliminated sites had notably more total issues.

The review team concludes that the process used by PSEG at this stage is consistent with the process described in the ESRP (NRC 2000-TN614). Because the process used by PSEG to select candidate sites would not improperly eliminate sites from consideration, the review team concludes that it is reasonable.

The PSEG evaluation of the remaining five candidate sites included field reconnaissance site visits to each site. PSEG then conducted numerical evaluations of each site to assign scores to 40 site characteristics related to environmental issues, nuclear licensing issues, and engineering and economic issues. Each of the site characteristics was given its own weighting factor, and each site was scored for each criterion. PSEG used the total weighted scores for each site to determine that Site 7-4 (the existing PSEG site) was the most suitable of the five candidate sites.

PSEG considered both environmental criteria and technical criteria in its scoring of the sites; however, the ESRP guidance (NRC 2000-TN614) considers only environmental factors in the comparison of the sites to determine whether any is environmentally preferable. Nevertheless, the review team examined the PSEG scores for each of the candidate sites based only on the numerical scores for the environmental issues and concluded that the proposed site (Site 7-4) would still be the site with the highest numerical score. The review team also examined the numerical values of the importance weighting factors that were applied by PSEG to each of the 40 site characteristics and concluded that no single one of these weighting factors was by itself sufficient to significantly skew the total score obtained by PSEG for any one site or to alter the ranking for the top two sites.

The review team concludes that the PSEG final site-selection process is reasonable, makes full use of the available candidate site data, and presents the data in a manner that permits valid comparisons between the candidate sites. Overall, the review team concludes that PSEG used a logical approach that adequately satisfied applicable NRC guidance for the identification of sites that are among the best in the ROI. Consequently, in addition to the proposed site (Site 7-4), the review team has chosen the remaining top four alternative sites identified by PSEG (i.e., Site 4-1, Site 7-1, Site 7-2, and Site 7-3) for the review team's independent analysis.

Review Team Alternative Site Evaluation

In accordance with Section 9.3 of the ESRP (NRC 2000-TN614), the review team performed an independent comparison of the proposed and alternative sites. The four alternative sites (Site 4-1, Site 7-1, Site 7-2, and Site 7-3) are examined in detail in Sections 9.3.2 through 9.3.5 of this EIS in the following subject areas: land use, water resources, terrestrial and aquatic ecology, socioeconomics and environmental justice, cultural resources and historic properties, air quality, nonradiological health, radiological health, and postulated accidents. The review team visited the proposed site and each alternative site in April 2012 (NRC 2012-TN2498; NRC 2012-TN2855). Section 9.3.6, which summarizes the impacts of the proposed action and alternative sites, contains a table with the review team's characterization of the cumulative impacts of building and operating a new nuclear power plant at the proposed site and at each of the alternative sites (Table 9-24).

Following the guidance promulgated in Section 9.3 of the ESRP (NRC 2000-TN614), the review team collected and analyzed reconnaissance-level information for each site. The review team then used the information provided in the ER (PSEG 2015-TN4280), RAI responses (PSEG 2012-TN2113; PSEG 2012-TN2214), information from other Federal and State agencies, and information gathered during the review team visits to each alternative site to evaluate the cumulative impacts of building and operating a new nuclear power plant at those sites. The analysis therefore included the impacts of NRC-authorized construction and operation and potential impacts associated with other actions affecting the same resources. Cumulative impacts occur when the effects of an action are added to or interact with other effects in a particular place and within a particular time; as a result, the cumulative impact assessment entails a more extensive and broader review of possible effects of the action beyond the site boundary.

The cumulative analysis for the impacts at the alternative sites was performed in the same manner as discussed in Chapter 7 of this EIS for the proposed site, except, as specified in Section 9.3 of the ESRP (NRC 2000-TN614), a reconnaissance-level analysis was conducted for the alternative sites. To inform the cumulative impacts analysis, PSEG conducted a search to identify other relevant projects in the vicinity of each of the alternative sites (PSEG 2012-TN2214). The search included information available through regional economic development agencies in the states of Delaware, Pennsylvania, and New Jersey; EPA databases for relevant EISs within the state; the USACE Philadelphia District website for recent permit applications; township and county planning websites; the New Jersey Department of Transportation website; and the Delaware Department of Transportation website. Information was also sought to identify projects in the geographic area funded by the American Recovery and Reinvestment Act of 2009 (Public Law 111-5; 26 USC 1-TN1250). The review team developed tables of the major projects near each alternative site that were considered relevant in the analysis of cumulative impacts. The review team used this information to perform an independent evaluation of the direct and cumulative impacts of the proposed action at the alternative sites to determine whether one or more of the alternative sites were environmentally preferable to the proposed site.

Included in the cumulative analysis are past, present, and reasonably foreseeable Federal, non-Federal, and private actions that could have meaningful cumulative impacts with the proposed action. For the purposes of this analysis, the past is defined as the time period before receipt of the ESP application. The present is defined as the time period from the receipt of the ESP application until the beginning of activities associated with building a new nuclear power plant at the PSEG Site. The future is defined as the beginning of building activities (construction and preconstruction activities) associated with a new nuclear plant at the PSEG Site through operation and eventual decommissioning.

Using the analyses in Chapter 7 of this EIS as a guide, the specific resources and components that could be affected by the new incremental effects of constructing and operating a new nuclear plant at each of the alternative sites and other actions in the same geographic areas were identified. The affected environment that serves as the baseline for the cumulative impacts analysis is described for each alternative site, and a qualitative discussion of the general effects of past actions is included. The geographic area over which past, present, and future actions could reasonably contribute to cumulative impacts is defined and described in

later sections for each resource area. The analysis for each resource area at each alternative site concludes with a cumulative impact finding (SMALL, MODERATE, or LARGE). For those cases in which the impact level to a resource was greater than SMALL, the review team also discussed whether building and operating a new nuclear plant would be a significant contributor to the cumulative impact. In the context of this evaluation, "significant" is defined as a contribution that is important in reaching that impact-level determination.

Cumulative impacts are summarized for each resource area at each site in Sections 9.3.2 through 9.3.5. The level of detail is commensurate with the significance of the impact for each resource area. The findings for each resource area at the PSEG Site and each alternative site then are compared in Table 9-24 in Section 9.3.6. The results of this comparison are used in Section 9.3.6 to determine whether any of the alternative sites are environmentally preferable to the proposed site. If any alternative site is determined to be environmentally preferable, the review team would evaluate whether that specific alternative site was obviously superior to the proposed site.

The impacts described in Chapter 6 of this EIS (e.g., nuclear fuel cycle and decommissioning) would not vary significantly from one site to another. This is true because all of the alternative sites and the proposed site are in low-population areas and because the review team assumes the same reactor plant parameter envelope is applicable for each of the sites, and, therefore, the same fuel cycle technology, transportation methods, and decommissioning methods. Because of this, these impacts would not differentiate between the sites and would not be useful in the determination of whether an alternative site is environmentally preferable to the proposed site. For this reason, these impacts are not discussed in the evaluation of the alternative sites.

Nonradiological waste impacts are described in Sections 4.10 and 5.10 and were determined to be SMALL for the PSEG Site. The nonradiological waste impacts would not vary significantly from one site to another because the types and quantities of nonradiological and mixed waste would be about the same at any of the alternative sites. For each alternative site, all wastes destined for land-based treatment or disposal would be transported off the site by licensed contractors to existing, licensed disposal facilities operating in compliance with all applicable Federal, State, and local requirements, and all nonradioactive liquid discharges would be discharged in compliance with the provisions of an applicable NPDES permit. Also, the amount of nonradioactive, nonhazardous municipal solid waste to be generated annually at the proposed site would be a relatively small percentage of the total solid waste generated within the geographic area of influence of any of the alternative sites.

Finally, as stated in Section 7.9, activities at the proposed site would generate a very small percentage of the hazardous waste produced in New Jersey, and no known capacity constraints exist for the treatment or disposal of hazardous wastes either within the State of New Jersey or for the nation as a whole. For these reasons, these impacts are not discussed separately in the evaluations of each alternative site in Sections 9.3.2 through 9.3.5.

9.3.2 Site 4-1

This section covers the review team evaluation of the potential environmental impacts of siting a new nuclear power plant at the site designated as Site 4-1 in Hunterdon County, New Jersey,

located about 80 mi north-northeast of the PSEG Site (see Figure 9-1). Site 4-1 is a greenfield site that is not owned by PSEG. The site is located about 5 mi from the Delaware River, which would be the source of cooling water for new nuclear units at this site. The site has a total area of 1,128 ac.

As indicated by PSEG, the use of Site 4-1 would require infrastructure upgrades and improvements, as follows (PSEG 2015-TN4280).

- Portions of the public roads that currently provide access to the site would need to be relocated around plant facilities and/or improved to increase their load-carrying capacity. An estimated total of 3.5 mi of road building would be required, and the ROW width would be 150 ft.
- A new rail spur would be required to allow delivery of materials and equipment to the site. PSEG identified a conceptual route and alignment for this new rail spur that would be 6.8 mi long and would require a ROW width of 150 ft.
- A new water supply pipeline would need to be installed to withdraw water from the Delaware River. A new discharge pipeline would also need to be installed to convey blowdown and wastewater to the Delaware River. PSEG assumed that the two new pipelines would be constructed parallel to each other and within the same 100-ft-wide ROW. The estimated length of the route is 6.6 mi.
- Three new 500-kV transmission lines would need to be installed to connect to the existing transmission line system. PSEG assumed that these three new lines would be installed parallel to one another, each within a 200-ft ROW. The length of these three new lines would be 1.1 mi.
- A new switchyard would be required at the connection of the above new transmission lines and the existing transmission line system. PSEG assumed that this new switchyard would be located on 25 ac.

The following sections include a cumulative impact assessment conducted for each major resource area. The assessment considered the specific resources and components that could be affected by the incremental effects of a new nuclear plant at Site 4-1, including the impacts of NRC-authorized construction and operations and impacts of preconstruction activities. Also included in the assessment are past, present, and reasonably foreseeable future Federal, non-Federal, and private actions in the same geographical area that could have meaningful cumulative impacts when considered together with a new nuclear plant if such a plant were to be built and operated at Site 4-1. Other actions and projects considered in this cumulative analysis are described in Table 9-8.

Table 9-8. Projects and Other Actions Considered in the Cumulative Impacts Analysis for Site 4-1

Project Name	Summary of Project	Location	Status
Nuclear Projects			
Hope Creek Generating Station, Unit 1	The station consists of a single operating boiling water reactor (BWR) rated at 3,840 MW(t), adjacent to the Salem units.	80 mi south-southwest of Site 4-1	Operational, licensed through April 11, 2046 (NRC 2012-TN2626)
Salem Generating Station, Units 1 and 2	The station consists of two operating pressurized water reactors (PWRs) rated at 3,459 MW(t) each, adjacent to the Hope Creek unit.	80 mi south-southwest of Site 4-1	Operational, licensed through August 13, 2036, and April 18, 2040 (NRC 2012-TN2626)
Oyster Creek Nuclear Generating Station	The station consists of a single operating BWR rated at 1,930 MW(t).	65 mi southeast of Site 4-1	Operational, licensed through April 9, 2029 (NRC 2012-TN2626). However, Exelon plans to shut the plant down in 2019 (Exelon 2013-TN2521)
Limerick Generating Station, Units 1 and 2	The station consists of two operating BWRs rated at 3,515 MW(t) each.	40 mi southwest of Site 4-1	Operational, licensed through October 26, 2024, and June 22, 2029 (NRC 2012-TN2626)
Peach Bottom Atomic Power Station, Units 2 and 3	The station consists of two operating BWRs rated at 3,514 MW(t) each, and one permanently shutdown unit (Unit 1).	87 mi southwest of Site 4-1	Operational, licensed through August 8, 2033, and July 2, 2034 (NRC 2012-TN2626)
Three Mile Island Nuclear Station, Unit 1	The station consists of a single operating PWR rated at 2,568 MW(t), and one permanently shutdown unit (Unit 2).	96 mi southwest of Site 4-1	Operational, licensed through April 19, 2034 (NRC 2012-TN2626)
Susquehanna Steam Electric Station, Units 1 and 2	The station consists of two operating BWRs rated at 3,952 MW(t) each.	73 mi northwest of Site 4-1	Operational, licensed through July 17, 2042, and March 23, 2044 (NRC 2012-TN2626)
Bell Bend Nuclear Power Plant	The station would consist of a single U.S. Evolutionary Power Reactor rated at 4,590 MW(t).	73 mi northwest of Site 4-1	Proposed, last revision of application submitted April 12, 2013 (PPL 2013-TN2625)
Indian Point Nuclear Generating Units 2 and 3	The station consists of two operating PWRs rated at 3,216 MW(t) each, and one permanently shutdown unit (Unit 1).	73 mi northeast of Site 4-1	Operational, licensed through September 28, 2013, and December 12, 2015 (NRC 2012-TN2626); application for license renewal dated April 23, 2007 (Entergy 2007-TN2624)

Table 9-8. (continued)

Project Name	Summary of Project	Location	Status
Energy Projects			
Gilbert Generating Station	608-MW Natural-Gas-/Oil-Fired Power Plant	5 mi northwest of Site 4-1	Operational (EPA 2013-TN2514)
Glen Gardner Generating Station	160-MW Natural-Gas-/Oil-Fired Power Plant	10 mi northeast of Site 4-1	Operational, planned closure by 2015 (EPA 2013-TN2514)
Hunterdon Cogeneration Facility	4-MW Natural-Gas-Fired Power Plant	14 mi northeast of Site 4-1	Operational (EPA 2013-TN2514)
Northeast Supply Link Project	Expansion of the Transco Mainline and Leidy natural-gas lines	5.7 mi west of Site 4-1	Approved by the Federal Energy Regulatory Commission (EPA 2012-TN3125; Williams Co. 2013-TN2616)
North Central Reliability Project	Upgrade of existing transmission lines and substations	29.6 mi northeast of Site 4-1	Operational (PSEG Inc. 2015-TN4264)
Susquehanna-Roseland Electric Reliability Project	Construction of new 500-kV transmission line	34.4 mi north of Site 4-1	Operational (PPL 2015-TN4263)
Transportation Projects			
Route 31, Church Street to River Road	Road widening	5.8 mi east of Site 4-1	In progress (NJDOT 2011-TN2619)
Parks and Recreation Activities			
Horseshoe Bend Park	313-ac park with bike, horse, and hiking trails	4.7 mi southwest of Site 4-1	Operational (Kingwood Township 2013-TN2622)
Voorhees State Park/ Spruce Run Recreation Area	1,336-ac park and 2,030-ac reservoir with trails, camping, boating, fishing, and hunting	7.8 mi north of Site 4-1	Operational (NJDEP 2013-TN2620)
Round Valley Recreation Area	3,684-ac park and reservoir with trails, camping, boating, fishing, scuba diving, and hunting	8.1 mi northeast of Site 4-1	Operational (NJDEP 2013-TN2621)
Other parks, forests, and reserves	Numerous State and National parks, forests, reserves, and other recreational areas are located within a 50-mi region	Throughout 50-mi region	Parks are currently being managed by National, State, and/or local agencies
Other Actions/Projects			
Tekni-Plex	Manufacturing plastic packaging and tubing	15 mi east of Site 4-1	Operational; planned expansion (EPA 2013-TN2514)
Air emissions sources	Nearby air emissions sources include small-scale commercial facilities (emissions below reporting limits), on-road mobile sources (cars and trucks), non-road mobile sources (airplanes,	Within Hunterdon County	Ongoing

Table 9-8. (continued)

Project Name	Summary of Project	Location	Status
	boats, tractors, etc.), and industrial stationary point emissions sources		
Surface-water withdrawals and discharges	Surface-water withdrawals for public water supply and other potable use and wastewater treatment plant discharges	Within 10 river miles of the intake and discharge for Site 4-1	Significant surface-water withdrawals and discharges have been taking place for decades. Withdrawal rates are expected to continue at current rates or increase slightly in the future
Groundwater withdrawals	Groundwater withdrawals for public water supply and other uses	Throughout region, including within 5 mi of Site 4-1	Significant groundwater withdrawals have been taking place for decades. Withdrawal rates are expected to continue at current rates or increase slightly in the future
Various hospitals and industries that use radioactive materials	Medical and other isotopes	Within 50 mi	Operational in nearby cities and towns
Future Urbanization	Construction of housing units and associated commercial buildings; roads, bridges, and rail; construction of water and/or wastewater treatment and distribution facilities and associated pipelines, as described in local land-use planning documents	Throughout region	Construction would occur in the future, as described in-State and local land-use planning documents

9.3.2.1 Land Use

Affected Environment

As discussed in Section 9.3.2, Site 4-1 covers 1,128 ac in Franklin Township, Hunterdon County, New Jersey (Figure 9-1). Existing land use at Site 4-1 is predominantly agricultural, with large areas planted in cultivated crops. The State of New Jersey operates an agricultural extension research farm on part of Site 4-1, and much of the soil on the site is classified as prime farmland.

Most of Site 4-1 is zoned Residential (with a zoning designation that specifies 3-ac lots), and there are about 25 single-family houses located within the site boundaries. Also, although the site is located 5 mi from the nearest incorporated town, there are small concentrations of houses within 1 mi of the site. There are no significant industrial land uses on Site 4-1 or in close proximity.

According to the 2012 State of New Jersey Department of Agriculture GIS mapping conducted by PSEG, a total of 270.8 ac within the Site 4-1 boundaries (24.0 percent of the total 1,128 ac) are designated County Preserved Farmlands under the State Farmland Preservation Program (Figure 9-2) (PSEG 2012-TN2282). The GIS mapping indicates that there are two County Preserved Farmland parcels within Site 4-1. One (148.9 ac) is located at the southwest corner of the site, and the other (121.9 ac) is located at the southeast corner of the site. However, PSEG has reviewed public records for Hunterdon County and could not locate any formal deed restrictions or evidence of County Preserved Farmland status for either parcel. Therefore, PSEG could not confirm the status of the County Preserved Farmland identified in the 2012 New Jersey Department of Agriculture GIS mapping (PSEG 2012-TN2282).

One 70-ac parcel within the Site 4-1 boundaries (6.0 percent of the total 1,128 ac) is owned by the New Jersey Audubon Society and preserved as open space under a Deed of Conservation Restriction (DCR) (Figure 9-3) (PSEG 2012-TN2282).

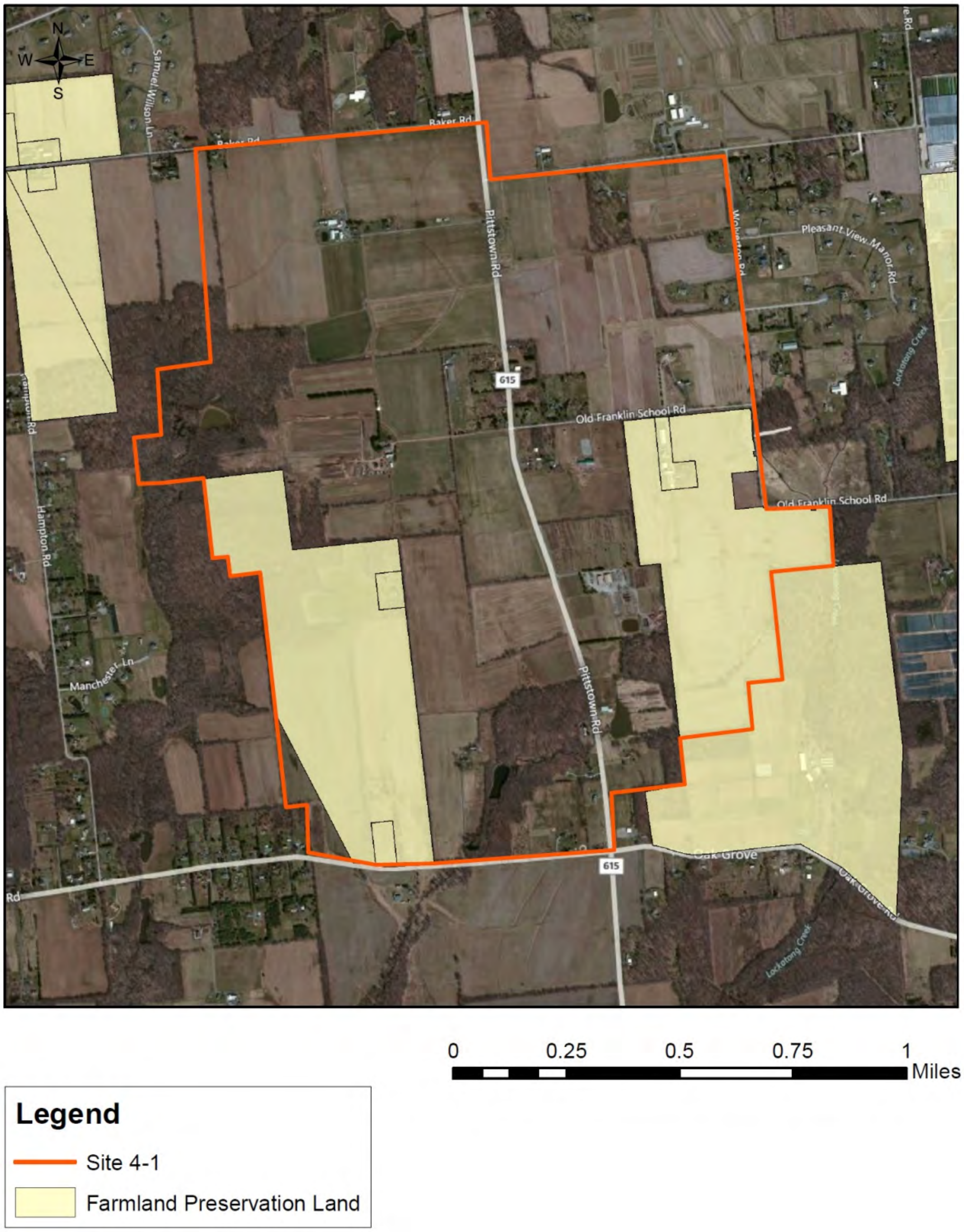
The offsite corridors for the access roads, rail spur, and water pipelines to Site 4-1, as well as the short connector transmission line from Site 4-1 to the grid, would be largely confined to the immediate site vicinity. Land uses within these corridors would be similar to the site itself, with most of the land in agricultural use and residences scattered throughout the area. There are no significant industrial land uses within the offsite corridors (PSEG 2015-TN4280).

Building Impacts

According to PSEG, building a new nuclear power plant at Site 4-1 would directly disturb (temporarily and permanently) a total of 401 ac on the site. The plant footprint would disturb about 323 ac of planted/cultivated land, 6.9 ac of developed land, 47 ac of barren land, 12 ac of forest land, and 2 ac of freshwater forested/shrub wetland. The remaining land within the Site 4-1 boundaries (727 ac) would not be directly disturbed, but access to this land would be controlled, and it would be unavailable for uses not related to a new nuclear power plant. In addition, developing the access road, rail spur, and water pipeline corridors for Site 4-1 would disturb 268 ac off the site. Therefore, a total of 1,396 ac, not including transmission line corridors, would be disturbed or made unavailable for uses not related to a new plant at Site 4-1 (PSEG 2015-TN4280).

PSEG has stated that a new nuclear power plant at Site 4-1 could tie into the new Susquehanna-Roseland Electric Reliability Project (SRERP) transmission lines that have been constructed in northern New Jersey, thereby negating the need for an additional stability line for Site 4-1 (PSEG 2012-TN2113). However, PSEG would need to develop a connector transmission line from Site 4-1 to the SRERP lines. This 1.1-mi connector transmission line corridor would disturb a total of 100 ac off the site. The tie-in to the SRERP would disturb about 79 ac of planted/cultivated land, less than 1 ac of developed land, about 3 ac of barren land, 16 ac of forest, and 0.4 ac of other wetland (PSEG 2015-TN4280).

Site 4-1 is predominantly zoned Residential, and the definitions for this zoning classification indicate that "power generation is not an allowable use" (PSEG 2010-TN257). Therefore, the current zoning designation would have to be changed or a variance granted before the site could be developed for a nuclear power plant.



Data Source: NJDEP Geographic Information System Clearinghouse
NJ Department of Agriculture SADC 2012

Figure 9-2. County Preserved Farmland at Alternative Site 4-1 (Source: PSEG 2012-TN2282)

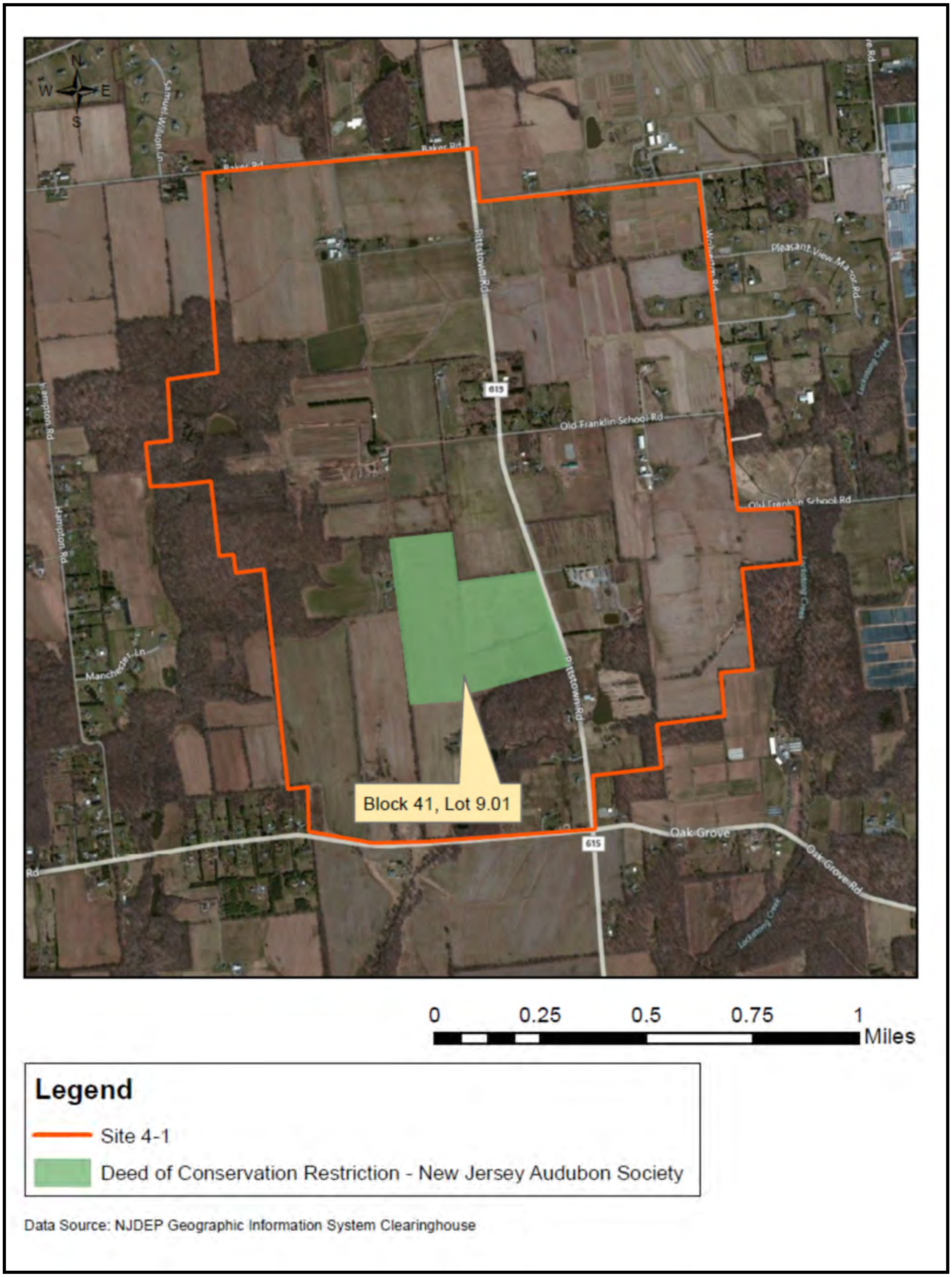


Figure 9-3. Deed of Conservation Restriction Parcel at Alternative Site 4-1 (Source: PSEG 2012-TN2282)

PSEG has stated that most of the 25 houses within the Site 4-1 boundaries would have to be removed before the site could be developed for a nuclear power plant. PSEG anticipates that the offsite corridors could be developed without removing existing houses, but has stated that some houses would be located in close proximity to the various ROW alignments (PSEG 2015-TN4280).

If the two parcels of County Preserved Farmland within the Site 4-1 boundaries are preserved under a development easement, and the lands were purchased using State funds, the easement would have to be removed in accordance with the State Agriculture Retention and Development Act (NJSA 4:1C-11 et seq. –TN4309). This would require that a governing body (municipal, county, State, or Federal agency) exercise the right of eminent domain on the parcels. Accordingly, PSEG would have to engage the appropriate governing body to initiate condemnation proceedings on its behalf to remove the existing easements. The condemnation process for an authorized governing body includes an analysis of alternatives, a public hearing, and a decision from the governor of New Jersey that the proposed action is necessary to ensure public health, safety, and welfare (PSEG 2012-TN2282).

According to PSEG correspondence with the New Jersey Department of Agriculture, there is no requirement that replacement land be acquired as part of the process to offset the loss of preserved farmland. However, PSEG would have to provide a payment equal to the value of the development easement, as determined by the State House Commission, as part of the process (PSEG 2012-TN2282).

The 70-ac parcel owned by the New Jersey Audubon Society and preserved as open space under a DCR (Figure 9-3) was purchased using funds from the State of New Jersey Green Acres Program, so removing the DCR would be guided by the State process, described in Section 4.1.2. However, PSEG has not identified compensatory land for removing the DCR from the New Jersey Audubon Society land within Site 4-1.

Site 4-1 has an existing site elevation between 540 and 640 ft above mean sea level (MSL). PSEG considers the site to be a bedrock site with rock at an estimated depth of 20 ft, so some rock excavation would be required for the power block structures. Because the existing Site 4-1 elevation would provide adequate final grade elevation to preclude flooding, PSEG has stated that no additional fill above existing grade elevation would be required. PSEG estimates that the total fill quantity for Site 4-1 would be 1.5 million yd^3, with 0.5 million yd^3 of Category 1 fill and 1.0 million yd^3 of Category 2 fill. PSEG has stated that the fill material for Site 4-1 could come from the same sources as the fill material for the PSEG Site (i.e., existing permitted borrow sites in New Jersey, Delaware, and Maryland). However, PSEG would likely conduct a new search for fill material sources if Site 4-1 were developed and would conduct testing to determine whether the material excavated from Site 4-1 could be reused as fill at the site (PSEG 2012-TN2282).

Overall, the land-use impacts of building a new nuclear power plant on Site 4-1 would be sufficient to alter noticeably, but not destabilize, important attributes of existing land uses at the site and in the vicinity. Building a new plant would directly disturb 401 ac of land and eliminate access to and use of another 727 ac of land that currently supports productive agricultural and rural residential uses. Building the new access road, rail spur, and water pipeline corridors for

Site 4-1 would disturb an additional 268 ac of similar land uses off the site. Further, developing the new connector transmission corridor from Site 4-1 to the SRERP lines would disturb an additional 100 ac of similar offsite land uses. There are about 43,671 ac of planted/cultivated land and 6,535 ac of developed land in the 6-mi vicinity of Site 4-1 (PSEG 2015-TN4280). In comparison to the vicinity, the conversion of land use from agricultural and rural residential to heavy industrial and transmission corridor would not noticeably alter existing land use in the surrounding area. However, building a new nuclear power plant on Site 4-1 would require that most of the 25 houses within the site boundaries be removed and that any residents be relocated; that 70 ac of land owned by the New Jersey Audubon Society and preserved as open space under a DCR be developed; and, potentially, that 270.8 ac of County Preserved Farmlands be developed.

Based on the information provided by PSEG and the review team's independent review, the review team concludes that the combined land-use impacts of preconstruction and construction activities on and off the site for Site 4-1 would be noticeable. The review team reaches this conclusion because the conversion of rural residential land uses to heavy industrial and transmission corridor use and the relocation of 25 residences would be sufficient to alter noticeably, but not destabilize, important attributes of existing land uses at the site and in the vicinity.

Operational Impacts

The land-use impacts of operating a new nuclear power plant at Site 4-1 would be smaller than the impacts of building the plant, but they would still permanently eliminate almost all access to and use of 1,396 ac of land on Site 4-1 that supports productive agricultural and rural residential uses. Most of these impacts would occur during the building phase at Site 4-1, and no additional impacts from operation would be expected. Additionally, there are sufficient agricultural and residential land-use resources in the vicinity, and the impacts would be minimal. Therefore, based on the information provided by PSEG and the review team's independent review, the review team concludes that the land-use impacts of operating a new nuclear power plant at Site 4-1 would be negligible.

Cumulative Impacts

The geographic area of interest for consideration of cumulative land-use impacts at Site 4-1 includes Hunterdon County, New Jersey (in which Site 4-1 is located) and the other counties in New Jersey, New York, and Pennsylvania within the 50-mi region around Site 4-1. The direct and indirect impacts to land use of building and operating a new nuclear power plant at Site 4-1 would be confined to Hunterdon County, but the cumulative impacts to land use when combined with other actions (discussed below) could extend to other counties in New Jersey, New York, and Pennsylvania.

Table 9-8 lists projects that, in combination with building and operating a new nuclear power plant at Site 4-1, could contribute to cumulative impacts in the region. Most of the other projects listed in Table 9-8 are not expected to create noticeable cumulative impacts to land use in the 50-mi region when combined with a new nuclear power plant at Site 4-1. The energy projects listed in Table 9-8 are all located too far from Site 4-1 and from each other to create noticeable

cumulative land-use impacts in the region. However, the SRERP, the Northeast Supply Link Project (NSLP), and the North Central Reliability Project energy infrastructure projects would contribute to the cumulative impacts of building and operating a new plant at Site 4-1. The NSLP could add an additional 12 mi of 42-in. pipeline in Hunterdon County to support natural-gas supplies (EPA 2012-TN3125). The SRERP added an additional 45 mi of transmission lines in the area, and the North Central Reliability Project added an additional 35 mi of transmission lines. Both the North Central Reliability Project and the SRERP were expected to use existing ROWs to the greatest extent possible, thereby further minimizing potential land-use impacts (PSEG 2013-TN2618; PSEG 2013-TN2617). The SRERP transmission lines could be used as tie-ins for a new nuclear power plant at Site 4-1. The National Park Service NEPA documentation for the SRERP line ROW concludes that the proposed ROW "would not greatly change existing land use itself, nor land use plans," and dismisses the topic of land use from further detailed analysis (NPS 2012-TN2676). Individually, these projects would not be expected to have a noticeable effect on land-use resources. However, the cumulative land-use impacts of building and operating a new plant at Site 4-1 with building and operating the NSLP, North Central Reliability Project, and SRERP would be noticeable in the context of total land use within the vicinity of Site 4-1 and the 50-mi region.

Likewise, the transportation project listed in Table 9-8 (Route 31) is not close to Site 4-1 and is a relatively minor, short-term project that is not expected to contribute to cumulative land-use impacts at the regional scale. The parks and recreation activities listed (Horseshoe Bend Park; Voorhees State Park; Round Valley Recreation Area; and other existing parks, forests, and reserves in the 50-mi region) are not expected to contribute to adverse land-use impacts, especially on the regional scale.

The report *Global Climate Change Impacts in the United States* (GCRP 2014-TN3472), prepared for the U.S. Global Change Research Program (GCRP), summarizes the projected impacts of future climate changes in the United States. The report divides the United States into nine regions, and Site 4-1 is located in the Northeast region. The report indicates that climate change could increase precipitation, sea level, and storm surges in the Northeast region, thus changing land use through the inundation of low-lying areas that are not buffered by high cliffs. However, cliffs could experience increased rates of erosion as a result of frequent storm surges, flooding events, and sea-level rise. Forest growth could increase as a result of more CO_2 in the atmosphere. Existing parks, reserves, and managed areas would help preserve wetlands and forested areas to the extent that they are not affected by the same factors. In addition, climate change could reduce crop yields and livestock productivity, which might change portions of agricultural land uses in the region (GCRP 2014-TN3472). Thus, direct changes resulting from climate change could cause a shift in land use in the 50-mi region that would contribute to the cumulative impacts of building and operating a new nuclear power plant on Site 4-1.

Overall, when combined with other past, present, and reasonably foreseeable future actions, the cumulative land-use impacts of building and operating a new nuclear power plant at Site 4-1 (along with the new connector transmission lines to the SRERP lines) would be sufficient to alter noticeably, but not destabilize, important attributes of existing land uses in the 6-mi vicinity of the site and the larger 50-mi region. Therefore, based on the information provided by PSEG and the review team independent review, the review team concludes that the cumulative land-

use impacts of developing Site 4-1 would be MODERATE. The incremental contribution of building and operating a new nuclear power plant at Site 4-1 would be a significant contributor to the cumulative impact.

9.3.2.2 Water Use and Quality

This section describes the review team's assessment of impacts on water use and quality associated with building and operating a new nuclear power plant at Site 4-1. The analysis also considers cumulative impacts from other past, present, and reasonably foreseeable future actions including the other Federal and non-Federal projects listed in Table 9-8 that could affect water use and quality. Site 4-1 hydrology, water use, and water quality are discussed in the ER (PSEG 2015-TN4280).

Site 4-1 is a 1,128-ac greenfield site in Hunterdon County, New Jersey, located about 5 mi east of the Delaware River at about River Mile (RM) 164. The geographic area of interest for the surface-water environment consists of the Delaware River Basin, which would be affected by water withdrawn from and wastewater discharged to the Delaware River. In 2008, the Delaware River Basin Commission (DRBC) permanently designated the Delaware River between Delaware RM 209.5 and RM 134.4 as Special Protection Waters with a classification of Significant Resource Waters (DRBC 2008-TN3210). The designation brought this reach of the river under the DRBC's anti-degradation regulations and established numeric standards for water quality. Intake and discharge for a new nuclear power plant at Site 4-1 would be located within the designated reach and would be subject to the Special Protection Waters regulations. For groundwater, the geographic area of interest contains the potentially impacted aquifers which, for reasons described below, are likely limited to those within a few miles of the site.

DRBC regulates discharges in excess of 10,000 gpd and withdrawals in excess of 100,000 gpd and provides some information on permitted projects (DRBC 2014-TN3212) but does not provide sensitive information such as the location of public water supplies. Available docket information from DRBC (DRBC 2014-TN3212) in the area of Site 4-1 includes the presence of wastewater treatment plant discharges at Delaware RM 164 and 167 and public water supply intakes at RM 154 and 157. The presence of two public water supplies derived from groundwater wells is also included in this information. In addition, two groundwater withdrawal projects are described, one supplying 160 gpm from four wells and one supplying 227 gpm from nine wells. The New Jersey Geological Survey (NJGS) (NJGS 2014-TN3220) identifies about 80 Mgd of surface-water withdrawals for public water supply in the Lockatong Creek watershed. From this information, the review team concludes that groundwater and surface water are used extensively in the area of Site 4-1.

PSEG stated in its ER that the Delaware River would be the primary source of water (PSEG 2015-TN4280). The Delaware River in the Site 4-1 area contains freshwater. Because of freshwater use, the cooling towers would be able to operate at three cycles of concentration or more at Site 4-1. As stated in Section 9.3.2 of the ER (PSEG 2015-TN4280), the total water withdrawal for this site would be 40,300 gpm (89.8 cfs). The consumptive water use, however, would remain the same as for the other sites, including the PSEG Site, at 26,420 gpm (58.9 cfs).

The nearest U.S. Geological Survey (USGS) gage to Site 4-1 is 01457500, "Delaware River at Riegelsville NJ," located at Delaware RM 174.8, about 11 mi upstream from the Site 4-1 water intake location. The available record for this gage is from 1906–1971 and 2002–2012. Table 9-9 lists representative historical flow values as reported by USGS (2014-TN3229). The mean annual river flow at this gage is 9,693 cfs (4.351×10^6 gpm) and the 7-day, 10-year low flow (7Q10) is 1,661 cfs (7.455×10^5 gpm). Because the gaging station is located upstream of the Site 4-1 water intake location, the actual river flow in the site area is expected to be higher than that at the gaging station. The 7Q10 is a typical measure of low flow and is defined as the lowest average flow during a 7-consecutive-day period, with a probability of occurrence of once in 10 years. Table 9-9 also includes the assessed impact levels. Because withdrawal of surface water to meet the consumptive needs of a new plant would reduce river flow by less than 5 percent of the mean annual flow, the associated water-use impact is assessed to be minor.

Table 9-9. Delaware River Reduction in Flow and Assessed Impact Levels

Delaware River at Riegelsville Flow Condition	River Flow Rate (cfs)	Normal Consumptive Use (cfs)	Percent Flow Reduction	Impact Level
Mean Annual Flow	9,693	58.9	0.6	Minor
7Q10	1,661	58.9	3.5	Minor

ER Section 9.3.2.1.3 states that groundwater use at Site 4-1 would not be mandatory but that available information indicates that one or two wells at the site could supply the groundwater needs identified for operation of a new nuclear power plant (210 gpm average, 953 gpm maximum) (PSEG 2015-TN4280). Site 4-1 lies in the Newark Basin of the Piedmont Physiographic Province (Trapp and Horn 1997-TN1865). Newark Basin aquifers in the area of Site 4-1 primarily consist of sandstone, siltstone, shale, and some conglomerate rocks of the Passaic Formation (part of the Brunswick Group), the Lockatong Formation, and the Stockton Formation (Herman et al. 1998-TN3217; Serfes 1994-TN3216). According to Trapp and Horn (1997-TN1865), the Lockatong Formation is the least productive of these formations. Four USGS observation wells in the Site 4-1 area access aquifers in the Passaic and Stockton Formations and are finished at depths of 21 to 299 ft below ground surface (USGS 2014-TN3230). Water movement in the Newark Basin occurs primarily along joints, fractures, and bedding planes, with limited flow across the confining units located between the individual aquifers (Trapp and Horn 1997-TN1865). Water supply wells are generally long, uncased boreholes that access multiple, relatively thin conductive zones separated by thicker beds of low-permeability rock (Trapp and Horn 1997-TN1865). Drawdown patterns and groundwater flow paths are dependent on the orientation of the rock beds and the occurrence of fractures and joints (Barton et al. 2003-TN3225; Michalski 1990-TN3215). Herman et al. (1998-TN3217) indicate that median well yields in the Brunswick Group and Stockton Formation aquifers are 100–250 gpm, although Trapp and Horn (1997-TN1865) describe typical yields of about 80 gpm from large-diameter wells completed in massive sandstones and conglomerates. Site 4-1 is not located above a sole-source aquifer, being to the east of the northwest New Jersey Fifteen Basin Sole-Source Aquifer (EPA 2010-TN3213).

Considering the relative difficulty of obtaining a sufficient groundwater supply, the review team concludes that use of Delaware River water to supply a new plant's freshwater needs would be

likely at Site 4-1. The average use of groundwater at the PSEG Site, 210 gpm (0.47 cfs), would be less than 1 percent of a new nuclear power plant's consumptive use. This small amount of water would have a negligible effect on the impacts resulting from the use of Delaware River water to support plant operations.

Building Impacts

Impacts to surface waters from building activities at Site 4-1 may occur from site-preparation and plant building activities. A barge docking facility would not be constructed in the Site 4-1 area. The offsite building activities to support a new nuclear power plant would include relocation of existing public roads around plant facilities, improvements to existing roads for plant-related traffic, building a new rail spur, installation of new makeup water and wastewater discharge pipelines, and building three new transmission lines.

PSEG proposes in ER Section 9.3.2 (PSEG 2015-TN4280) to use surface water withdrawn from the Delaware River or groundwater to support building activities. The anticipated water use during building activities would be significantly less than that during the operation of a new nuclear power plant. During building activities, as estimated by PSEG in ER Section 4.2 (PSEG 2015-TN4280), water use to support concrete plant operations, dust suppression, and potable water would be 119 gpm. Assuming use of surface water for building activities, compared to the flow data in Table 9-9, the withdrawal rate of 119 gpm (0.27 cfs) during building activities would be quite insignificant (less than 0.5 percent of consumptive use). Therefore, the review team concludes that the impact on the surface-water resource from water use for building activities at Site 4-1 would be minor.

During building, water-quality-related impacts would be similar to those expected for any other large project. Alterations to the Delaware River would occur during installation of the makeup water intake structure and the wastewater discharge structure. During installation of these structures, some additional turbidity in the river is expected because of disturbance of bottom sediments. However, these sediments would be localized to the area needed to install the structures, and engineering measures would be in place as part of BMPs to minimize movement of the disturbed sediment beyond the immediate work area. These impacts would also be temporary and not occur after the structures were installed. Because these activities would occur in waters of the United States, appropriate permits from the USACE and the New Jersey Department of Environmental Protection (NJDEP) would be required. PSEG would be required to implement BMPs to control erosion and sedimentation and discharge of building-related pollutants to the Delaware River or nearby water bodies. Because the effects from building-related activities would be minimized using BMPs, would be temporary and localized, and would be controlled under various permits, the review team concludes that the impact from building-related activities on the water quality of the Delaware River and nearby water bodies would be minor.

PSEG indicated in its ER that groundwater withdrawal would not be mandatory to support building activities at Site 4-1 (PSEG 2015-TN4280). As stated above, the availability of Delaware River water for freshwater plant needs and the relative difficulty of obtaining a sufficient groundwater supply leads the review team to conclude that groundwater would not be used for building. Therefore the impact to groundwater due to building-related use would be minor.

It must be assumed, however, that temporary dewatering would be needed to build the power block, similar to the PSEG Site. There are significant differences between the aquifers at Site 4-1 and the PSEG Site that affect the impact of dewatering. The Newark Basin aquifers in the Site 4-1 region consist of fractured, consolidated rocks with water flow occurring primarily along fractures, joints, and bedding planes. In addition, Newark Basin surficial aquifers in the Site 4-1 region may be used as the primary drinking water supply, unlike at the PSEG Site where the drinking water aquifers are much deeper and separated from the surficial units by intervening confining units.

Dewatering flow rates for the site excavation cannot be estimated without characterization of Site 4-1. However, water storage is primarily within the rock fractures and joints, thus limiting the amount of water likely to infiltrate the excavation. Barton et al. (2003-TN3225) state that the effective porosity of the Brunswick and Lockatong Formations is likely not to exceed 0.7 percent. Carleton et al. (1999-TN3224) estimated effective porosities of about 0.1 percent for the Passaic Formation at a site near Hopewell, New Jersey, in Mercer County. Because of the presence of fractured rock at Site 4-1, with these low effective porosities, the review team concludes that infiltration to the excavation would be limited and could likely be controlled by engineering methods, such as grouting the fractures and using a sump to remove residual infiltrated water. Discharge of infiltrated water would be managed using BMPs according to NJDEP requirements. The impacts of dewatering under these conditions would be minor.

Impacts to groundwater quality from building activities could occur from inadvertent spills of pollutants such as fuel or oil that might infiltrate into the subsurface. BMPs would be used to minimize potential discharges to the environment. In addition, NJDEP requires reporting and remediation of any chemical spills. Monitoring and remediating spills at Site 4-1 may be more difficult than at the PSEG Site due to the presence of fractured rock at Site 4-1 and the potential use of the uppermost aquifer as a source of drinking water. Based on the use of BMPs and NJDEP remediation requirements, the review team concludes that the effect on groundwater quality of inadvertent chemical spills would be localized, temporary, and minor.

Operational Impacts

During operation of a new nuclear power plant at Site 4-1, surface water withdrawn from the Delaware River would be used to provide makeup water to the plant circulating water system (CWS). The blowdown from the plant and other wastewater streams would be discharged to the Delaware River. PSEG has stated that DRBC has indicated that Site 4-1 is not located in any declared critical areas for water use and that there are no unconditional restrictions to obtaining the water allocation needed for a new nuclear power plant (PSEG 2012-TN2113). PSEG has also stated that water allocations in the Delaware River Basin are not made based on prior water rights but are based on equitable apportionment under which PSEG would have to demonstrate that the withdrawal would not result in adverse impact to the resource or to nearby users (PSEG 2012-TN2113). The review team's independent assessment of the DRBC rules related to water allocation in the basin confirmed that there were no restrictions on a possible allocation of new withdrawals from the Delaware River for a new nuclear power plant at Site 4-1.

As discussed above, because the Delaware River water in the vicinity of Site 4-1 is fresh, the CWS cooling towers would operate at three cycles of concentration rather than the one and a-half cycles of concentration appropriate for the brackish water that would be used at the PSEG Site. Assuming that the 210 gpm of average groundwater use at the PSEG Site would be satisfied at Site 4-1 by withdrawals from the Delaware River, the required freshwater withdrawal for Site 4-1 would be 40,510 gpm (90.3 cfs), 40,300 gpm for the CWS and 210 gpm for other plant needs. Assuming that the 210 gpm for non-CWS needs would be entirely consumed, the consumptive use at Site 4-1 would be 26,630 gpm (59.3 cfs), 26,420 gpm for the CWS and 210 gpm for other plant needs. Because the water withdrawn for a new nuclear power plant at Site 4-1 would be freshwater, the amount PSEG would need to offset to meet instream flow targets under a DRBC-declared drought would be the same as the total consumptive use: 26,630 gpm (59.3 cfs).

Because brackish water consumptive use has a lesser impact on salinity intrusion than an equal consumptive use of freshwater, the DRBC has developed an equivalent impact factor (EIF) to account for the difference (DRBC 2005-TN3376). The EIF for the PSEG Site was determined to be 0.18 (PSEG 2015-TN4280). As discussed in Section 5.2.2.1, if a new nuclear power plant were built at the PSEG Site, PSEG estimated that during a declared drought its currently permitted allocation in the Merrill Creek reservoir of 6,695 ac-ft would fall short by 465 ac-ft (6.9 percent) of the volume required to support the operations of all PSEG-owned power plants, including a new nuclear power plant. Because the Delaware River water in the vicinity of Site 4-1 is fresh and not brackish, the review team applied the 0.18 EIF to estimate the shortfall in the PSEG Merrill Creek allocation if a new nuclear power plant were built and operated at Site 4-1. The review team determined that the shortfall would increase from 465 ac-ft to more than 2,583 ac-ft (465 ac-ft divided by 0.18). (The actual shortfall would be slightly more than this because this calculation does not include the 210 gpm used for non-CWS plant operations.) This shortfall would be at least 39 percent of the current PSEG Merrill Creek allocation.

Consumptive use of Delaware River water at Site 4-1 to support operation of a new nuclear power plant would be about 3.5 percent of the 7Q10, as presented in Table 9-9. The review team determined that although this withdrawal from the Delaware River near Site 4-1 would have a minimal impact, operating a new nuclear power plant at Site 4-1 would require PSEG to obtain an additional 39 percent of its current allocation in the Merrill Creek reservoir to meet instream flow targets if PSEG continued operations at all its power plants during a DRBC-declared drought. This additional allocation would have to be acquired from existing owners of Merrill Creek reservoir's storage or by significantly revising consumptive use allocations among other PSEG plants. The review team determined that PSEG acquisition of an additional 39 percent of its current allocation in Merrill Creek reservoir would likely result in a noticeable impact to existing water allocations in the Delaware River Basin.

The review team agrees with the PSEG evaluation that use of groundwater to support plant operations is unlikely, considering the relatively close proximity of the Delaware River (5 mi) and the widespread use of the Newark Basin aquifers for public and private water supplies.

A new nuclear power plant at Site 4-1 would discharge its wastewater effluent to the Delaware River. PSEG did not provide an analysis of the effects of this discharge on the Delaware River. The review team assumed that the water-quality parameters of the discharge would be similar

to those estimated for the PSEG Site. Because the Delaware River is not affected by tidal action near Site 4-1, the discharged effluent would spread downstream from the discharge point. If a new nuclear power plant were built and operated at Site 4-1, PSEG would have to provide a comprehensive analysis of the effects of the effluent discharge to NJDEP and DRBC. Discharges from a new plant would be permitted under a New Jersey Pollutant Discharge Elimination System (NJPDES) permit, which would set limits on effluent concentrations that would be protective of the environment. This discharge permitting process is similar to what would be needed at any industrial facility, including the discharge permitting process at the PSEG Site. Discharges at Site 4-1 would also be subject to DRBC regulations governing discharges to Special Protection Waters. The review team concludes, based on the history of the NJPDES permitting process, that the impacts to surface-water quality from operations of a new nuclear power plant at Site 4-1 could be limited in magnitude and extent and would be minor.

Groundwater quality could be impacted by nonroutine chemical spills that may migrate to shallow groundwater. BMPs would be used during operations to minimize potential impacts of chemical spills on groundwater quality. If a spill occurs, NJDEP requires reporting and remediation to minimize or prevent groundwater impacts. Monitoring and remediating spills at Site 4-1 may be more difficult than at the PSEG Site because of the presence of fractured rock at Site 4-1 and the potential use of the uppermost aquifer as a source of drinking water. Considering these factors, the review team concludes the impacts to groundwater quality would range from minor to noticeable.

Cumulative Impacts

In addition to water-use and water-quality impacts from building and operations activities, this cumulative analysis considers past, present, and reasonably foreseeable future actions that could affect the same water resources.

As discussed in Section 7.2, the review team is aware of the potential climate changes that could affect the water resources available for cooling and the potential impacts of reactor operations on water resources for other users. Though Site 4-1 is not located in the same physiographic province as the proposed PSEG Site, the potential changes in climate would nonetheless be similar (GCRP 2014-TN3472). Therefore the review team concludes that the impact of climate change on water resources would be similar to that for the PSEG Site.

<u>Cumulative Water-Use Impacts</u>

The geographic area of interest for surface water is the Delaware River Basin. As stated in Section 7.2.1.1, the Delaware River Basin has a long history of water use by the “basin states” (New York, New Jersey, Pennsylvania, and Delaware). DRBC is responsible for protecting water quality, allocating and permitting water supply, conserving water resources, managing drought, reducing flood losses, and developing recreation in the basin (DRBC 2013-TN2366). Surface water from the Delaware River has been extensively used in the past. To better manage the surface-water resources of the Delaware River Basin, the governors of the four basin states in 1999 directed the development of a comprehensive water resources plan (DRBC 2004-TN2278). This goal-based plan was developed to manage the quantity and quality

of basin water for sustainable use, reduce flood losses, improve recreation, and protect riparian and aquatic ecosystems, among other goals. Based on a review of the history of water-use and water-resources planning in the Delaware River Basin, the review team determined that past and present use of the surface waters in the basin has been noticeable.

None of the specific projects listed in Table 9-8 is expected to result in significant consumption of water. As stated previously, the water-use impacts from building a new nuclear power plant at Site 4-1 would be minor, but the water-use impacts from operation of a new plant at Site 4-1 would be noticeable. Therefore, the review team concluded that the cumulative surface-water-use impact because of past and present actions and building and operating a new nuclear power plant at Site 4-1 would be MODERATE and that the incremental contribution of a new nuclear power plant to this impact would be a significant contributor to the cumulative impact.

The primary past and present activity potentially affecting groundwater use in the region is the widespread withdrawal of groundwater. Unlike groundwater use in the New Jersey Coastal Plain aquifer system, however, the use of groundwater in the Newark Basin has not resulted in widespread reductions in groundwater elevations such as seen in Water Supply Critical Area 2. This is likely due to the occurrence of groundwater in the Newark Basin in discrete fracture zones that are not well connected across large distances (Barton et al. 2003-TN3225). Under these conditions, wells can be located to minimize impacts on other groundwater users (Trapp and Horn 1997-TN1865). In addition, as described above, it is unlikely that a new nuclear power plant at Site 4-1 would use groundwater to support either construction or operation. Therefore, the review team concluded that the cumulative groundwater-use impact from past and present actions and from building and operating a new nuclear power plant at Site 4-1 would be SMALL.

Cumulative Water-Quality Impacts

As stated in Section 7.2.2.1, DRBC has implemented careful planning and regulation of surface-water quality in the Delaware River Basin. Although there have been improvements in water quality (e.g., improved levels of dissolved oxygen in the Delaware River Basin because of careful planning and management policies put in place by DRBC), the presence of toxic compounds leads to advisories for fish consumption (DRBC 2008-TN2277). The review team concluded that past and present actions in the Delaware River Basin have resulted in noticeable impacts to water quality, which has prompted careful planning and management of the quality of the river waters. The projects listed in Table 9-8 may result in alterations to land surface, surface-water drainage pathways, and water bodies within which limited building activities could occur. These projects would need Federal, State, and local permits that require implementation of BMPs. Because of the Special Protection Waters designation, discharges to the Delaware River in the area of Site 4-1 are subject to DRBC's anti-degradation regulations. Therefore, the impacts to surface-water quality from these projects are not expected to be noticeable.

As stated previously, the incremental impacts to surface-water quality from operation of a new nuclear power plant at Site 4-1 would be minor. Therefore, the review team concludes that the cumulative impact on water quality in the Delaware River Basin would be MODERATE, and that the incremental contribution of a new nuclear power plant to this impact would not be a significant contributor to the cumulative impact.

Past and present activities affecting shallow groundwater quality in the Newark Basin include urbanization, industrial activities, and agriculture (Serfes et al. 2007-TN3219). However, there is no indication that the quality of groundwater in the area of Site 4-1 has been noticeably affected by these, or any of the other projects and activities listed in Table 9-8. In addition, as described above, it is unlikely that a plant at Site 4-1 would use groundwater to support either construction or operation. Therefore, the review team concluded that the cumulative groundwater-quality impact from past and present actions and from building and operating a new nuclear power plant at Site 4-1 would be SMALL.

9.3.2.3 Terrestrial and Wetland Resources

The following analysis includes potential impacts to terrestrial and wetland resources resulting from building activities and operations associated with a new nuclear power plant on Site 4-1. The analysis also considers other past, present, and reasonably foreseeable future actions that may impact terrestrial and wetland resources, including the other Federal and non-Federal projects listed in Table 9-8.

Site Description

Site 4-1 is located in Hunterdon County, New Jersey. This is a flat greenfield site located about 5 mi east of the Delaware River, which would act as the primary water source. The elevations on this site range from 540 to 640 ft above MSL. The site has a total area of about 1,128 ac (PSEG 2015-TN4280).

Site 4-1 is located in the Southern Highlands Zone of the Skylands Landscape Region. The dominant habitats in the Southern Highlands are agricultural fields and pastures. Highly fragmented forest habitat exists mainly in small patches interspersed with agricultural land and developed areas. There are wetlands scattered throughout the zone, with many having been disturbed by human activity. The Delaware River floodplains provide important habitat for migrating birds. The terrestrial species of concern in the Southern Highlands Zone are primarily found in wetland, forest, or grassland habitats (NJDEP 2008-TN3117).

The ecological conditions for Site 4-1 are similar to those described above for the Southern Highlands. Most of the land is in agriculture and forested areas consisting mainly of scattered woodlots and tree-lined stream corridors. The forest would provide daytime habitat for large mammals such as white-tailed deer (*Odocoileus virginianus*) and smaller mammal species. Additionally, forest habitat would provide nesting habitat for avian species. Wetlands are mainly present in isolated low areas, and some are farmed. There are virtually no grasslands in this area. Offsite corridors for access roads, the rail spur, and water pipelines are largely restricted to the immediate 6-mi vicinity, and the natural habitats within these corridors are similar to those found on Site 4-1 (PSEG 2015-TN4280).

Federally and State-Listed Species

No site-specific surveys for threatened and endangered species were conducted at Site 4-1. Information on protected and rare species that may occur in the area of Site 4-1 was obtained from NJDEP and the U.S. Fish and Wildlife Service (FWS) Environmental Conservation Online System (ECOS). The bog turtle (*Clemmys muhlenbergii*) (Federally listed as threatened),

Indiana bat (*Myotis sodalis*) (Federally listed as endangered), and northern long-eared bat (*Myotis septentrionalis*) (Federally listed as threatened) are the only Federally listed species that could occur in Hunterdon County and have the potential to occur on Site 4-1. The NJDEP endangered and threatened species list includes all Federally listed species as endangered. In addition, 5 State-listed endangered species, 9 State-listed threatened species, and 60 species listed by NJDEP as species of concern in the Southern Highlands Zone may occur in the area of Site 4-1 (FWS 2014-TN3333; NJDEP 2008-TN3117).

A total of 13 listed animal species and one listed plant species have been recorded within about 1 mi of Site 4-1 (Table 9-10). Also, the nearby Lockatong Wildlife Management Area (WMA) has records for two additional State-listed bird species, the American kestrel (*Falco sparvenius*) and the grasshopper sparrow (*Ammodramus savannarum*) (PSEG 2012-TN2389). None of the species recorded was Federally listed as endangered or threatened. Documentation of the actual presence of any of these species on the site and along offsite corridors would require that detailed field surveys be conducted.

Table 9-10. State and Federal Threatened, Endangered, and Rare Species Recorded in the Site 4-1 Area

Common Name	Scientific Name/Description	State or Regional Status-Rank	Federal Status
Plants			
Bush's Sedge	*Carex bushii*	E	
Birds			
Bobolink	*Dolichonyx oryzivorus*	T[(a)]/SC[(b)]	
Eastern Meadowlark	*Sturnella magna*	SC[(a,b)]	
Great Blue Heron	*Ardea herodias*	SC[(a)]	
Red-Shouldered Hawk	*Buteo lineatus*	E[(b)]/SC[(b)]	
Savannah Sparrow	*Passerculus sandwichensis*	T[(a)]	
Veery	*Catharus fuscescens*	SC[(a)]	
Vesper Sparrow	*Pooecetes gramineus*	E[(a)]/SC[(b)]	
Wood Thrush	*Hylocichla mustelina*	SC[(b)]	
Amphibians			
Long-Tailed Salamander	*Eurycea longicauda longicauda*	T	
Northern Spring Salamander	*Gyrinophilus porphyriticus porphyriticus*	SC	
Reptiles			
Eastern Box Turtle	*Terrapene carolina carolina*	SC	
Wood Turtle	*Glyptemys insculpta*	T	
Mammals			
Bobcat	*Lynx rufus*	E	

(a) Breeding
(b) Nonbreeding
Abbreviations
E = endangered species
T = threatened species
SC = special concern

Source: PSEG 2015-TN4280.

Wildlife Sanctuaries, Refuges, and Preserves

There are several areas that qualify as wildlife sanctuaries, refuges, and preserves within the 6-mi vicinity of Site 4-1 (Figure 9-4) that have the potential to be affected by building and operating a new nuclear power plant at Site 4-1 (PSEG 2012-TN2389). These areas include parks, WMAs, preserves, and greenways. The Southern Highlands have a limited number of publicly available lands (NJDEP 2008-TN3117). A brief description of these areas is given below.

<u>Delaware and Raritan Canal State Park</u>

The Delaware and Raritan Canal State Park is a 6,595-ac state park managed by the NJDEP Division of Parks and Forestry (State Park Service). This 70-mi-long park is one of central New Jersey's most popular recreational corridors for canoeing, jogging, hiking, bicycling, fishing, and horseback riding. The canal and the park are part of the National Recreational Trail System. The park is also a valuable wildlife corridor, connecting field and forest habitat. During a recent bird survey conducted in the park, 160 species were recorded, almost 90 of which nested within the park (NJDEP 2013-TN3118).

<u>Lockatong Wildlife Management Area</u>

Lockatong is a 583-ac WMA in Franklin and Kingwood Townships along Lockatong Creek. The main habitats on the site are deciduous upland forest, deciduous wetland forest, and open field. According to landscape mapping done by NJDEP, the WMA provides habitat for the State threatened American kestrel, savannah sparrow (*Passerculus sandwichensis*), grasshopper sparrow, and bobolink (*Dolichonyx oryzivorus*) (PSEG 2012-TN2389).

<u>Hoffman Park</u>

Hoffman Park covers 354 ac and contains a mix of hardwood forest, grasslands, and 32 ponds of various sizes. The onsite ponds were created in the 1940s for erosion control, crop irrigation, and cattle management at a time when the park was a working farm. Paved and gravel paths at the park provide opportunities for bike riding and walking. The ponds provide opportunities for fishing and nature study. The paths are also used for cross-country skiing in the winter. Hunting is also allowed in the park during designated seasons (PSEG 2012-TN2389).

<u>Plum Brook Greenway</u>

This greenway was partially preserved through a partnership with the New Jersey Water Supply Authority, Hunterdon County, Delaware Township, and the NJDEP Green Acres program. The property is 260 ac. An almost half-mile corridor is protected along Plum Brook, which is a tributary to Wickecheoke Creek, identified by NJDEP as a waterway of the highest quality. The greenway consists of a combination of riparian woodlands and managed shrubland. Plum Brook flows into the Delaware and Raritan Canal, and the preservation of the greenway aids in the protection of drinking water quality in the area (PSEG 2012-TN2389).

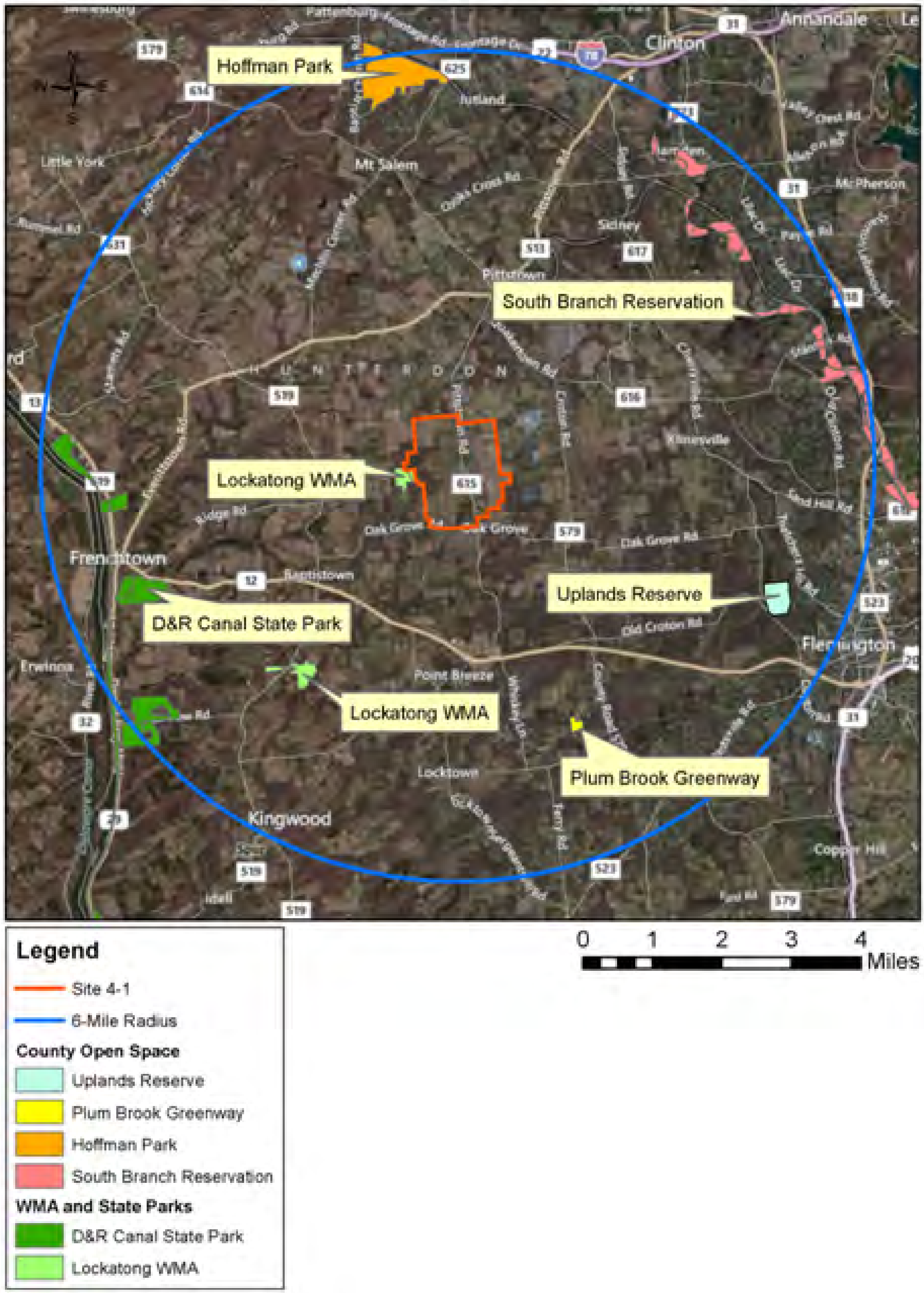


Figure 9-4. Wildlife Sanctuaries, Refuges, and Preserves Within the 6-mi Vicinity of Alternative Site 4-1 (Source: PSEG 2015-TN4280)

South Branch Reservation

The South Branch Reservation is over 1,000 ac in size and is located in Clinton, Franklin, Raritan, and Readington Townships. The reservation aids in the protection of the South Branch of the Raritan River. It is also a popular fishing spot, and the river is stocked with rainbow (*Oncorhynchus mykiss*), brook (*Salvelinus fontinalis*), and brown trout (*Salmo trutta*) (PSEG 2012-TN2389).

Uplands Preserve

This 101-ac preserve is located in Raritan Township. The preserve contains steep slopes, open fields, and hardwood forests. Walnut Brook flows through the preserve, which was originally a farm and estate. The property was acquired by Hunterdon County in 1986 (PSEG 2012-TN2389).

Building Impacts

Building a new nuclear power plant on Site 4-1 would directly disturb about 401 ac of land (permanently and temporarily). A total of about 727 ac of land within the site boundaries would not be directly disturbed. However, certain building activities would result in indirect disturbance (noise, dust, etc.) to much of the area within the site boundaries. This could result in additional wildlife impacts in terms of affecting movements and causing further displacement from the site. The development of the access road, rail spur, and water pipeline corridors would result in the additional disturbance of about 268 ac of potential habitat. In total, about 1,396 ac of potential habitat would be directly or indirectly impacted by building activities on Site 4-1. The plant footprint would disturb about 323 ac of planted/cultivated land, 6.9 ac of developed land, 47 ac of barren land, 12 ac of forest land, and 2 ac of freshwater forested/shrub wetland (PSEG 2015-TN4280).

A new 1.1-mi transmission line corridor would be required to connect Site 4-1 to the SRERP constructed by PPL and PSEG in northern New Jersey. This 500-kV transmission line and associated corridor would encompass about 100 ac of offsite land. The total acreage includes about 79 ac of planted/cultivate land, less than 1 ac of developed land, about 3 ac of barren land, 16 ac of forest, and 0.4 ac of other wetland (PSEG 2015-TN4280).

The amount of habitat that would be potentially impacted by building activities on Site 4-1 is minor compared to the acreage of similar habitat present in the 6-mi vicinity. Habitat in the 6-mi vicinity includes about 43,671 ac of planted/cultivated land, 6,535 ac of developed land, 4,759 ac of barren land, 35,232 ac of forestland, 636 ac of freshwater emergent wetlands, 5,175 ac of freshwater forested/shrub wetland, and 1,357 ac of other wetlands (PSEG 2015-TN4280). In addition, onsite habitat is generally limited to areas that are relatively small and isolated from larger areas of habitat in the 6-mi vicinity. Therefore, the impacts on terrestrial and wetland habitats due to building activities are expected to be negligible.

There is the potential for impacts to open country bird species (e.g., bobolink, eastern meadowlark [*Sturnella magna*], grasshopper sparrow, and vesper sparrow [*Pooecetes gramineus*]) and those that frequent smaller woodlots. Fragmentation and loss of forested

areas could also potentially impact more area-sensitive species such as red-shouldered hawk (*Buteo lineatus*), northern long-eared bats, and wood thrush (*Hylocichla mustelina*). Inadvertent impacts to slower moving species (e.g., eastern box turtle [*Terrapene carolina carolina*]) are also a possibility. Such impacts would be expected to be minor for most species due to the relatively minimal impacts to natural habitats and the fact that there are extensive areas of similar habitats in the 6-mi vicinity. However, wetland and forested areas are considered important resources for Federally listed species. The loss of about 92 ac of wetlands and 220 ac of forest could affect the Federally listed bog turtle, Indiana bat, and northern long-eared bat. Impacts to these species could warrant mitigation. Therefore, impacts to these listed species as a result of building a new nuclear power plant at Site 4-1 would be expected to be noticeable, but not destabilizing.

It is expected that a project of this size would result in impacts to terrestrial and wetland resources, including habitat loss, fragmentation, and disturbance. Building a new nuclear power plant would result in the loss of available onsite habitat. Noise, lights, and dust during construction activities may further displace species in adjacent areas, thereby further reducing viable habitat. Less mobile wildlife species would likely be the most impacted species with the development of a new plant. It is expected that most wildlife species would be capable of moving to habitat in adjacent areas. These displaced species may also experience impacts resulting from loss of habitat acreage and increased competition for more limited resources. Adjacent WMAs, preserves, and refuges could be affected by increased demand for limited resources as a result of species displacement. The available habitat at Site 4-1 is common to Hunterdon County, and sufficient resources exist in the Southern Highlands. However, the loss of wetland and forest habitat that is important to Federally listed and proposed Federally listed species would be noticeable. Thus, the review team has determined that the impacts to terrestrial and wetland resources from building a new nuclear power plant at Site 4-1 would be noticeable, but not destabilizing.

Operational Impacts

Potential impacts to terrestrial and wetland resources that may result from operation of a new nuclear power plant at Site 4-1 include those associated with cooling towers, transmission system structures, maintenance of transmission line ROWs, and the presence of project facilities that permanently eliminate habitat (PSEG 2015-TN4280). Operational impacts would be similar to those described in Section 5.3.1, although there may be minor differences as a result of topography, climate, and elevation. The review team has determined that the operational impacts to terrestrial and wetland resources at Site 4-1 would be minimal.

Cumulative Impacts

Several past, present, and reasonably foreseeable projects could affect terrestrial and wetland resources in ways similar to siting a new nuclear power plant at Site 4-1. Table 9-8 lists these projects, and descriptions of their contributions to cumulative impacts to terrestrial and wetland resources are provided below.

The Southern Highlands have seen extensive agricultural development and much of the remaining natural habitat is highly fragmented and exists in small patches surrounded by urban

development and agriculture. Forested ravines and floodplain forests exist along the Delaware River and tributaries. Scattered emergent wetlands have been impacted by human activities and development (NJDEP 2008-TN3117). Very little publicly owned land exists in this region, and the WMAs and parks listed in Table 9-8 are not expected to contribute to further adverse impacts to terrestrial and wetland resources.

Most of the projects listed in Table 9-8 are operational and have resulted in the conversion of natural areas to industrial and commercial development. These past actions have resulted in loss and/or fragmentation of natural habitat and displacement of wildlife. These projects include one operational nuclear power plant (Limerick Generating Station). Additionally, there are three operational fossil-fuel facilities. The development and operation of these projects would continue to reduce, fragment, and degrade natural forest, open field, and wetland habitats in the Southern Highlands. Operational projects with tall structures, such as the cooling towers at Limerick Generating Station, would cause avian and bat mortalities. However, the projects listed are spread throughout the region, and avian and bat mortalities as a result of collision with tall structures would not cause a noticeable effect on avian or bat populations.

Future residential development and further urbanization of the area would result in the continued increase in fragmentation and loss of habitat. The New Jersey Department of Labor and Workforce Development (NJLWD) projected that the population of Hunterdon County would increase by about 6.8 percent between 2010 and 2030 (NJLWD 2014-TN3332). Future urbanization in the area of Site 4-1 could result in further losses of agricultural lands, wetlands, and forested areas. Urbanization in the vicinity of Site 4-1 would reduce area in natural vegetation and open space and decrease connectivity between wetlands, forests, and other wildlife habitat. The loss of habitats as a result of urbanization would result in added pressures to the remaining habitat available for wildlife populations. However, it is not expected that these activities would substantially affect the overall availability of wildlife habitat or travel corridors near Site 4-1 or the general extent of forested areas in the site vicinity.

As noted in Table 9-8, there are three energy infrastructure projects planned for or completed in the vicinity of Site 4-1 that would add to the cumulative impacts. An additional 12 mi of 42-in. pipeline in Hunterdon County will be added to support natural-gas supplies as a result of NSLP (EPA 2012-TN3125). SRERP added an additional 45 mi of transmission lines in the area, and the North Central Reliability Project added an additional 35 mi of transmission lines. These projects affected forestland, open areas, and wetland habitats and caused further habitat degradation and fragmentation in the area. Both the North Central Reliability Project and SRERP were expected to use existing ROWs to the greatest extent possible, thereby further minimizing potential impacts to terrestrial and wetland resources (PSEG 2013-TN2618; PSEG 2013-TN2617). Overall, due to their extent, these energy infrastructure projects would have the potential to have a noticeable impact on terrestrial and wetland resources when added together. It is not expected that proposed road-widening and road improvement projects planned for the area would have significant impacts on terrestrial and wetland resources. Overall, the potential for cumulative impacts from other foreseeable actions altering the terrestrial and wetland resources impact rating for Site 4-1 would be noticeable but would not destabilize terrestrial and wetland resources.

The report on climate change impacts in the United States provided by GCRP (2014-TN3472) summarizes the projected impacts of future climate changes in the United States. The report divides the United States into nine regions. Site 4-1 is located in the Northeast region. The GCRP climate models for this region project temperatures to rise over the next several decades by 4.5°F to 10°F if emissions continue or 3°F to 6°F if emissions are reduced substantially. Frequency, intensity, and duration of heat waves are projected to increase under both of the warming scenarios but with larger increases under the continuing emissions scenario. Winters are projected to be much shorter, with fewer cold days and more precipitation. With higher temperatures and earlier winter and spring snow melt, seasonal drought risk is projected to increase in summer and fall (GCRP 2014-TN3472). Increased frequency of summer heat stress can also impact crop yields and livestock productivity in the Northeast region. New Jersey is projected to experience 60 additional days above 90°F by mid-century under the continuing emissions scenario. Sea level is projected to rise more than the global average due to land subsidence, with more frequent severe flooding and heavy downpours. These projected changes could potentially alter wildlife habitat and the composition of wildlife populations. Large-scale shifts in the ranges of wildlife species and the timing of seasons and animal migration that are already occurring are very likely to continue.

The potential cumulative impacts to terrestrial and wetland resources from building and operating a new nuclear power plant on Site 4-1, in combination with the other activities described above, would noticeably alter terrestrial and wetland resources. These activities would result in the loss or modification of terrestrial and wetland habitats, which could potentially affect important species that live in or migrate through the area.

Summary

Potential impacts to terrestrial and wetland resources were evaluated based on information provided by PSEG, the conceptual layout of a new nuclear power plant at Site 4-1, and an independent review by the review team. Permanent impacts to terrestrial and wetland habitat and wildlife would result in some localized effects on these resources. Any terrestrial and wetland resources temporarily disturbed by building a new nuclear power plant are expected to return to preconstruction conditions. The potential loss of habitat important to Federally listed species would be a noticeable impact, but would not be destabilizing. Operational impacts to terrestrial and wetland resources would be similar to those of the PSEG Site. Therefore, the conclusion of the review team is that cumulative impacts on terrestrial and wetland plants and wildlife, including threatened and endangered species, and wildlife habitat would be noticeable in the surrounding landscape, and therefore MODERATE. Building and operating a new nuclear power plant at Site 4-1 would be a significant contributor to the cumulative impact.

9.3.2.4 Aquatic Resources

The following analysis evaluates the impacts from building activities and operations on aquatic ecology resources at Site 4-1. The analysis also considers cumulative impacts from other past, present, and reasonably foreseeable future actions, including the other Federal and non-Federal projects listed in Table 9-8, that could affect aquatic resources. In developing this EIS, the review team relied on reconnaissance-level information to perform the alternative site evaluation in accordance with ESRP 9.3 (NRC 2000-TN614). Reconnaissance-level information is data

that are readily available from regulatory or resources agencies (e.g., NJDEP, National Marine Fisheries Service [NMFS], and FWS) and other public sources such as scientific literature, books, and Internet websites. It can also include information obtained through site visits (NRC 2012-TN2498; NRC 2012-TN2499; NRC 2012-TN2855) and documents provided by the applicant.

Affected Environment

The affected aquatic environment consists of the Delaware River and numerous freshwater streams on and near Site 4-1. The withdrawal required from the Delaware River for the water intake structure would be 40,300 gpm because this portion of the Delaware River is freshwater and can be used at three cycles of concentration (PSEG 2015-TN4280). Under drought conditions, PSEG would need to acquire an additional 39 percent of its current Merrill Creek reserve as described in detail in Section 9.3.2.2. Reconnaissance information for Hunterdon County, New Jersey, did not suggest that any of the water resources in the area have exceptional or high ecological value. In addition, freshwater habitat would be lost in the Delaware River because of the installation of water intake and discharge structures in the vicinity of Delaware RM 163.7 in Hunterdon County (S&L 2010-TN2671). Aquatic resources in the Delaware River could be affected by operation of the closed-cycle cooling system.

Commercial/Recreational Species

There are no commercial fishery activities associated with Hunterdon County, New Jersey, waters. However, recreational angling for a number of freshwater species occurs in the Delaware River. There are numerous public boat launch sites along the nontidal Delaware River. Angling for stocked Brook Trout (*Salvelinus fontinalis*) and Rainbow Trout (*Oncorhynchus mykiss*) is popular in many small lakes and water bodies within Hunterdon County. In addition, fishing in the Delaware River results in catches of Smallmouth Bass (*Micropterus dolomieu*), Yellow Perch (*Perca flavescens*), Channel Catfish (*Ictalurus punctatus*), Largemouth Bass (*M. salmoides*), and crappie (*Pomoxis* spp.). Fish consumption advisories are updated regularly for fish caught in New Jersey tributaries and for the Delaware River. Hunterdon County had restrictions on fish consumption for Channel Catfish, Striped Bass (*Morone saxatilis*), American Eel (*Anguilla rostrata*), White Sucker (*Catostomus commersonii*), Largemouth Bass, and Smallmouth Bass caught in the Delaware River in 2012 (NJDEP 2013-TN2368).

Non-Native and Nuisance Species

The Northern Snakehead (*Channa argus*) prefers stagnant waters (shallow ponds, swamps) and slow streams and has a wide temperature tolerance. Northern Snakehead have been observed in tributaries of the Delaware River beginning in 2009 (USGS 2012-TN2201). Flathead Catfish (*Pylodictis olivaris*) are reported to occur in the Delaware River Basin, primarily in the main stem of the Delaware River (NJDEP 2012-TN2185). More recently, Northern Snakehead are being reported further up the Delaware River and its tributaries and are becoming more of a concern for the Delaware River Basin (DeRitis 2013-TN2854). In freshwaters, water chestnut (*Trapa natans*) forms dense mats that create difficulty in accessing water resources for recreation and is a common nuisance species in New Jersey waters (NJDEP 2013-TN2367). Chinese pond mussel (*Sinanodonta woodiana*) has recently been reported in Hunterdon County where it prefers eutrophic ponds to slow running streams and

rivers, and uses carp species as a fish host (NJISST 2011-TN2679). Recently, an invasive diatom species, didymo, or "rock snot" (*Didymosphenia geminata)* has become more prevalent in the Delaware River from north of Site 4-1 south to Trenton, New Jersey. Didymo forms thick mats that quickly colonize riverbed habitats and alter the physical and biological conditions of a stream to inhibit growth of native algae and other beneficial species that support the food chain (DRBC 2013-TN3279).

Federally and State-Listed Species

There are no critical habitats designated by NMFS or FWS in the vicinity of Site 4-1 (NMFS 2013-TN2614; FWS 2013-TN2147). Based on reconnaissance information, there may be one Federally listed endangered aquatic species within a 1-mi radius of the Site 4-1 intake (NJDEP 2013-TN2722). Shortnose Sturgeon (*Acipenser brevirostrum*) have been traditionally reported as far upriver as Delaware RM 147, but typically overwinter in the Delaware River around RM 131.6 near Trenton, New Jersey (Hastings et al. 1987). However, records from the State of New Jersey indicated sightings of Shortnose Sturgeon within 1 mi of the water intake location for Site 4-1 (RM 163.7) (NJDEP 2013-TN2722). There are several freshwater mussel species listed as endangered or threatened by the State of New Jersey in Hunterdon County; they are included in Table 9-11 and described below. One State-listed threatened freshwater mussel species, the yellow lampmussel (*Lampsilis cariosa*), is known to occur within a 1-mi radius of the Site 4-1 intake (NJDEP 2013-TN2722). There are no State-listed occurrences of aquatic species within a 1-mi radius of the Site 4-1 location (NJDEP 2013-TN3567).

Table 9-11. Federally and State-Listed Aquatic Species in Hunterdon County, New Jersey, Near the Proposed Location of Water Intake and Discharge Structures

Scientific Name	Common Name	Federal Status	New Jersey Status
Acipenser brevirostrum	Shortnose Sturgeon	Endangered	Endangered
Alasmidonta varicosa	Brook floater		Endangered
Leptodea ochracea	Tidewater mucket		Threatened
Alasmidonta undulata	Triangle floater		Threatened
Lampsilis cariosa	Yellow lampmussel		Threatened

Source: NJDEP 2012-TN2186; 2013-TN2722.

<u>Brook Floater</u>

The brook floater (*Alasmidonta varicosa*) ranges from South Carolina to the St. Lawrence River Basin in Canada and prefers rapids or riffles over rock and gravel substrates that are found in small streams in the upper Delaware River Basin in New Jersey (NJDEP 2013-TN2188). Potential fish host species include the Pumpkinseed (*Lepomis gibbosus*), Golden Shiner (*Notemigonus crysoleucas*), and Longnose Dace (*Rhinichthys cataractae*). Brook floater are reported to occur in Hunterdon County, New Jersey, and are listed as a State endangered species (Cordeiro and Bowers-Altman 2003-TN2131; NJDEP 2012-TN2186).

Tidewater Mucket

The tidewater mucket (*Leptodea ochracea*) is found in New Jersey in Delaware River-associated tidewaters in sand and silt substrates. The host fish species may be the White Perch (*Morone americana*) (Cordeiro and Bowers-Altman 2003-TN2131). The tidewater mucket is State-listed as threatened in New Jersey (NJDEP 2012-TN2186) and occurs in Atlantic, Burlington, Camden, Cumberland, Hunterdon, Mercer, and Salem Counties in New Jersey (Cordeiro and Bowers-Altman 2003-TN2131; NatureServe 2012-TN2182).

Triangle Floater

The triangle floater (*Alasmidonta undulata*) has been found in a variety of habitats including silt/sand in slower moving waters, gravel/sand in riffles and runs, and crevices in bedrock. Because the triangle floater is found in a variety of habitats, it is assumed the fish hosts of the triangle floater are also variable and diverse (NJDEP 2013-TN2188). The triangle floater is listed as threatened in New Jersey (NJDEP 2012-TN2186) and occurs primarily in northern New Jersey counties which include Hunterdon County (NatureServe 2012-TN2183).

Yellow Lampmussel

Yellow lampmussel (*Lampsilis cariosa*) inhabit sand and silt substrates along shorelines and margins in both large rivers and small streams. This species spawns in the summer and the Alewife (*Alosa pseudoharengus*) has been suggested as the host fish for the yellow lampmussel; however, there may be other freshwater hosts (NJDEP 2013-TN2188). The yellow lampmussel is State-listed as threatened in New Jersey (NJDEP 2012-TN2186) and has been documented to occur in Hunterdon County near the proposed water intake site (NJDEP 2013-TN2722).

Field studies would be required to definitively determine whether any rare or protected species are present in streams in the project area or nearby Delaware River.

Building Impacts

Installation of the water intake structure and the discharge structure would result in a loss of habitat in the Delaware River and temporary degradation of water quality because of turbidity and sedimentation. Effects on aquatic organisms are expected to be minimal and temporary because adjacent habitat is accessible, and mobile aquatic organisms such as fish would be able to move away from the affected area during dredging and in-water installation activities. There would be some permanent loss of onsite aquatic stream habitat from the building of project structures and in the installation of pipelines to and from the Delaware River for the water intake and discharge structures. Dredging would disturb about 2 ac of bottom habitat in the Delaware River and would remove about 35,000 yd^3 of dredged material (S&L 2010-TN2671). Because barge access is not possible in the Delaware River near Site 4-1, no barge facilities would be developed (PSEG 2015-TN4280). Building impacts to streams and the Delaware River would be regulated under Federal, State, and local permits and would be expected to be minimized and mitigated through the use of BMPs.

A total of 2,946 ft of freshwater streams would be affected by building activities on the site and for building the access roads and rail spur and installing water pipelines (PSEG 2015-TN4280). In addition to buildings and other structures, buried water intake and discharge pipes would run 6.6 mi from the Delaware River to the site. The total length of streams that would be affected by building on Site 4-1 represents 0.1 percent of the total length of streams within 6 mi of the site. In addition, an estimated 533 ft of streams are contained in a new 1.1-mi-long transmission corridor and a switchyard (representing less than 0.1 percent of the total stream lengths in the area) (S&L 2010-TN2671), but in most cases impacts to streams from transmission line installation could be avoided (PSEG 2015-TN4280). Therefore, the impact on aquatic ecology of the Delaware River and streams on the site and in pipeline and transmission corridors during building activities would be minimal.

Operational Impacts

During operation of a new nuclear power plant at Site 4-1, there would be no direct discharges and few impacts to small freshwater streams on the site. Operation of the cooling and service water systems would require water to be withdrawn from and discharged back to the Delaware River. Aquatic impacts associated with impingement and entrainment of aquatic biota in the Delaware River and discharge of cooling water to the Delaware River could occur. Because the specifications associated with the water intake structure include a closed-cycle cooling system designed to meet EPA Phase I regulations for new facilities (66 FR 65256-TN243), the maximum through-screen velocity at the water intake structure would be less than 0.5 fps. Thus, if a new nuclear power plant is built and operated at Site 4-1, the anticipated impacts to aquatic communities from impingement and entrainment in the Delaware River are expected to be minimal. Operational impacts associated with water quality and discharge cannot be determined without additional detailed analysis. However, based on the review team's experience with other facilities, the review team concludes that, with proper design, the impacts on aquatic resources from operation of a new nuclear power plant at Site 4-1 would be minimal. Maintenance activities on the site and in offsite corridors would follow BMPs required by Federal and State permits to minimize impacts on aquatic resources. Consequently, impacts on aquatic ecology due to project operations at Site 4-1 are expected to be minor.

Cumulative Impacts

The geographic area of interest for aquatic resources is the Delaware River and numerous freshwater streams on and near Site 4-1. Past alteration and degradation of the Delaware River, as described in Sections 2.4.2.1 and 7.3.2, have had long-term noticeable and sometimes destabilizing consequences on the aquatic resources within the Delaware River Basin and continue to be the subject of numerous restoration activities in targeted portions of the area. For assessment of cumulative impacts for Site 4-1, the ROI includes a 6-mi radius of water resources around the site and a 6-mi radius around the point of the water intake and discharge structures on the Delaware River.

New transmission lines to connect to the SRERP lines in the region could affect stream habitat within the new transmission corridor (NPS 2012-TN2676). Corridor development and installation of transmission structures would require BMPs to protect water quality and minimize effects to aquatic habitats that may be at risk from clearing activities, runoff, and bank erosion.

The projects listed in Table 9-8 may result in alterations to surface-water drainage pathways and water bodies. Anthropogenic activities such as residential or industrial development near the vicinity of a new nuclear power plant could present additional constraints on aquatic resources. It is not expected that these projects would have noticeable effects on water quality within the vicinity because these projects would need Federal, State, and local permits that require implementation of BMPs. The review team is also aware of the potential for climate change to affect aquatic resources. The potential impacts of climate change on aquatic organisms and habitat in the geographic area of interest are not precisely known. In addition to rising sea levels, climate change could lead to regional increases in the frequency and intensity of extreme precipitation events, increases in annual precipitation, and increases in average temperature (GCRP 2014-TN3472). Such changes in climate could alter aquatic community composition on or near Site 4-1 through changes in species diversity, abundance, and distribution. Elevated water temperatures, droughts, and severe weather phenomena could adversely affect or severely reduce aquatic habitat, but specific predictions of aquatic habitat changes in this region due to climate change are inconclusive at this time. The level of impact resulting from these events would depend on the intensity of the perturbation and the resiliency of the aquatic communities.

Summary

Impacts on aquatic ecology resources are estimated based on the information provided by PSEG, the State of New Jersey, and the review team's independent review. Properly siting the associated transmission line and switchyard; avoiding habitat for protected species; minimizing interactions with water bodies and watercourses along the corridors; and use of BMPs during water intake and discharge structure installation, transmission line corridor preparation, and tower placement would minimize building and operation impacts. The review team concludes that the cumulative impacts on most aquatic resources, including Federally and State threatened and endangered species, in the region of building and operating a new nuclear power plant at Site 4-1, combined with other past, present, and future activities, would be MODERATE, but the incremental contribution from building and operating a new plant at Site 4-1 would not be a significant contributor to the cumulative impact.

9.3.2.5 Socioeconomics

The economic impact areas for Site 4-1 are Hunterdon County in New Jersey and Bucks County in Pennsylvania. The site is located in Hunterdon County, about 5 mi east of the Delaware River. Hunterdon County is part of the Philadelphia-Camden-Wilmington, PA-NJ-DE-MD, Metro Area. The site is about 50 mi west of Newark, New Jersey, and about 50 mi north of Philadelphia, Pennsylvania.

Because of the geographical location of the site, members of the workforce at a new plant that would be drawn from the region may live elsewhere within the metropolitan statistical area (MSA). However, the review team expects that most of the in-migrating construction and operations workers would likely relocate in the economic impact area counties. Impacts beyond these counties are not likely to be significant in any single jurisdiction, because the number of in-migrating workers within any single jurisdiction outside of the economic impact area would be minor. Therefore, this analysis focuses on the economic impact area counties.

Physical and Aesthetic Impacts

Physical impacts include impacts on workers and the general public, noise, air quality, buildings, roads, and aesthetics. The physical impacts on workers would be similar to those described for the PSEG Site. The primary differences would be due to the presence of the Hope Creek Generating Station (HCGS) and Salem Generating Station (SGS) workforces on the PSEG Site.

About 100 houses are within 0.5 mi of the site boundary. The site is about 0.5 mi from an active church and 1 mi from an elementary school (PSEG 2015-TN4280). Site 4-1 would retrieve its cooling water from the Delaware River, requiring 6.6 mi of water pipeline. PSEG would also build a 6.8-mi-long rail spur and require 3.5 mi of road construction. Because the site is a greenfield site, PSEG estimates three new 500-kV transmission lines, constructed parallel to each other, would need to be constructed over 1.1 mi. PSEG indicates that the rail spur would cross the New Jersey Highlands, an area designated by the State legislature for special preservation and planning (PSEG 2010-TN257; PSEG 2015-TN4280). Aesthetic impacts from building and operations at Site 4-1 would be similar to those discussed in Sections 4.4.1.6 and 5.4.1.6. The primary differences would be due to the presence of HCGS and SGS at the PSEG Site and the proximity of the Delaware River to the PSEG Site. Because Site 4-1 is a greenfield site that would have infrastructure in previously undisturbed rural areas and a rail spur crossing the New Jersey Highlands, the review team expects the aesthetic impacts from building and operations to be noticeable and locally destabilizing.

Demography

Site 4-1 is located in Franklin Township, Hunterdon County, 4 mi east of Frenchtown and about 20 mi southeast from Bethlehem, Pennsylvania (PSEG 2010-TN257). Hunterdon County has a population of 127,351; however, the center and western portions of Hunterdon County, where the site is located, are rural (USCB 2013-TN2640). Bucks County has a population of 625,249 (USCB 2013-TN2640); however, northeast Bucks County, the area closest to the site, is sparsely populated and rural.

PSEG estimates that the size of the construction workforce needed for building activities would range from a minimum of 208 workers to a maximum of 4,100 workers. Because the site is within the New York–Northern New Jersey–Long Island, NY-NJ-PA, MSA, and due to the large workforce available in Bucks County (part of the Philadelphia-Camden-Wilmington MSA), the review team based the analysis on the assumptions presented in Section 4.4.2. About 15 percent (617 workers during peak building) would in-migrate to the region. The other 85 percent (3,483 workers) would be drawn from the existing workforce in the 50-mi region.

If a new nuclear power plant were built at Site 4-1, PSEG expects an operations workforce of 600 workers. For similar reasons as with the building workforce, the review team determined that the basis for operations workers is from Section 5.4.2. According to Section 5.4.2, 240 workers would in-migrate for operations.

The review team determined, through a gravity model of migration, that 40 percent of the in-migrating building and operations workforce would reside in Hunterdon County and 20 percent in Bucks County. The review team also expects about 10 percent of the in-migrating

workforce would reside in Somerset County, New Jersey, and 10 percent in Northampton County, Pennsylvania. However, due to the large populations of the two counties, the impact of in-migrating workers would be minor. The other 20 percent of in-migrating workers would reside throughout the 50-mi region. During peak building activities, about 246 and 123 workers would move into Hunterdon and Bucks County, respectively. During operations, 96 and 48 workers would move into Hunterdon and Bucks County, respectively. The single largest concentration of new workers would be in Raritan Township (population 22,185) in Hunterdon County, where about 11 percent of the in-migrating workers would reside (67 for peak building activities and 26 for operations activities). Assuming a household size of 2.68, about 619 people would move into the economic impact area during peak building and 241 during operations. The analysis for the building workforce is an upper bound because many of the workers live elsewhere permanently and would only stay in the economic impact area for the term of their employment at the site. The largest increase among these localities would be in Hunterdon County, with a population increase of three-tenths of 1 percent. Therefore, the review team determined the impacts of in-migrating building and operations workforces to be minimal.

Of the 3,483 workers that already live in the region, some would have been unemployed prior to building activities. In March 2013, the national unemployment rate for the construction industry was 14.7 percent (BLS 2013-TN2482). Of the workforce that would not in-migrate, the review team assumes that 512 of them would have been previously unemployed. Assuming a distribution similar to the in-migrating workforce, 40 percent of the unemployed workers would already reside in Hunterdon County, while 20 percent would already reside in Bucks County. About 204 workers would be hired in Hunterdon County and 102 in Salem County. In the economic impact area, 675 jobs would be filled between unemployed workers and in-migrating workers.

In 2011, the unemployment rate for utilities workers in New Jersey was 5.7 percent (USCB 2013-TN2640). Therefore, of the operations workforce that already lives in the region (360 workers), the review team assumed 20 would have been unemployed when hired by PSEG. Assuming the same distribution as the in-migrating workforce, 40 percent of the unemployed workers would already reside in Hunterdon County (8 workers), while 20 percent (4 workers) would already reside in the Bucks County. In the economic impact area, 156 jobs would be filled by unemployed workers (12) and in-migrating workers (144). In addition to the full-time operations workforce at Site 4-1, there would be 1,000 workers every 18 to 24 months for outages. Using similar assumptions as those in Section 5.4.2, about 70 percent of the outage workers (700 workers) would in-migrate into the economic impact area for less than a month at a time and then leave at the end of the outage. Because outages last less than a month, outage workers typically do not bring their families. The maximum size of the in-migrating workforce during operations (144 operations workers and 700 outage workers) would be about two and a-half times the in-migrating peak employment building workforce (369). Because the in-migrating building phase workforce would constitute less than one-half of 1 percent of the baseline population, the review team expects the demographic impact of in-migrating outage and operations workers to be minimal.

The review team concluded that the increase in population would not noticeably affect the demographic character of the economic impact area or any of its counties; therefore, the impact would be SMALL.

A small number of operations workers and their families would in-migrate to counties outside of the economic impact area. Their impact on any one jurisdiction would not be noticeable. The current and projected populations of the regional area are so large and the in-migrating populations so small that the in-migrating workers would represent less than 1 percent of the total population in any of the counties where these employees reside (Table 9-12). Therefore, the review team concluded the demographic impacts of operation on the remainder of the 50-mi region also would be SMALL.

Table 9-12. Estimated Population Increase in the Alternative 4-1 Site Economic Impact Area

County/ Township	Building Workforce In-migrants	Total Population Increase	Operations Workforce In-migrants	Total Population Increase	2010 Population
Hunterdon County	246	413	96	161	127,351
Raritan Township	67	112	26	43	22,185
Bucks County	123	206	48	80	625,249
Total	**369**	**619**	**144**	**241**	**752,600**

Economic and Tax Impacts

Economy

Building and operations at Site 4-1 would have a positive impact on the local and regional economy through direct employment of the workforces, purchase of materials and supplies for operation, and maintenance of the plant and any capital expenditures that occur within the region.

Using similar assumptions and analysis to Sections 4.4.3.1 and 5.4.3.1, PSEG would employ 4,100 workers during peak building, 600 full-time operations workers, and 1,000 temporary outage workers every 18 to 24 months. PSEG would spend about $47 million annually during building and $15 million annually during operation on materials and services in the economic impact area. The added employment from this spending in the economic impact area would equate to about 512 and 60 indirect jobs created during building and operations, respectively.

Although the size of the building workforce and associated payroll spending would vary depending on the building schedule and mobilization each particular year, assuming an average of 2,722 workers per year, the review team estimates that PSEG would spend an average of $142 million annually on payroll during building in 2012 dollars. At peak construction, this number rises to $214 million.

As discussed in Section 4.4.2, most of these wages would be paid to construction workers residing in the economic impact area. A total of 369 construction workers are expected to move into the economic impact area at peak construction employment. These 369 workers would receive an estimated annual total wage of $19.26 million, assuming $52,200 annual income per worker. PSEG would hire about 306 previously unemployed construction workers who would receive a total of $15.97 million in compensation. This total would be $35.23 million for the 675 newly hired workers in the economic impact area.

As discussed in Section 5.4.2, most of the wages paid during operations would go to the 156 workers who would reside in the economic impact area. A total of 144 workers are expected to move into the economic impact area for operations. These 144 workers would receive an estimated annual total wage of $13.81 million, assuming $95,869 annual income per worker. PSEG would hire about 12 previously unemployed operations workers who already reside in the area, and they would receive a total of $1.15 million in compensation. This total would be $14.96 million for the 156 newly hired workers in the economic impact area.

Given the size of the economies and workforces in the economic impact area, the review team estimated the impact of building and operations at the Site 4-1 would be minor, and positive.

Taxes

Primary tax revenues associated with building and operations activities at Site 4-1 would be from (1) State and local taxes on worker incomes, (2) State sales taxes on worker expenditures, (3) State sales taxes on the purchases of materials and supplies, (4) corporate taxes, and (5) local property taxes or payments in lieu of taxes based on the assessed value of the PSEG plant during building. Due to the tax structure discussed and analyzed in Sections 2.5.2.2, 4.4.3.2, and 5.4.3.2 of this EIS, the review team assumed similar impacts on State sales taxes on worker expenditures and on materials and supplies—both of which were minimal and positive. The review team also assumed similar corporate tax impacts, which were deemed to be noticeable and positive.

State and Local Income Taxes. Pennsylvania and New Jersey would receive additional income tax revenue from the wages of new workers. The exact amount of income tax revenue would be determined on the basis of many factors such as rates, residency status, and deductions. These income tax revenues would be smaller in non-peak building years and during operations.

The majority of the building workforce would already live in the region, would commute daily to and from the site, and would be employed elsewhere prior to building activities at Site 4-1. Sections 4.4.3.2 and 5.4.3.2 discuss income tax levels in New Jersey. Because the PSEG Site would have larger in-migrating workforces and more previously unemployed workers than Site 4-1, the impacts at the PSEG Site are bounding. Therefore, the income tax effects from in-migrating and previously unemployed local workers at Site 4-1 also must be minimal. Due to the size of Pennsylvania's income tax base, the review team assumed minimal impacts as well for Pennsylvania.

As discussed in Section 4.4.3.2, PSEG pays an energy receipts tax to the State of New Jersey based on revenues from electricity sales. However, because PSEG would not sell electricity from a new plant during building, the energy receipts tax would not change from the baseline tax payments to New Jersey. PSEG would pay the energy receipts tax during operations, and according to the analysis in Section 5.4.3.2, PSEG would pay between $144 million and $244 million to New Jersey. These revenues would account for between 6 and 11 percent of New Jersey's corporate income tax receipts.

Property Taxes. Employees who own their residences would pay property taxes to the counties and/or municipalities in which their homes were located. In New Jersey, property tax rates vary from one county to another and also within townships in the same county. Property tax rates in

Hunterdon County, New Jersey, range between $1.788 and $3.168 per hundred dollars of assessed value. The rate for Franklin Township, where Site 4-1 is located, is $2.361 per hundred (Hunterdon County 2013-TN2634).

Property taxes paid by construction workers that already live in the economic impact area are a part of the baseline and not relevant to this analysis. In-migrating construction workers would most likely move into existing houses rather than building new houses, resulting in a transfer of property taxes instead of an increase in local property tax revenues. Based on the above assessments, the review team determined there would be no property tax impact from construction workers.

Hunterdon County does not assess a property tax against construction projects in progress. Consequently, PSEG would not pay property taxes to Hunterdon County until the project is completed and commercial operations commence.

From the above assessments, the review team determined there would be no construction-phase property tax impacts in the economic impact area, and that the overall impact of new tax revenues at the State and local levels would be minimal and positive.

As was the case in the PSEG Site analysis, the review team assumed 144 in-migrating operations workers would either purchase or build homes in the economic impact area. For existing homes, the property tax effect would be zero. For new homes, the review team expects only a limited number of in-migrating workers would prefer to build. Given the magnitude of the property tax base in each of the counties in the economic impact area, the contribution of new real property to each area would result in a minor but beneficial impact.

All of the real property and improvements related to Site 4-1 are located in Hunterdon County, New Jersey. The review team determined that the 2012 township property tax in Franklin Township was about $2.361 per hundred dollars of assessed value on all improvements. For an Advanced Passive 1000 reactor (AP1000) design, the expected property tax revenue to Hunterdon County would be about $234 million for the first year of operation, declining thereafter over the 40-year life of the plant. In total, Franklin Township would collect about $4.8 billion in property tax revenues from a new plant at Site 4-1. For the Advanced Boiling Water Reactor (ABWR) design, the property tax revenue would be about $138 million for the first year of operation, declining thereafter over the 40-year life of the plant. In total, Franklin Township would collect about $2.8 billion in property tax revenues. Hunterdon County's 2013 budget shows an expected total revenue of $89 million (Hunterdon County 2013-TN2584). Therefore, a new nuclear power plant would add between about 272 percent (AP1000) and 161 percent (ABWR) to the current Hunterdon County budget in the first year of operation. Consequently, the review team determined that Hunterdon County would experience a major and beneficial impact from the anticipated new property tax revenues, and the economic impact area and the remainder of the 50-mi region would experience a minimal and beneficial impact.

Summary of Economic and Tax Impacts

Based on the information provided by PSEG and the review team's independent evaluation and outreach, the review team concluded the economic and tax impacts of a new nuclear power

plant at Site 4-1 would be SMALL and beneficial for the region and the economic impact area during building. The review team also concluded the economic impacts would be SMALL and beneficial for the region and the economic impact area during operations. The review team determined SMALL and beneficial impacts to sales and excise tax and income tax receipts in the economic impact area and region. The review team also predicts MODERATE and beneficial impacts to the State of New Jersey from PSEG corporate tax payments and LARGE and beneficial impacts to Hunterdon County from property tax payments.

Infrastructure and Community Service Impacts

This section provides the review team's estimated impacts on infrastructure and community services, including transportation, recreation, housing, public services, and education.

<u>Traffic</u>

Road access to the Site 4-1 area is provided primarily by New Jersey Routes 513 and 579, both of which are wide two-lane highways. The current daily vehicle counts for New Jersey Routes 513 and 579 are 3,284 and 4,504, respectively. Road access to the site itself is provided by County Road 615, a narrow two-lane road (PSEG 2015-TN4280). The daily vehicle count for County Road 615 is 2,005 vehicles per day. The site is about 8 mi from Interstate 78 via Route 513. The nearest rail spur is about 7 mi from the site, and barge access would not be feasible for Site 4-1. Therefore, major components for building and operations would be delivered via rail. The site would require about 3.5 mi of roadway improvements and a rail spur (PSEG 2010-TN257). Due to the size of the workforce for building, the review team expects a temporary, noticeable, but not destabilizing impact from traffic. Because the workforce for operations would be smaller (even during outages), the review team expects traffic impacts to be minimal.

<u>Recreation</u>

In the economic impact area, Hunterdon County has 25 park areas totaling 8,281 ac. Bucks County has 31 park areas totaling over 7,000 ac (New Jersey 2013-TN2651). None of the parks found appear to be within 5 mi of the site.

Recreational resources may be affected by building and operating a new plant at Site 4-1. Impacts may include increased user demand associated with the projected increase in population from in-migrating workers and families; an impaired recreational experience associated with the views of the proposed cooling towers, plumes, and offsite facilities; or access delays associated with increased traffic on local roadways.

Because of the size of the in-migrating population compared to the baseline and the minor increase in traffic, the review team determined there would be minimal impacts to the recreational resources from increased usage and traffic around the resources. However, due to the noticeable physical offsite impacts around the New Jersey Highlands, the review team estimated a noticeable and destabilizing aesthetic impact on recreational resources in and around the New Jersey Highlands.

Housing

As shown in Table 9-13, an estimated 294,610 housing units are located within the economic impact area. Of these, 17,200 are vacant, primarily in Bucks County. The review team estimated demand for short-term housing primarily during the peak building period, and demand for long-term housing during operations. Based on this analysis, the review team determined the majority of the building and operations workforces would reside in existing housing in the 50-mi region, with about 369 construction workers and 144 operations workers located within the economic impact area. Considering that the building workforce may choose short-term accommodations such as campsites or hotels, and some of the operations workers may decide to build new residences, the review team determined the existing housing supply is sufficient to accommodate both the building and operations workforces. Because Site 4-1 is a greenfield site, as many as 25 houses within the conceptual site boundaries would have to be removed to build and operate a new nuclear plant (PSEG 2015-TN4280). The review team determines the housing impact from building and operations at Site 4-1 would be minimal.

Table 9-13. Housing Units at the Alternative 4-1 Site in Hunterdon and Bucks Counties

Type of Housing Unit	Hunterdon County	Bucks County
Total Housing Units	49,394	245,216
Occupied	47,455	229,955
Owner-Occupied (units)	40,505	180,127
Owner-Occupied (percent)	85	78
Renter-Occupied (units)	6,950	49,828
Renter-Occupied (percent)	15	22
Vacant	1,939	15,261
Vacancy Rate (percent)	3.9	6.2
Homeowner (percent)	1.0	1.0
Rental (percent)	4.0	8.7

Source: USCB 2013-TN2640.

Public Services

Hunterdon County residents primarily rely on private wells for drinking water and individual septic systems and tanks for wastewater disposal. There are no public systems in the county (New Jersey 2013-TN2651). Bucks County is served by a mixture of private water companies, municipal water departments, and water supply authorities. Forty-seven of the 54 municipalities in the county are served by these. The rest are served by private wells. Bucks County has 3 municipal sewer departments and 22 municipal authorities providing sewage collection or treatment (New Jersey 2013-TN2651).

Because Hunterdon County has individual, private sources for water and wastewater instead of a centralized municipal utility, there is no impact from in-migrating persons on Hunterdon municipal water and wastewater services. Assuming per capita consumption of 100 gpd, the entire population of Bucks County consumes about 62 million gpd. The influx of 206 persons during the construction period would account for three-hundredths of 1 percent increase in demand during building and even less during the operations period. Assuming 75 gpd of

wastewater per person, the population of Bucks County consumes about 47 million gpd. The building workforce population increase in Bucks County would increase wastewater treatment demand by three-hundredths of 1 percent and even less for operations. The review team, therefore, predicted a minimal increase in water and wastewater impacts in the economic impact area.

Hunterdon County has 27 police departments, 25 emergency medical services (EMS) squads, and 39 fire departments. It also has a 200-bed hospital, three family health centers, and two mental health facilities (New Jersey 2013-TN2651). Bucks County has 42 municipal and regional police departments, 27 EMS squads, and 62 fire companies. Bucks County also has six general hospitals and three specialty health centers (New Jersey 2013-TN2651). Because the construction and operations workforces constitute an increase in population of less than 1 percent in both of the economic impact area counties, the review team determined the impacts of building and operations on local public services would be minor and no mitigation would be warranted.

Education

There are numerous public school districts in the economic impact area. Hunterdon County has 28 school districts that enroll 21,426 children and a polytechnical school with 384 students during the 2012–2013 school year (New Jersey 2013-TN2651). Bucks County has 13 school districts with 89,353 students enrolled in the 2012–2013 school year (New Jersey 2013-TN2651). About 85 percent of the project workforce would be local workers who currently reside in the region. The majority of these workers would commute from their homes to the project site and would not relocate. Therefore, the majority of workers are currently served by the educational services within the communities where they reside. According to Sections 4.4.4.5 and 5.4.4.5, the average percent of the population between 5 and 18 years old for the PSEG Site was 17.1 percent. As shown in Table 9-14, during peak building there would be an estimated increase of 105 students and 41 students during operations in the economic impact area. The review team determined this to be a small increase compared to the existing rolls in the economic impact area (more than 110,000 students). The review team estimated minimal impacts on local school districts and schools in the economic impact area and no mitigation would be warranted.

Table 9-14. Estimated Number of School-Aged Children Associated with the In-Migrating Workforce Associated with Building and Operations at Site 4-1

County	Estimated Increase in Population during Building	Estimated Increase in School-Age Children[(a)]	Estimated Increase in Population during Operations	Estimated Increase in School-Age Children[(a)]
Hunterdon	413	70	161	27
Bucks	206	35	80	14
Total	**619**	**105**	**241**	**41**

(a) Assuming 17.1% of population between 5 and 18 years old.

Summary of Infrastructure and Community Service Impacts

Based on the information provided by PSEG and the review team's independent evaluation and outreach, the review team concluded that nearly all infrastructure and community impacts would be SMALL for the region and the economic impact area during building and operations. The review team predicted MODERATE traffic impacts to Hunterdon County during building and a SMALL impact during operations. The review team predicted LARGE impacts to Hunterdon County recreational resources during building and operations from offsite infrastructure and aesthetic impacts.

Cumulative Impacts

As discussed above, the economic impact area for Site 4-1 is Hunterdon County, New Jersey, and Bucks County, Pennsylvania. This section discusses information pertaining to these areas. Table 9-8 discusses past, present, and reasonably foreseeable future activities associated with Site 4-1. Building and operating a new nuclear power plant at Site 4-1 could result in cumulative impacts on the demographics, economy, and community infrastructure of the economic impact area counties in conjunction with those reasonably foreseeable future actions.

The impact analyses presented for Site 4-1 are cumulative in nature. Past and current economic impacts associated with the activities listed in Table 9-8 have already been considered as part of the baseline for Site 4-1. Building and operating a new nuclear power plant at Site 4-1 could result in cumulative physical and socioeconomic impacts on the demographics, economy, and community infrastructure of the economic impact area, in conjunction with those reasonably foreseeable future actions shown in Table 9-8, and in general result in increased urbanization. However, many impacts, such as those on housing or public services, would decrease over time, particularly with increased tax revenues. Furthermore, State and County plans, along with modeled demographics projections, include forecasts for future development. Because the projects identified in Table 9-8 would be consistent with applicable land-use plans and control policies, the review team considers the cumulative socioeconomic impacts from the projects to be manageable.

Summary of Socioeconomic Impacts

Based on information provided by PSEG, a review of existing reconnaissance-level documentation, and its own independent evaluation, the review team concluded that the cumulative impacts of building and operations activities on physical resources would be SMALL, with the exception of a LARGE impact to aesthetic resources. The LARGE impact to aesthetic resources is because Site 4-1 is a greenfield site that would have infrastructure in previously undisturbed rural areas and a rail spur crossing the New Jersey Highlands. The cumulative impacts on demography would be SMALL. The cumulative impacts on taxes and the economy would be SMALL and beneficial throughout the region, except for a MODERATE and beneficial income tax impact to the State of New Jersey and a LARGE and beneficial economic and tax impact to Hunterdon County. The cumulative impacts on infrastructure and community services would be SMALL throughout the region with the exception of a MODERATE impact from traffic to Hunterdon County during building activities and a LARGE impact to recreation-based aesthetics. Based on the above considerations, the review team concludes that cumulative

socioeconomic impacts from building and operations at Site 4-1, with the exception of the physical impacts and the beneficial impacts to taxes and the economy, would not noticeably contribute to the existing cumulative socioeconomic effects discussed earlier in this section.

9.3.2.6 Environmental Justice

The economic impact area for Site 4-1 is Hunterdon County, New Jersey, and Bucks County, Pennsylvania. To evaluate the distribution of minority and low-income populations near Site 4-1, the review team conducted a demographic analysis of populations within the 50-mi region surrounding the proposed site in accordance with the methodology discussed in Section 2.6.1. In the 50-mi region, 2,773 aggregate minority and 770 low-income block groups meet one or both of the criteria presented in Section 2.6.1 (PSEG 2015-TN4280). Figure 9-5 and Figure 9-6 show the location of block groups with aggregate minority and low-income populations within the region. In Hunterdon County, no low-income block groups were found, but one Hispanic ethnicity block group was found to meet one or both of the criteria (PSEG 2012-TN2370). This block group is between 5 and 10 mi southeast of the site. The block groups that meet one or both of the criteria in Bucks County are found in the southern portion of the county, over 20 mi away from the site. The aggregate minority block groups are focused primarily along the I-95 corridor from Philadelphia to New York City, with some focused around Bethlehem and Allentown, Pennsylvania. The rest of the low-income block groups that meet one or both of the criteria are located in and around the Philadelphia, Trenton, and New York City metro areas. There are no low-income or minority high-density communities in Hunterdon County (Hunterdon County 2010-TN2589). Therefore, the review team has found no pathways for impacts to these communities.

The review team performed a reconnaissance-level analysis for the presence of unique characteristics or practices in minority or low-income communities that could result in disproportionately high and adverse impacts from Site 4-1 compared to the rest of the population. All of the populations are some distance from the site and therefore would not receive any disproportionately high and adverse human health, environmental, or physical impacts from building and operations at Site 4-1. The socioeconomic impacts from building and operations at Site 4-1 to minority and low-income populations would be similar to those to the general population in the economic impact area and region.

Cumulative Impacts

Based on the analysis above and the discussion of cumulative impacts in Section 9.3.2.5, the review team determined that there would not be any further disproportionately high and adverse impacts on environmental justice populations above and beyond those discussed in this section. The review team did not identify any pathways for environmental justice impacts.

9.3.2.7 Historic and Cultural Resources

The following impact analysis includes impacts from building and operating a new nuclear power plant at Site 4-1 in Hunterdon County, New Jersey. The analysis also considers other past, present, and reasonably foreseeable future actions that impact historic and cultural resources, including the Federal and non-Federal projects listed in Table 9-8. For the analysis

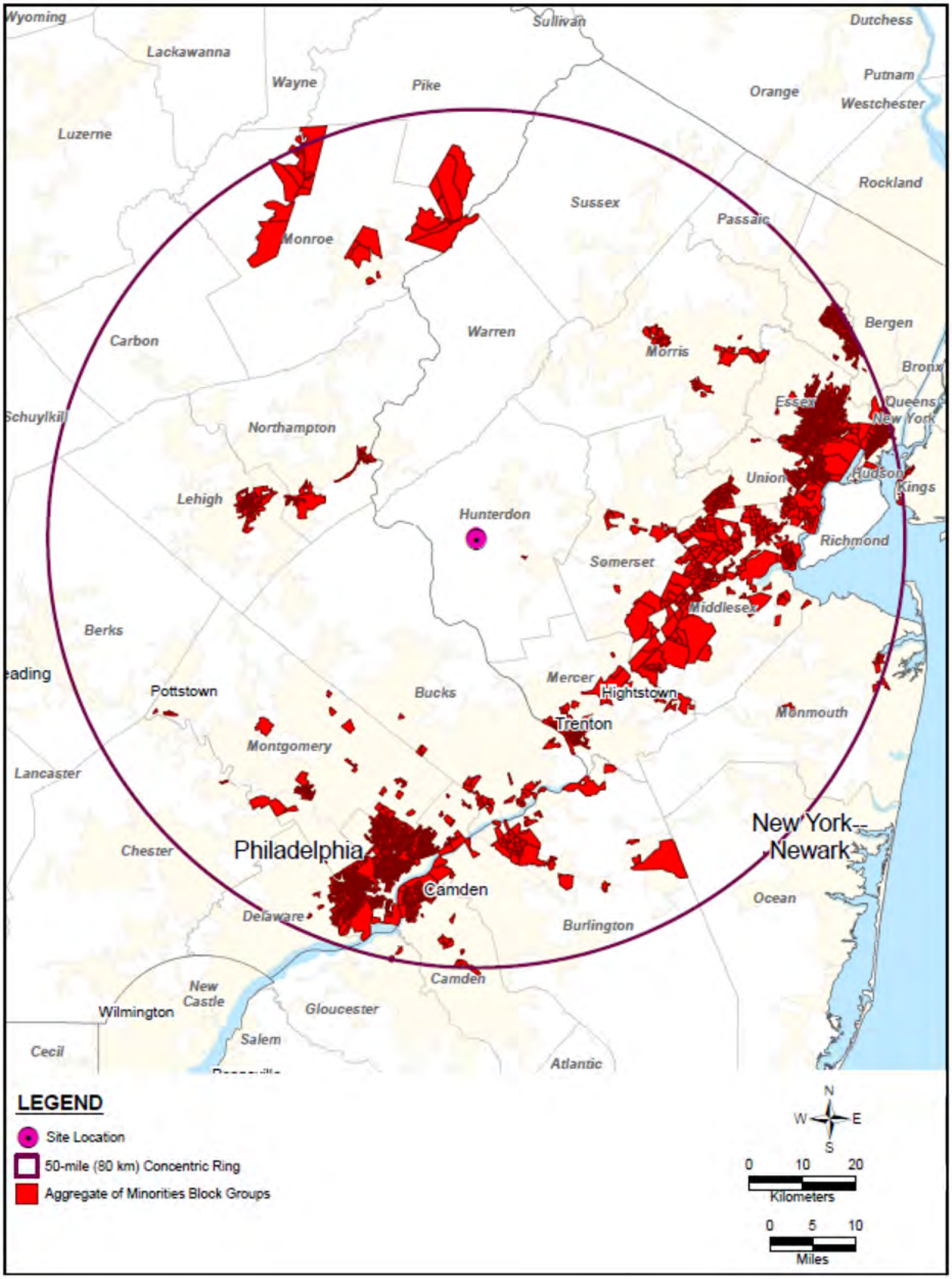


Figure 9-5. Aggregate of Minorities Block Groups Within 50 Mi of Site 4-1 (Source: Modified from PSEG 2012-TN2370)

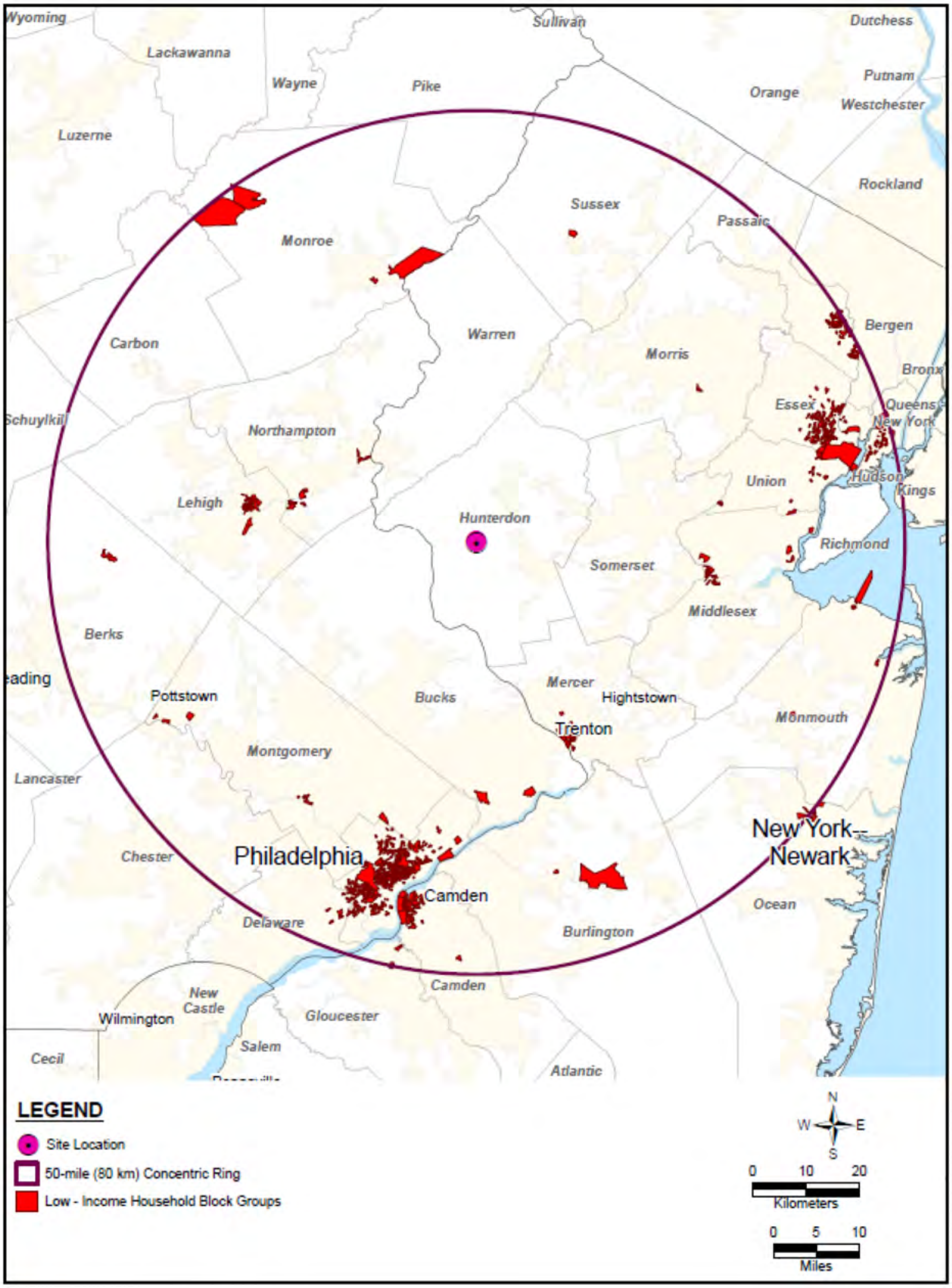


Figure 9-6. Low-Income Block Groups Within 50 Mi of Site 4-1 (Source: Modified from PSEG 2012-TN2370)

of cultural resources and historical properties impacts at Site 4-1, the geographic area of interest is considered to be the area of potential effect (APE) defined for this proposed undertaking. This includes the physical APE, defined as the area directly affected by the site-development, operation activities at the site, and transmission lines and the visual APE. The visual APE is defined as the additional 4.9-mi radius around the physical APE. The 4.9-mi radius was chosen by the New Jersey State Historic Preservation Office (SHPO) as the appropriate distance for consideration of visual resources near the PSEG Site and was therefore applied to the alternative sites (AKRF 2012-TN2876).

Reconnaissance-level activities in this cultural resource review have a particular meaning. For example, these activities include preliminary field investigations to confirm the presence or absence of cultural resources. In developing this EIS, the review team relies upon reconnaissance-level information to perform alternative site evaluations. Reconnaissance-level information consists of data that are readily available from agencies and other public sources. It can also include information obtained through visits to the alternative site area. The following information was used to identify the cultural resources and historical properties at Site 4-1:

- the PSEG ER (PSEG 2015-TN4280),
- *Field Verification of Key Resources at PSEG Alternative Sites* (AKRF 2011-TN2869), and
- New Jersey SHPO archaeological site files.

Affected Environment

Site 4-1 is a greenfield site located in Hunterdon County in northwestern New Jersey. Historically, Site 4-1 has been used for agricultural purposes. Site 4-1 encompasses a total of 1,128 ac. The location would require 3.5 mi of new roads, a 6.8-mi railroad spur, a 6.8-mi-long makeup water pipeline, and three new 500-kV transmission lines covering a total distance of 84 mi. The current major industry in Hunterdon County is agriculture. There are 81 properties listed in the National Register of Historic Places (NRHP) located in Hunterdon County, New Jersey (NPS 2013-TN2774).

Four archaeological sites have been recorded within 1 mi of Site 4-1. These include Sites 28-HU-390, 28-HU-391, 28-HU-392, and 28-HU-393. Only one of these four archaeological sites, 28-HU-390, a prehistoric site, is located within the conceptual footprint for the new plant. No previously identified archaeological sites are identified near the conceptual corridors for Site 4-1.

There are 43 previously identified architectural resources within 4.9 mi of Site 4-1 and its ancillary components. Resources include residences, historic districts, bridges, mills, churches, and other miscellaneous buildings. Ten significant architectural resources have been identified within 1 mi of Site 4-1 and the conceptual corridors. These resources include historic districts, taverns, churches, and a Quaker meeting house. Three significant (i.e., NRHP-listed or State register–listed) architectural resources are within 1,000 ft of Site 4-1 and its conceptual offsite corridors. They are the Rockhill Agricultural Historic District, Pittstown Historic District, and Lehigh Valley Railroad Historic District. The Lehigh Valley Railroad Historic District is within the conceptual rail spur needed for the location. A review of architectural resources in the immediate vicinity of Site 4-1 identified nine additional architectural resources within 1,000 ft of

Site 4-1 that could potentially be eligible for NRHP listing (AKRF 2011-TN2869). These resources include farm houses, farms, and a historic district. The historic district is in the Village of Baptistown. Six additional buildings with potential for NRHP listing were identified within 1 mi of Site 4-1, including two churches and cemeteries, a municipal building, and three residences. Another 15 structures and architectural features that have the potential for listing in NRHP were identified between 1 and 10 mi of Site 4-1.

Building Impacts

Site 28-HU-390 is located within the footprint of the plant. It would be destroyed, which would destabilize the resource. An additional cultural resources inventory would likely be needed for any portion of Site 4-1 that has not been previously surveyed. Other areas subject to ground disturbance (e.g., for roads and pipeline corridors) would also likely require a survey to identify potential historic and cultural resources and the mitigation measures to offset the potential adverse effects. The types of cultural resource and historic property impacts resulting from construction and operation of new nuclear units would consist of alterations to archaeological sites from ground-disturbing activities and visual alteration of the settings for historic structures. In some cases vibrations from construction equipment could affect historic structures.

The existing viewshed does not contain any existing cooling towers or any large industrial facilities with which the proposed plant could blend. The visual impact to the historic properties from the building of the plant, including the 590-ft-tall cooling towers, would be significant.

No existing transmission corridors connect directly to Site 4-1 (PSEG 2015-TN4280). Three new transmission line corridors would be needed to connect Site 4-1 to existing lines. Construction of the SRERP power line may reduce the need for the additional transmission lines. No NRHP-listed or previously recorded historic or prehistoric sites are in the area where the SRERP transmission line was routed. In the event that Site 4-1 was chosen for the proposed project, the review team assumes that the transmission service provider for this region would conduct cultural resource surveys for all areas needed for the transmission lines. If NRHP-eligible resources are identified, then efforts to avoid, minimize, or mitigate impacts would be developed in consultation with the New Jersey SHPO and any interested parties as required under Section 106 of the NHPA (54 USC 300101 et seq. -TN4157). In addition, visual impacts from transmission lines could result in significant alterations to the visual landscape within the geographic area of interest. It is likely that there would be significant impacts to historic and cultural resources from building a plant at Site 4-1 given that significant resources are within the physical and visual APE for the project, including offsite corridors. These impacts would be reduced if the number and length of the transmission lines are not needed due to electrical system improvements in the region.

Operational Impacts

Operational impacts from a new plant located at Site 4-1, with exception of visual impacts, would be expected to be minimal. Most impacts to cultural resources would occur during preconstruction and construction. Visual impacts to historic structures would occur within the viewshed of the new plant during operation. The visual impact during operation from the 590-ft-tall cooling tower would be significant.

Cumulative Impacts

Most cumulative impacts would result from non-NRC-licensed activities associated with construction of the transmission lines and pipelines. These impacts would depend on the locations of the various activities and the nature, number, and significance of cultural resources present. Existing information suggests that the region surrounding Site 4-1 contains intact historic and cultural resources. It is possible that currently unknown cultural resources would be found in close proximity to areas needed for the transmission lines and pipelines. Because site 28-HU-390 would be destroyed and because of the impacts to the historic properties within the viewshed from the cooling towers, the cumulative impacts would be expected to destabilize historic properties.

Summary

Cultural resources are nonrenewable; therefore, the impact of destruction of cultural resources is cumulative. The impact-level determination reflects the fact that (1) cultural resources are found within the boundaries of the proposed plant at Site 4-1 and (2) one would be destroyed as and (3) the cooling towers would visually impact historic properties in the area. Based on the reconnaissance-level information collected for this EIS, the review team concludes that the cumulative impacts on historic and cultural resources of building and operating new nuclear units at Site 4-1 would be LARGE. Building and operating a new nuclear power plant at Site 4-1 would be a significant contributor to the impacts.

9.3.2.8 Air Quality

Criteria Pollutants

The air-quality impacts of building and operating a new nuclear power plant and offsite facilities at Site 4-1 would be similar to the impacts expected for the PSEG Site, as described in Chapters 4 and 5. Site 4-1 is a greenfield site in Hunterdon County, New Jersey, about 5 mi east of the Delaware River. Similar to Salem County, where the PSEG Site is located, Hunterdon County is classified as a nonattainment area for the 8-hour ozone NAAQSs and in attainment or better than national standards for all other criteria pollutants (40 CFR Part 81-TN255). Hunterdon County is in the Northeast Pennsylvania-Upper Delaware Valley Interstate Air Quality Control Region (AQCR; 40 CFR 81.55 [TN255]), while Salem County is administratively in the Metropolitan Philadelphia Interstate AQCR (40 CFR 81.15 [TN255]). Similar to the PSEG Site, an applicability analysis would need to be performed if a nuclear power plant was built on Site 4-1 per 40 CFR Part 93, Subpart B (TN2495), to determine whether a general conformity determination was needed.

As discussed in Section 4.7, emissions of criteria pollutants from building a new nuclear power plant are expected to be temporary and limited in magnitude. Emissions from these activities would be primarily the fugitive dust from ground-disturbing activities and engine exhaust from heavy equipment and vehicles. These impacts would be similar to the impacts associated with any large construction project. During building activities, a New Jersey State Air Quality Permit would be required that would prescribe emissions limits and mitigation measures to be implemented. The applicant also plans to implement a fugitive dust control program (PSEG 2015-TN4280).

Section 5.7 discusses air-quality impacts during operations. Emissions during operations would primarily be from operation of the cooling towers, auxiliary boilers, diesel generators and/or gas turbines, and commuter traffic. Stationary sources such as the diesel generators and/or gas turbines (operating infrequently) and auxiliary boilers (operating mostly during the winter months) would be operated according to State and Federal regulatory requirements.

A Title V operating permit administered through the State of New Jersey would ensure compliance with NAAQSs and other applicable regulatory requirements and prescribe mitigation measures to ensure compliance. There are six major sources of air emissions in Hunterdon County with existing Title V operating permits (EPA 2013-TN2514). These existing sources include the energy and industrial projects listed in Table 9-8. The existing energy and industrial projects and the planned transportation projects would contribute to air-quality impacts in Hunterdon County. However, the impacts on air quality in the county from emissions from Site 4-1 would be temporary and not noticeable when combined with other past, present, and reasonably foreseeable future projects. The cumulative air-quality impacts of building and operating a new nuclear power plant at Site 4-1 would be minor.

Greenhouse Gases

The cumulative impacts of GHG emissions related to nuclear power are discussed in Section 7.6. The impacts of the emissions are not sensitive to the location of the source. Consequently, the discussion in Section 7.6 would be applicable to a nuclear power plant located at Site 4-1. The review team concludes that the national and worldwide cumulative impacts of GHG emissions are noticeable but not destabilizing. The review team further concludes that the cumulative impacts would be noticeable but not destabilizing, with or without the GHG emissions of a nuclear power plant at Site 4-1.

Summary

The review team concludes that the cumulative impacts from other past, present, and reasonably foreseeable future actions on air-quality resources in the geographic areas of interest would be SMALL for criteria pollutants and MODERATE for GHG emissions. The incremental contribution of impacts on air-quality resources from building and operating a new nuclear power plant at Site 4-1 would not be a significant contributor to the impacts for both criteria pollutants and GHG emissions.

9.3.2.9 Nonradiological Health

The following impact analysis considers nonradiological health impacts from building activities and operations on the public and workers from a new nuclear power plant at Site 4-1, which is located in Franklin Township, Hunterdon County, New Jersey (about 80 mi north-northeast of the PSEG Site). The analysis also considers other past, present, and reasonably foreseeable future actions that could affect nonradiological health, including other Federal and non-Federal projects and those projects listed in Table 9-8 within the geographic area of interest. The building-related activities that have the potential to affect the health of members of the public and workers include exposure to dust and vehicle exhaust, occupational injuries, noise, and the transport of construction materials and personnel to and from the site. The operation-related

activities that have the potential to affect the health of members of the public and workers include exposure to etiological agents, noise, and electromagnetic fields (EMFs), and transport of workers to and from the site.

Most of the nonradiological impacts of building and operation (e.g., noise, etiological agents, and occupational injuries) would be localized and would not have significant impact at offsite locations. However, activities such as vehicle emissions from transport of personnel to and from the site would encompass a larger area. Therefore, for nonradiological health impacts associated with the influence of vehicle and other air emissions sources, the geographic area of interest for cumulative impacts analysis includes projects within a 50-mi radius of Site 4-1. For cumulative impacts associated with transmission lines, the geographical area of interest is the transmission line corridor. These geographical areas are expected to encompass areas where cumulative impacts to public and worker health could occur in combination with any past, present, or reasonably foreseeable future actions.

Building Impacts

Nonradiological health impacts on the construction workers from building a new nuclear power plant at Site 4-1 would be similar to those from building a new plant at the PSEG Site, as evaluated in Section 4.8. They include occupational injuries, noise, odor, vehicle exhaust, and dust. Applicable Federal, State, and local regulations on air quality and noise would be complied with during the plant construction phase. Site 4-1 does not have any characteristics that would be expected to lead to fewer or more construction accidents than would be expected for the PSEG Site. Transportation of personnel and construction materials at Site 4-1 would result in minimal nonradiological health impacts. Site 4-1 is in a greenfield area, and construction impacts would likely be minimal on the surrounding areas, which are classified as low-population areas.

Operational Impacts

Nonradiological health impacts on occupational health of workers and members of the public from operation of a new nuclear power plant at Site 4-1 would be similar to those evaluated in Section 5.8 for a new plant at the PSEG Site. Occupational health impacts on workers (e.g., falls, electric shock, or exposure to other hazards) at Site 4-1 would likely be the same as those evaluated for workers at a new plant at the PSEG Site. Discharges to the Delaware River would be controlled by NPDES permits issued by NJDEP. The growth of etiological agents would not be significantly encouraged at Site 4-1 because of the temperature attenuation in the length of the pipe required for a discharge system. Noise and EMF exposure would be monitored and controlled in accordance with applicable Occupational Safety and Health Administration (OSHA) regulations. Effects of EMFs on human health would be controlled and minimized by conformance with National Electric Safety Code (NESC) criteria. Nonradiological impacts of traffic during operations would be less than the impacts during preconstruction and construction. Mitigation measures used during building to improve traffic flow would also minimize impacts during operation of the new plant.

Cumulative Impacts

Past and present actions within the geographic area of interest that could contribute to cumulative nonradiological health impacts include the energy projects in Table 9-8, as well as vehicle emissions and existing urbanization. Reasonably foreseeable future projects in the geographical area of interest that could contribute to cumulative nonradiological health impacts include expansion of natural-gas pipelines, improvement and new construction for roadways and interstates, future transmission line development, and future urbanization. The review team is also aware of the potential climate changes that could affect human health. The review team considered a recent compilation of the state of the knowledge in this area (GCRP 2014-TN3472) in the preparation of this EIS. Projected changes in climate for the region include an increase in average temperature; increased likelihood of drought in summer; more heavy downpours; and increase in precipitation, especially in the winter and spring, which may alter the presence of microorganisms and parasites. In view of the water source characteristics, the review team did not identify anything that would alter its conclusion regarding the presence of etiological agents or change in the incidence of waterborne diseases.

Summary

Based on the information provided by PSEG and the review team independent evaluation, the review team expects that the impacts on nonradiological health from building and operating a new nuclear power plant at Site 4-1 would be similar to the impacts evaluated for the PSEG Site. Although there are past, present, and future activities in the geographical area of interest that could affect nonradiological health in ways similar to the building and operation of a new plant at Site 4-1, those impacts would be localized and managed through adherence to existing regulatory requirements. Similarly, impacts on public health of operating a new nuclear power plant at Site 4-1 would be expected to be minimal. The review team concludes, therefore, that the cumulative impacts of building and operating a new nuclear power plant at Site 4-1 on nonradiological health would be SMALL.

9.3.2.10 Radiological Impacts of Normal Operations

The following impact analysis includes radiological impacts on the public and workers from building activities and operations for a new nuclear power plant at Site 4-1, located in Franklin Township, Hunterdon County, New Jersey (about 80 mi north-northeast of the PSEG Site). The analysis also considers other past, present, and reasonably foreseeable future actions that could affect radiological health, including other Federal and non-Federal projects and the projects listed in Table 9-8. As described in Section 9.3.2, Site 4-1 is a greenfield site; there are currently no nuclear facilities on the site. The geographic area of interest is the area within a 50-mi radius of Site 4-1. The only facility that potentially affects radiological health within this geographic area of interest is the Limerick Generating Station, Units 1 and 2. In addition, medical, industrial, and research facilities that use radioactive materials are likely to be within 50 mi of Site 4-1.

The radiological impacts of building and operating a new nuclear power plant at Site 4-1 include doses from direct radiation and liquid and gaseous radioactive effluents. These pathways would result in doses to people and biota other than humans off the site that would be well below regulatory limits. The impacts are expected to be similar to those at the PSEG Site.

The radiological impacts of the Limerick Generating Station include doses from direct radiation and liquid and gaseous radioactive effluents. These pathways result in doses to people and biota other than humans off the site that are well below regulatory limits as demonstrated by the ongoing radiological environmental monitoring program conducted around Limerick Generating Station. The NRC staff concludes that the dose from direct radiation and effluents from medical, industrial, and research facilities that use radioactive material would be an insignificant contribution to the cumulative impact around Site 4-1. This conclusion is based on data from the radiological environmental monitoring programs conducted around currently operating nuclear power plants. Based on the information provided by PSEG and the NRC staff's independent analysis, the NRC staff concludes that the cumulative radiological impacts from building and operating a new nuclear power plant and other existing and planned projects and actions in the geographic area of interest around Site 4-1 would be SMALL.

9.3.2.11 Postulated Accidents

The following impact analysis includes radiological impacts from postulated accidents from the operation of a new nuclear power plant at Site 4-1 in Hunterdon County, New Jersey. The analysis also considers other past, present, and reasonably foreseeable future actions that could affect radiological health from postulated accidents, including other Federal and non-Federal projects and those projects listed in Table 9-8 within the geographic area of interest. As described in Section 9.3.2, Site 4-1 is a greenfield site, and there are currently no nuclear facilities on the site. The geographic area of interest considers all existing and proposed nuclear power plants that have the potential to increase the probability-weighted consequences (i.e., risks) from a severe accident at any location within 50 mi of this site. Existing facilities potentially affecting radiological accident risk within this geographic area of interest are HCGS Unit 1, SGS Units 1 and 2, Oyster Creek Nuclear Generating Station, Limerick Generating Station Units 1 and 2, Peach Bottom Atomic Power Station Units 2 and 3, Three Mile Island Nuclear Station Unit 1, Susquehanna Steam Electric Station Units 1 and 2, and Indian Point Nuclear Generating Units 2 and 3. In addition, a new reactor, known as the Bell Bend Nuclear Power Plant, has been proposed within the geographic area of interest next to the Susquehanna Steam Electric Station.

As described in Section 5.11, the NRC staff concludes that the environmental consequences of design basis accidents (DBAs) at the PSEG Site would be minimal for a U.S. Advanced Pressurized Water Reactor (US-APWR), two AP1000s, a U.S. Evolutionary Power Reactor (U.S. EPR), or an ABWR. DBAs are addressed specifically to demonstrate that any of these four reactor designs is sufficiently robust to meet the NRC safety criteria. The reactor designs are independent of site conditions, and the meteorological data for Site 4-1 and the PSEG Site are similar; therefore, the NRC staff concludes that the environmental consequences of DBAs at Site 4-1 would be SMALL.

Because the meteorology, population distribution, and land use for Site 4-1 are expected to be similar to those at the PSEG Site, risks from a severe accident for a new nuclear power plant located at Site 4-1 are expected to be similar to those analyzed for the PSEG Site. These risks for the PSEG Site are presented in Tables 5-30 and 5-31 and are well below the mean and median values for current-generation reactors. In addition, as discussed in Section 5.11.2.1, estimates of average individual early fatality and latent cancer fatality risks are well below

Commission safety goals (51 FR 30028-TN594). For existing plants within the geographic area of interest (i.e., whose 50-mi radius overlaps with the 50-mi radius around the PSEG Site), namely HCGS Unit 1, SGS Units 1 and 2, Oyster Creek Nuclear Generating Station, Limerick Generating Station Units 1 and 2, Peach Bottom Atomic Power Station Units 2 and 3, Three Mile Island Nuclear Station Unit 1, Susquehanna Steam Electric Station Units 1 and 2, and Indian Point Nuclear Generating Units 2 and 3, the Commission determined the probability-weighted consequences of severe accidents are small (10 CFR Part 51, Appendix B, Table B-1 [TN250]). Because of the NRC safety review criteria, it is expected that risks for any new reactors at any other locations within the geographic area of interest for Site 4-1 would be below the risks for current-generation reactors and would meet Commission safety goals. The severe accident risk due to any particular nuclear power plant becomes smaller as the distance from that plant increases. However, the combined risk at any location within 50 mi of Site 4-1 would be bounded by the sum of risks for all of these operating nuclear power plants and would still be low.

Finally, a single U.S. EPR unit has been proposed for the Bell Bend site next to the Susquehanna Steam Electric Station. According to the *Draft Environmental Impact Statement for the Combined License for Bell Bend Nuclear Power Plant*, NUREG-2179 (NRC and USACE 2015-TN4278), the risks from the proposed Bell Bend Nuclear Power Plant would also be well below the risks for current-generation reactors and would meet the Commission's safety goals.

The postulated accident risk due to any particular nuclear power plant gets smaller as the distance from that plant increases. However, the combined risk at any location within 50 mi of Site 4-1 would be bounded by the sum of risks for all operating and proposed nuclear power plants. Even though there would be potentially several plants included in the combination, this combined risk would still be low. On this basis, the NRC staff concludes that the cumulative risks of postulated accidents at any location within 50 mi of Site 4-1 would be SMALL.

9.3.3 Site 7-1

This section covers the review team evaluation of the potential environmental impacts of siting a new nuclear power plant at the site designated as Site 7-1 in Salem County, New Jersey, located about 15 mi north-northeast of the PSEG Site (see Figure 9-1). Site 7-1 is a greenfield site that is not owned by PSEG. The site is located about 5 mi from the Delaware River, which would be the source of cooling water for new nuclear units at this site. The site has a total area of 987 ac.

As indicated by PSEG, the use of Site 7-1 would require infrastructure upgrades and improvements, as follows (PSEG 2015-TN4280):

- Portions of the public roads that currently provide access to the site would need to be relocated around plant facilities and/or improved to increase their load-carrying capacity. An estimated total of 3.3 mi of road building would be required, and the ROW width would be 150 ft.
- A new rail spur would be required to allow delivery of materials and equipment to the site. PSEG has identified a conceptual route and alignment for this new rail spur that would be 6.9 mi long and would require a ROW width of 150 ft.

- A new water supply pipeline would need to be installed to withdraw water from the Delaware River. A new discharge pipeline would also need to be installed to convey blowdown and wastewater to the Delaware River. PSEG assumed that the two new pipelines would be installed parallel to each other and within the same 100-ft-wide ROW. The estimated length of the route is 5.1 mi.
- Three new 500-kV transmission lines would need to be installed to connect to the existing transmission line system. PSEG assumed that these three new lines would be installed parallel to one another, each within a 200-ft ROW. The length of these three new lines would be 5.4 mi.
- A new switchyard would be required at the connection of the above new transmission lines and the existing transmission line system. PSEG assumed that this new switchyard would be located on 25 ac.

The following sections include a cumulative impact assessment conducted for each major resource area. The assessment considered the specific resources and components that could be affected by the incremental effects of a new nuclear power plant at Site 7-1, including the impacts of the NRC-authorized construction and operations and impacts of preconstruction activities. Also included in the assessment are past, present, and reasonably foreseeable future Federal, non-Federal, and private actions in the same geographical area that could have meaningful cumulative impacts when considered together with a new nuclear power plant if such a plant were to be built and operated at Site 7-1. Other actions and projects considered in this cumulative analysis are described in Table 9-15.

Table 9-15. Projects and Other Actions Considered in the Cumulative Impacts Analysis for Site 7-1

Project Name	Summary of Project	Location	Status
Nuclear Projects			
Hope Creek Generating Station, Unit 1	The station consists of a single operating boiling water reactor (BWR) rated at 3,840 MW(t), adjacent to the Salem units	13.4 mi south of Site 7-1	Operational, licensed through April 11, 2046 (NRC 2012-TN2626)
Salem Generating Station, Units 1 and 2	The station consists of two operating pressurized water reactors (PWRs) rated at 3,459 MW(t) each, adjacent to the Hope Creek unit	13.4 mi south of Site 7-1	Operational, licensed through August 13, 2036, and April 18, 2040 (NRC 2012-TN2626)
Oyster Creek Nuclear Generating Station	The station consists of a single operating BWR rated at 1,930 MW(t)	53 mi east-northeast of Site 7-1	Operational, licensed through April 9, 2029 (NRC 2012-TN2626). However, Exelon plans to shut the plant down in 2019 (Exelon 2013-TN2521)
Limerick Generating Station, Units 1 and 2	The station consists of two operating BWRs rated at 3,515 MW(t) each	40 mi north of Site 7-1	Operational, licensed through October 26, 2024, and June 22, 2029 (NRC 2012-TN2626)

Table 9-15. (continued)

Project Name	Summary of Project	Location	Status
Peach Bottom Atomic Power Station, Units 2 and 3	The station consists of two operating BWRs rated at 3,514 MW(t) each and one permanently shutdown unit (Unit 1)	45 mi west of Site 7-1	Operational, licensed through August 8, 2033, and July 2, 2034 (NRC 2012-TN2626)
Three Mile Island Nuclear Station, Unit 1	The station consists of a single operating PWR rated at 2,568 MW(t) and one permanently shut down unit (Unit 2)	75 mi northwest of Site 7-1	Operational, licensed through April 19, 2034 (NRC 2012-TN2626)
Calvert Cliffs Nuclear Power Plant Units 1 and 2	The station consists of two operating PWRs rated at 2,737 MW(t) each	98 mi southwest of Site 7-1	Operational, licensed through July 31, 2034, and August 13, 2036 (NRC 2012-TN2626)
Energy Projects			
Deepwater Energy Center	158-MW two-unit natural-gas peaking facility	12 mi southwest of Site 7-1	Operational (EPA 2013-TN2504)
Carneys Point Generating Plant	Cogeneration power plant	6 mi northwest of Site 7-1	Operational (EPA 2013-TN2504)
Pedricktown Combined Cycle Cogeneration Plant	120-MW peaking facility	9 mi north of Site 7-1	Operational (EPA 2013-TN2504)
Grid stability transmission line for Artificial Island	Line needed to support the grid in the area around the island. No specific route is known. Review team assumes a line west to the Peach Bottom substation	13.4 mi south of Site 7-1	Proposals requested by PJM (PSEG 2013-TN2669)
New Developments/Redevelopment			
Camp Pedricktown Redevelopment	Site redevelopment due to Base Realignment and Closure	7.3 mi north of Site 7-1	In progress (Davis 2013-TN2533)
Parks and Recreation Activities			
Mad Horse Creek Wildlife Management Area	Restoration of about 200 ac	12.7 mi south of Site 7-1	In progress (NJDEP 2013-TN2534)
Supawna Meadows National Wildlife Refuge	About 3,000-ac refuge with some walking and boating trails	7.3 mi southwest of Site 7-1	Operational (FWS 2013-TN2530)
Fort Mott State Park	124-ac park built around a historical site	7.3 mi southwest of Site 7-1	Operational (NJDEP 2013-TN2532)
Parvin State Park	2,092-ac park with trails, camping, boating, fishing, and hunting	18 mi southeast of Site 7-1	Operational (NJDEP 2013-TN2531)
Glassboro Fish and Wildlife Management Area	2,393-ac wildlife management area with trails	18 mi east of Site 7-1	Operational (NJDEP 2013-TN2534)

Table 9-15. (continued)

Project Name	Summary of Project	Location	Status
Other parks, forests, and reserves	Numerous State and National parks, forests, reserves, and other recreational areas are located within a 50-mi region	Throughout 50-mi region	Parks are currently being managed by National, State, and/or local agencies
Other Actions/Projects			
USACE Delaware River Main Channel Deepening Project	Deepening of river channel; Reach C: Delaware RM 68 to 55; Reach D: Delaware RM 55 to 41	Reach C is 5.6 mi west of Site 7-1; Reach D is 9 mi southwest of Site 7-1	In progress (USACE 2013-TN2665)
Salem County Solid Waste Landfill	Regional landfill for solid waste	4 mi southeast of Site 7-1	Operational (SCIA 2013-TN2664)
Air emissions sources	Nearby air emissions sources include small-scale commercial facilities (emissions below reporting limits), on-road mobile sources (cars and trucks), non-road mobile sources (airplanes, boats, tractors, etc.), and industrial stationary point emissions sources (Mannington Mills Inc. flooring manufacturer, DuPont Dow Performance Elastomers, LLC synthetic rubber manufacturer)	Within Salem County	Ongoing
Surface-water withdrawals and discharges	Surface-water withdrawals for public water supply and other potable use and wastewater treatment plant discharges	Within 10 RM of the intake and discharge for Site 7-1	Significant surface-water withdrawals and discharges have been taking place for decades. Withdrawal rates are expected to continue at current rates or increase slightly in the future
Groundwater withdrawals	Groundwater withdrawals throughout the region supply the majority of freshwater needs. Major pumping centers in Salem, Gloucester, and Camden Counties in New Jersey and New Castle County in Delaware affect groundwater heads and groundwater flow paths throughout the region	Throughout region	Significant groundwater withdrawals have been taking place since the 1950s. Withdrawal rates are expected to continue at current rates or increase slightly in the future
Various hospitals and industries that use radioactive materials	Medical and other isotopes	Within 50 mi	Operational in nearby cities and towns

Table 9-15. (continued)

Project Name	Summary of Project	Location	Status
Future Urbanization	Construction of housing units and associated commercial buildings; roads, bridges, and rail; construction of water and/or wastewater treatment and distribution facilities and associated pipelines, as described in local land-use planning documents	Throughout region	Construction would occur in the future, as described in-state and local land-use planning documents

9.3.3.1 Land Use

Affected Environment

As discussed in Section 9.3.3, Site 7-1 covers 987 ac in Salem County, New Jersey (Figure 9-1). Existing land use at Site 7-1 is predominantly agricultural, with large areas planted in cultivated crops. Most of Site 7-1 is zoned for agricultural use, and soils classified as prime farmland or Farmland of Statewide Importance occur across much of the site (PSEG 2015-TN4280).

About 17 single-family houses and an active church and a cemetery are located within the Site 7-1 boundaries. Also, although the site is located about 4 mi from the nearest incorporated town, there are small groups of houses within 1 mi of the site. There are no significant industrial land uses on Site 7-1 or in close proximity (PSEG 2015-TN4280).

According to the 2012 State of New Jersey Department of Agriculture GIS mapping conducted by PSEG, a total of 196.8 ac within the Site 7-1 boundaries (19.9 percent of the total 987 ac) are designated County Preserved Farmlands under the State Farmland Preservation Program (PSEG 2012-TN2282) (Figure 9-7). The GIS mapping indicates that there are two County Preserved Farmland parcels within Site 7-1, both located southwest of the intersection of Haines Neck Road and Marshalltown Road. PSEG conducted a review of deeds for the parcel identified as Block 25, Lot 14, and verified the presence of a permanent Deed of Easement on the property. The PSEG review of deeds for the parcel identified as Block 25, Lot 13, verified an Eight-Year Preservation on the property recorded December 2003. PSEG found no evidence that this second property is still in the Farmland Preservation Program (PSEG 2012-TN2282).

The offsite corridors for the access roads, rail spur, and water pipelines to Site 7-1, as well as the short connector transmission line from Site 7-1 to the grid, would be largely confined to the immediate site vicinity. Land uses within these corridors are similar to the site itself, with most of the land in agricultural use and residences scattered throughout the area. There are no significant industrial land uses within the offsite corridors (PSEG 2015-TN4280).

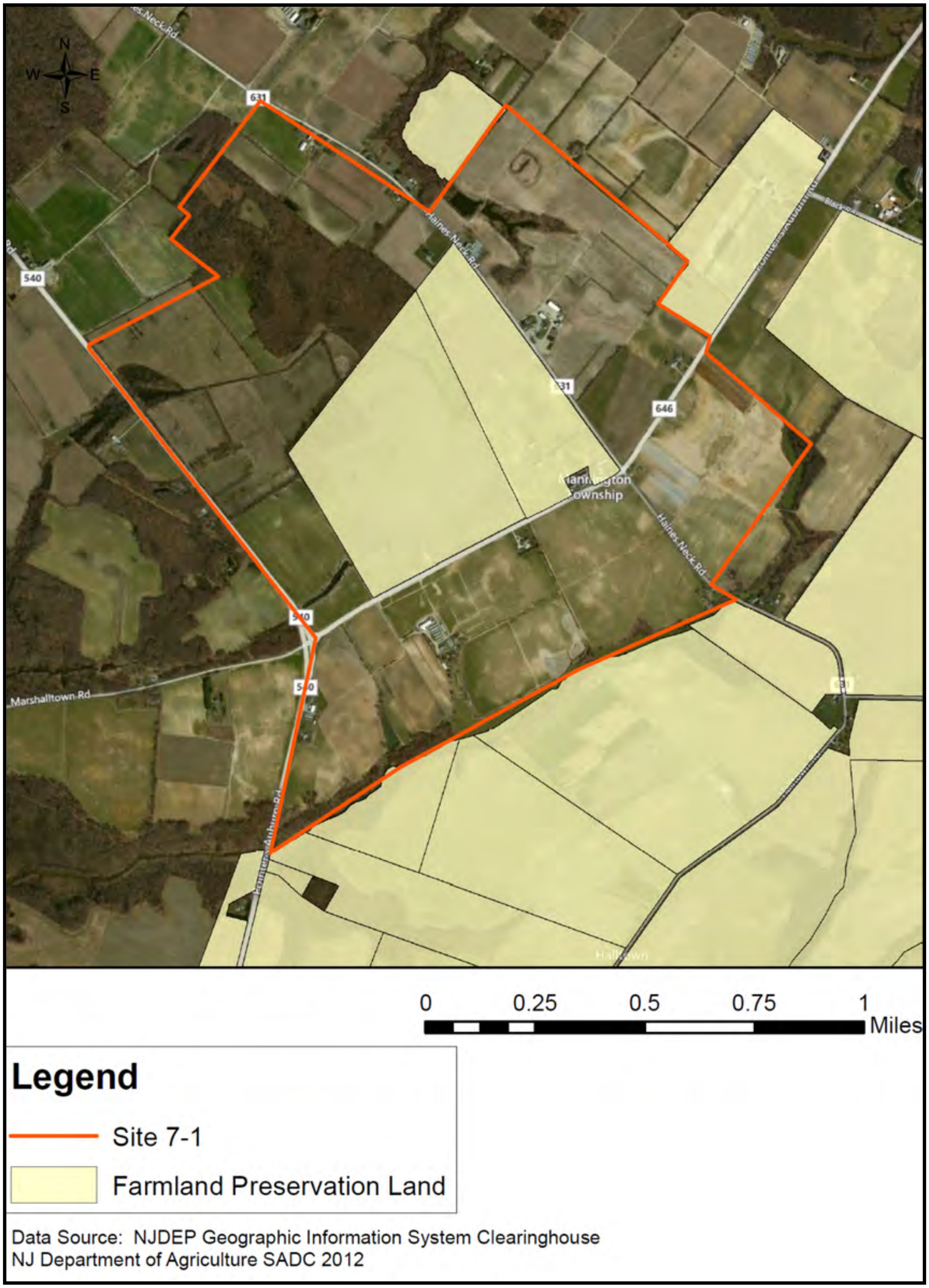


Figure 9-7. County Preserved Farmland at Alternative Site 7-1 (Source: PSEG 2012-TN2282)

Building Impacts

According to PSEG, building a new nuclear power plant at Site 7-1 would directly disturb (temporarily and permanently) a total of 432 ac on the site. The remaining land within the Site 7-1 boundaries (555 ac) would not be directly disturbed, but access to this land would be controlled and it would be unavailable for uses not related to the new nuclear power plant. In addition, developing the access road, rail spur, and water pipeline corridors for Site 7-1 would disturb 246 ac off the site. Therefore, a total of 1,233 ac, not including transmission line corridors, would be disturbed or made unavailable for uses not related to a new plant at Site 7-1. Land-use disturbances associated with building a new nuclear power plant at Site 7-1 and the access road, rail spur, and water pipeline to support the plant include impacts to about 971 ac of planted/cultivated land, 14 ac of developed land, 46 ac of barren land, 116 ac of forestland, 1 ac of estuarine and marine deepwater areas, 8 ac of freshwater emergent wetland, 86 ac of freshwater forested/shrub wetland, and 19 ac of other wetlands (PSEG 2015-TN4280).

It is likely that a new nuclear power plant at Site 7-1 would connect with the potential transmission line corridor that could be developed to address voltage and stability constraints within the PJM region (see Section 7.0). However, PSEG would need to develop a connector transmission line from Site 7-1 to the new grid stability line. Land-use disturbances associated with building this 5.4-mi-long connector line for Site 7-1 would include about 141 ac of planted/cultivated land, 5 ac of developed land, 9 ac of barren land, 63 ac of forested land, 59 ac of estuarine and marine deepwater area, 70 ac of estuarine and marine wetland, 6 ac of freshwater emergent wetland, 90 ac of freshwater forested/shrub wetland, and 9 ac of other wetlands (PSEG 2015-TN4280).

Site 7-1 has an existing site elevation between 15 and 35 ft MSL. PSEG estimated the excavation and fill quantities for Site 7-1 based on the quantities needed to raise the site to 12 ft above site grade (to a final grade elevation of about 36.9 ft MSL) to provide adequate final grade elevation to preclude flooding. PSEG estimates that the total fill quantity for Site 7-1 would be 4.6 million yd^3, with 1.0 million yd^3 of Category 1 fill and 3.6 million yd^3 of Category 2 fill. PSEG has stated that the fill material for Site 7-1 could come from the same sources as the fill material for the PSEG Site (i.e., existing permitted borrow sites in New Jersey, Delaware, and Maryland). However, PSEG would conduct testing to determine whether the material excavated from Site 7-1 could be reused as fill at the site (PSEG 2012-TN2282).

Overall, the land-use impacts of building a new nuclear power plant on Site 7-1 would be sufficient to alter noticeably, but not destabilize, important attributes of existing land uses at the site and in the vicinity. Building a new plant would directly disturb 432 ac of land and eliminate access to and use of another 555 ac of land that currently supports productive agricultural and rural residential uses. Building the new access road, rail spur, and water pipeline corridors for Site 7-1 would disturb an additional 246 ac of similar land uses off the site. Further, developing the new connector transmission corridor from Site 7-1 to the new grid stability lines would disturb an additional 412 ac of similar offsite land uses. In comparison, there are about 41,353 ac of planted/cultivated land, 9,828 ac of developed land, 2,261 ac of barren land, 13,015 ac of forested land, 10,170 ac of estuarine and marine deepwater area, 5,197 ac of estuarine and marine wetland, 2,262 ac of freshwater emergent wetland, 12,610 ac of freshwater forested/shrub wetland, and 3,382 ac of other wetlands in the vicinity of Site 7-1

(PSEG 2015-TN4280). The land-use changes resulting from building a new nuclear power plant at Site 7-1 would not noticeably affect these land-use resources. However, building a new plant on Site 7-1 would require that most of the 17 houses within the site boundaries be removed and that any residents be relocated, that access to an active church and a cemetery be restricted (if not eliminated), and that 196.8 ac of County Preserved Farmlands be developed.

Based on the information provided by PSEG and the review team independent review, the review team concludes that the combined land-use impacts of preconstruction and construction activities on and off the site for Site 7-1 would be noticeable. The review team reaches this conclusion as a result of the relocation of 17 residences and the restriction of access to an active church and a cemetery, which would alter noticeably, but not destabilize, important attributes of existing land uses at the site and in the vicinity.

Operational Impacts

The land-use impacts of operating a new nuclear power plant at Site 7-1 would be smaller than the impacts of building the plant, but they would still permanently eliminate almost all access to and use of 1,233 ac of land (not including transmission corridors) that supports productive agricultural uses, rural residential uses, and an active church and cemetery. Most of these impacts would occur during the building period for a new nuclear power plant, and no additional land-use impacts from operations would be expected. Additionally, there are sufficient agricultural and residential land-use resources in the vicinity, and the impacts would be minimal. Therefore, based on the information provided by PSEG and the review team independent review, the review team concludes that the land-use impacts of operating a new nuclear power plant at Site 7-1 would be negligible.

Cumulative Impacts

The geographic area of interest includes Salem County, New Jersey (in which Site 7-1 is located) and the other 24 counties located in the 50-mi region around the site. The 50-mi region includes counties in New Jersey, Delaware, Pennsylvania, and Maryland. The direct and indirect impacts to land use of building and operating a new nuclear power plant at Site 7-1 would be confined to Salem County, but the cumulative impacts to land use when combined with other actions (discussed below) would extend to other counties in New Jersey, Delaware, Maryland, and Pennsylvania.

Table 9-15 lists projects that, in combination with building and operating a new nuclear power plant at Site 7-1, could contribute to cumulative impacts in the region. One of the projects closest to Site 7-1 would be the continued operation of SGS and HCGS. In 2011, the NRC issued new operating licenses for SGS Unit 1 (expires 2036), SGS Unit 2 (expires 2040), and HCGS (expires 2046). The cumulative land-use impact would result from the combined commitment of land for a new plant at Site 7-1 (987 ac) with the land already dedicated to SGS and HCGS (734 ac). Although this would represent a relatively large land-use impact in Salem County, the cumulative impact to land use in the 50-mi region would be relatively small.

The only other nuclear projects listed in Table 9-15 within the 50-mi region are Peach Bottom Units 2 and 3 (located 45 mi northwest of Site 7-1) and Limerick Generating Station

Units 1 and 2 (located 40 mi north of Site 7-1). Because the Peach Bottom and Limerick projects are located so far from Site 7-1, the cumulative land-use impacts of their continued operation and development of Site 7-1 would be relatively minor in the regional context.

Another project that could occur in relatively close proximity to Site 7-1 is the USACE Delaware River Main Channel Deepening Project. In this project, the USACE is conducting dredging operations to deepen a section of the Delaware River, including the portion of the river adjacent to the existing PSEG property (USACE 2011-TN2262). The primary land-use impact of this deepening project would be the USACE use of some of the existing confined disposal facilities (CDFs) along the Delaware River for the disposal of dredge materials. The total dredging operation would generate an estimated 16 million yd^3 of spoil material. The USACE NEPA documentation for the channel deepening project (USACE 1997-TN2281; USACE 2009-TN2663; USACE 2011-TN2262) concludes that there would be no significant land-use impacts from the project.

A third project that could occur in close proximity to Site 7-1 is the potential transmission line corridor that could be developed to address voltage and stability constraints within the PJM region. In its ER (PSEG 2015-TN4280), PSEG identifies a new 5-mi-wide transmission "macro-corridor" known as the "West Macro-Corridor" (WMC). The WMC is 55 mi long and generally follows existing transmission line corridors from the existing PSEG property to the Peach Bottom Substation in Pennsylvania (PSEG 2015-TN4280). PSEG considers this WMC to be "the most effective route for addressing the regional voltage and stability constraints that PJM is trying to resolve" (PSEG 2013-TN2669).

In its ER, PSEG cites a GIS analysis that assumes a 5-mi-wide hypothetical macro-corridor and a transmission line ROW width of 200 ft within the corridor (PSEG 2015-TN4280). This PSEG analysis did not identify a specific 200-ft-wide ROW within the hypothetical corridor but calculated the amount of each land-use type that could be affected in a 200-ft-wide ROW based on each land-use type as a percentage of total land use within the corridor. However, PJM has not selected a specific route for the potential new transmission line. The review team has determined, based on the analysis performed by PSEG and the land uses that could be affected, that a new transmission line could have a noticeable impact on land uses within the region.

Most of the other projects listed in Table 9-15 are not expected to create noticeable cumulative impacts to land use in the 50-mi region when combined with building and operating a new nuclear power plant at Site 7-1. The other energy projects listed in Table 9-15 (the closest being Carneys Point Generating Plant and Pedricktown Combined Cycle Cogeneration Plant) are all too far from Site 7-1 and from each other to create noticeable cumulative land-use impacts in the region. The new development/redevelopment project listed (Camp Pedricktown Redevelopment) also is too far from Site 7-1 to create noticeable cumulative land-use impacts in the region. The parks and recreation activities listed (the closest being Supawna Meadows National Wildlife Refuge, Fort Mott State Park, and Mad Horse Creek WMA) are not expected to contribute to adverse land-use impacts, especially on the regional scale. Finally, the Salem County Solid Waste Landfill project listed in Table 9-15 is located too far from Site 7-1 to create noticeable cumulative land-use impacts in the region.

The GCRP report *Global Climate Change Impacts in the United States* (GCRP 2014-TN3472) summarizes the projected impacts of future climate changes in the United States. The report divides the United States into nine regions, and Site 7-1 is located in the Northeast region. The report indicates that climate change could increase precipitation, sea level, and storm surges in the Northeast region, thus changing land use through the inundation of low-lying areas that are not buffered by high cliffs. However, cliffs could experience increased rates of erosion as a result of frequent storm surges, flooding events, and sea-level rise. Forest growth could increase as a result of more CO_2 in the atmosphere. Existing parks, reserves, and managed areas would help preserve wetlands and forested areas to the extent that they are not affected by the same factors. In addition, climate change could reduce crop yields and livestock productivity, which might change portions of agricultural land uses in the region (GCRP 2014-TN3472). Thus, direct changes resulting from climate change could cause a shift in land use in the 50-mi region that would contribute to the cumulative impacts of building and operating a new nuclear power plant on Site 7-1.

Overall, when combined with other past, present, and reasonably foreseeable future actions, the cumulative land-use impacts of building and operating a new nuclear power plant at Site 7-1 (along with the new connector transmission line corridor) would be sufficient to alter noticeably, but not destabilize, important attributes of existing land uses in the 6-mi vicinity of the site and the larger 50-mi region. Therefore, based on the information provided by PSEG and the review team independent review, the review team concludes that the cumulative land-use impacts of developing Site 7-1 would be MODERATE. The incremental contribution of building and operating a new nuclear power plant at Site 7-1 would be a significant contributor to the cumulative impact.

9.3.3.2 Water Use and Quality

The following analysis includes impacts from building activities and operations at Site 7-1. The analysis also considers cumulative impacts from other past, present, and reasonably foreseeable future actions, including the other Federal and non-Federal projects listed in Table 9-15, that could affect water use and quality.

The potentially affected surface-water environment consists of the Delaware River Basin, which would be affected by water withdrawn from and wastewater discharged to the river. Site 7-1 is a 987-ac greenfield site in Salem County, New Jersey, located on undeveloped land 5 mi east of the Delaware River and about 13 mi northeast of the PSEG Site. Site 7-1 is flat with elevations across the site ranging from 15 to 35 ft MSL. PSEG has stated that the Delaware River would be the primary source of water (PSEG 2015-TN4280). The Delaware River reach adjacent to Site 7-1 lies in DRBC water-quality Zone 5, which is the same zone within which the PSEG Site is located.

Flow data for the Delaware River at USGS Gaging Station 01463500 at Delaware RM 131.0, near Trenton, New Jersey, are described in Section 2.3. This gaging station is located more than 60 mi upstream of the Site 7-1 conceptual water intake location at RM 67.9. The mean annual river flow at the Trenton gage is 12,004 cfs. Mean annual flow during the historic low-water period of 1961–1967 was 7,888 cfs, with the minimum monthly flow of 1,548 cfs recorded in July 1965.

As mentioned in Section 2.3, the Coastal Plain deposits dip and thicken to the southeast toward the coast. Site 7-1 is located northeast of the PSEG Site, and as a result, the hydrogeologic environment is somewhat different. In its ER, the applicant indicated that "plant groundwater requirements could be supplied by one or two wells drilled to the Kirkwood-Cohansey" aquifer system (PSEG 2015-TN4280). However, this unit is thought not to exist or to be very thin at the site. Because Site 7-1 is a greenfield site located away from the Delaware River, there is no hydraulic fill or alluvium. USGS studies (Martin 1998-TN2259; dePaul et al. 2009-TN2948) indicate that in north-central Salem County the uppermost aquifer is the Wenonah-Mount Laurel and that this unit outcrops in the area of Site 7-1. The major withdrawal centers for the Wenonah-Mount Laurel aquifer are outside the outcrop area to the east. Site 7-1 falls outside this usage area. As a result, it is unlikely that groundwater from this aquifer would be used for plant needs.

As indicated by dePaul et al. (2009-TN2948), salinity within the upper and middle Potomac-Raritan-Magothy (PRM) aquifers in the Site 7-1 area is below the drinking water standard (250 mg/L). These aquifers outcrop to the north at the Delaware River and each aquifer supplies in excess of 1 million gallons of water per year near Site 7-1. Regional pumping of the middle PRM has drawn down water levels about 17 ft in a USGS observation well near Site 7-1, and salinity within the lower PRM aquifer is at or above 250 mg/L in the vicinity of the site. If the PRM aquifer were to be used, groundwater needed for construction and operation of Site 7-1 would likely be obtained from the upper or middle PRM aquifers.

Building Impacts

Impacts to surface waters from building activities at Site 7-1 would be similar to those at the proposed PSEG Site and may occur from site-preparation and plant building activities. Potential impacts to surface water would result from physical alteration of surface-water bodies because of installation of intake and discharge structures; alteration of land surface and surface-water drainage pathways; potential for increased runoff from the site area that may include additional sediment load and building-related pollutants; and potential for impacts to wetlands, floodplains, and surface-water bodies from building transmission lines. Additional disturbance to the shoreline and river bottom may occur from building a new barge docking facility, if needed. The offsite building activities to support a new nuclear power plant would include building the rail spur, access roads, and other offsite facilities. Impacts from these activities are expected to be managed as described in Section 4.2 for the proposed PSEG Site and would be minor.

PSEG has proposed in Section 9.3.2 of its ER (PSEG 2015-TN4280) to withdraw surface water or groundwater for building activities. The review team assumes that the water use for building activities at Site 7-1 would be similar to that for the PSEG Site. As estimated by PSEG in Section 4.2 of its ER (PSEG 2015-TN4280), water use to support concrete plant operations, dust suppression, and potable water needs would be 119 gpm. Because water quality in the Delaware River is brackish near Site 7-1, potable and sanitary use of the river water is not expected.

Dewatering of the plant area and the nuclear island foundation would also likely be required to limit inflow from the Wenonah-Mount Laurel aquifer during construction at Site 7-1. Because this aquifer is unconfined and productive at Site 7-1, it is assumed that dewatering flow rates

would be reduced through the use of vertical low-permeability barriers, which would also limit the horizontal effects of dewatering. It is assumed that the extracted groundwater would be managed and disposed of in compliance with the permit requirements.

As mentioned above, the upper and middle PRM aquifers could supply water required for building at Site 7-1. Impacts from groundwater use and dewatering during construction activities would be limited due to the temporary time frame of construction. In addition, construction-related pumping would be bounded by the impacts from pumping to support plant operation. Therefore, the review team concludes that the groundwater-use impacts of building a new nuclear power plant at Site 7-1 would be minor.

During building, water-quality-related impacts would be similar to those expected for any other large project. Alterations to the Delaware River would occur during installation of the makeup water intake structure and the wastewater discharge structure. During installation of these structures, some additional turbidity in the river is expected because of disturbance of bottom sediments. However, these sediments would be localized to the area needed to install the structures and engineering measures would be in place as part of BMPs to minimize movement of the disturbed sediment beyond the immediate work area. These impacts would also be temporary and would not occur after the structures are installed. Because these activities would occur in waters of the United States, appropriate permits from the USACE and NJDEP would be required. PSEG would be required to implement BMPs to control erosion and sedimentation and discharge of building-related pollutants to the Delaware River or to nearby water bodies. Because the effects from building-related activities would be minimized using BMPs, would be temporary and localized, and would be controlled under various permits, the review team concludes that the impact from building-related activities on the water quality of the Delaware River and nearby water bodies would be minor.

During building activities for a new nuclear power plant at Site 7-1, groundwater quality may be affected by leaching of spilled effluents into the subsurface. The review team assumes that the BMPs PSEG has proposed for the PSEG Site would also be in place at Site 7-1 during building activities, and therefore the review team concludes that any spills would be quickly detected and remediated. In addition, groundwater impacts would be limited to the duration of these activities and therefore would be temporary. Because any spills related to building activities would be quickly remediated under BMPs, the activities would be temporary, and pumping rates would be greater during operations than during building, the review team concludes that the groundwater-quality impacts from building at Site 7-1 would be minimal

Operational Impacts

During operation of a new nuclear power plant at Site 7-1, surface water would be withdrawn from the Delaware River to provide makeup water to the new plant CWS. Because water quality in the Delaware River near Site 7-1 is brackish, similar to that at the PSEG Site, it is assumed that the withdrawal rate and the consumptive use rate at Site 7-1 would be the same as that at the PSEG Site: 78,196 gpm (174.2 cfs) and 26,420 gpm (58.9 cfs), respectively. As described in Section 5.2, applying an equivalent impact factor of 0.18 to account for the salinity of the withdrawn river water makes the water consumption equivalent to a freshwater consumption of 4,756 gpm (10.6 cfs). This equivalent freshwater consumptive use is

0.1 percent of the mean annual flow at Trenton, New Jersey, during the historic low-water period of 1961–1967 (7,888 cfs) and 0.7 percent of the minimum monthly flow (1,548 cfs) recorded in July 1965. Assuming similar tidal flows at Site 7-1 and at the proposed PSEG Site, the total consumptive losses associated with a new nuclear power plant at Site 7-1 would be less than 0.01 percent of the tidal flows. Because of the similarity of Site 7-1 to the PSEG Site, the review team determined that water-use impacts would be similar to those at the PSEG Site. The review team also determined that PSEG would need to acquire an additional 465 ac-ft or 6.9 percent of its currently allocated storage in the Merrill Creek reservoir to meet instream flow targets during a DRBC-declared drought. Merrill Creek reservoir has a storage capacity of 46,000 ac-ft, far exceeding that needed to meet the 465 ac-ft exceedance. In addition, DRBC allows for temporary or permanent acquisition of releases from other owners of Merrill Creek reservoir storage (DRBC 2004-TN2278). For these reasons, the review team determined that surface-water use for operations of a new nuclear power plant would be met without a noticeable impact to the instream flow targets in the Delaware River. Therefore, the review team concludes that the surface-water-use impact of operating a new nuclear power plant at Site 7-1 would be minor.

Because Site 7-1 is located near the PSEG Site, Delaware River water quality, flow characteristics, and river cross section are expected to be similar to those at the PSEG Site. Therefore, the review team concludes that the incremental water-quality impacts from operation of a new nuclear power plant at Site 7-1 would be similar to those determined for the PSEG Site in Section 5.2.3 and that the surface-water-quality impacts from operation of a new nuclear power plant at Site 7-1 would be minor.

Groundwater withdrawal, as indicated in Section 9.3.2 of the ER (PSEG 2015-TN4280), would be necessary to provide freshwater for plant uses because the Delaware River water is brackish in the Site 7-1 area. For the sake of consistency in comparison, it was assumed that the amount of groundwater withdrawal for general site purposes including the potable and sanitary water system, demineralized water distribution system, fire protection system, and other miscellaneous systems at Site 7-1 would be the same as that required at the PSEG Site. As discussed in ER Section 3.3 (PSEG 2015-TN4280) an average of 210 gpm and a maximum of 953 gpm would be needed to provide freshwater for plant uses. This water would likely be supplied from pumping of the upper or middle PRM aquifers. As discussed in Section 5.2.2.2, an independent evaluation completed by the review team indicated that pumping of the middle PRM aquifer at rates proposed by the applicant could draw down water levels within that aquifer 16.6 ft at a distance of 3 mi from the site. As mentioned above, groundwater levels have already been drawn down about 17 ft near Site 7-1 (dePaul et al. 2009-TN2948). According to ER Figure 2.3-20, existing groundwater production wells could be located as close as 1 mi from Site 7-1, much closer than the existing offsite groundwater wells nearest the PSEG Site (PSEG 2015-TN4280). Therefore, the impact of potential pumping on the nearest offsite wells would be greater at Site 7-1 than at the PSEG Site and would be noticeable.

During the operation of a new nuclear power plant at Site 7-1, impacts on groundwater quality could result from accidental spills. Because BMPs would be used to quickly remediate spills and no intentional discharge to groundwater would occur, the review team concludes that the groundwater-quality impacts from accidental spills at Site 7-1 would be minimal. Groundwater withdrawal for operation of a new plant at Site 7-1 would likely be from the upper or middle PRM

aquifers, which outcrop at the Delaware River east and north of Site 7-1. Although salinity is currently below drinking water standards in the region between Site 7-1 and the outcrop areas, additional pumping may increase salinity somewhat within the aquifers where they are recharged by the river. Because Site 7-1 is more than 5 mi from the Delaware River, the review team expects that any salinity increases from pumping at the site would be minor and would be localized to areas near the river. Therefore, the review team concludes that groundwater-quality impacts from the operation of a new plant at Site 7-1 would be minor.

Cumulative Impacts

The geographic area of interest is the entire Delaware River Basin. In addition to water-use and water-quality impacts from building and operations activities, this cumulative analysis considers past, present, and reasonably foreseeable future actions that could affect the same water resources. The actions and projects in the vicinity of Site 7-1 that are considered in this cumulative analysis are listed in Table 9-15.

The review team is aware of the potential climate changes that could affect the water resources available for cooling and the impacts of reactor operations on water resources for other users. Because Site 7-1 is located near the proposed PSEG Site, the potential changes in climate would be similar (GCRP 2014-TN3472). Therefore the review team concludes that the impact of climate change on water resources would be similar to that for the proposed site.

Cumulative Water-Use Impacts

Based on a review of the history of water-use and water-resources planning in the Delaware River Basin, the review team determined that past and present use of the surface waters in the basin has been noticeable, necessitating consideration, development, and implementation of careful planning.

Of the projects listed in Table 9-15, consumptive water use by SGS and HCGS were considered by the review team in evaluating cumulative surface-water impacts. Because the water quality and potential consumptive use of a new nuclear power plant at Site 7-1 would be similar to those at the PSEG Site, PSEG would need to acquire an additional 6.9 percent of its current allocation in the Merrill Creek reservoir. As stated in Section 5.2.2, the review team determined that obtaining this additional allocation was feasible and would ensure that a new nuclear power plant could operate without noticeable impacts to other water users even under declared drought conditions and without the need to release additional flows to meet instream flow targets in the Delaware River.

Mainly because of extensive past and present use of surface waters from the Delaware River, the review team concludes that the cumulative impact to surface-water use from past and present actions and building and operating a new nuclear power plant at Site 7-1 would be MODERATE. However, the review team further concludes that a new plant’s incremental contribution to the cumulative impact would not be significant.

Of the projects listed in Table 9-15, regional groundwater withdrawal was considered by the review team in evaluating cumulative groundwater impacts. The two business parks listed in

Table 9-15 would most likely be connected to the municipal water supply. Other projects do not use groundwater or are too far from Site 7-1 to interact with groundwater use at the site. However, as mentioned above, production wells could be located as close as 1 mi from the alternative site and groundwater-use impact from building and operating a new nuclear power plant at Site 7-1 would be noticeable. Therefore, the review team concludes that the cumulative impact on groundwater use would be MODERATE, and a new plant's incremental contribution to this impact would be significant.

Cumulative Water-Quality Impacts

As stated in Section 7.2.2.1, DRBC has implemented careful planning and regulation of water quality in the Delaware River Basin. Although there have been improvements in water quality in the Delaware River Basin because of careful planning and management policies put in place by DRBC (e.g., improved levels of dissolved oxygen), the presence of toxic compounds leads to advisories for fish consumption (DRBC 2008-TN2277). In its review of the PSEG license renewal application for SGS and HCGS, the NRC staff concluded that water quality will likely continue to be adversely affected by human activities in the Delaware River Basin (NRC 2011-TN3131). The review team concludes that past and present actions in the Delaware River Basin have resulted in noticeable impacts to water quality.

The projects listed in Table 9-15 may result in alterations to land surface, surface-water drainage pathways, and water bodies. These projects would need Federal, State, and local permits that would require implementation of BMPs. Therefore, the impacts to surface-water quality from these projects are not expected to be noticeable. The discharge for a plant at Site 7-1 would be located at Delaware RM 67.9, about 17 mi from the SGS discharge and outside the SGS thermal plume heat dissipation area (HDA). The area affected by the thermal plume from a plant at Site 7-1 would be small, would be localized near the discharge outlet, and would not interact with the thermal plumes from SGS. Therefore, the review team determined the cumulative impact of the combined discharges from SGS and a plant at Site 7-1 would not be noticeable.

Because of extensive past and present use of surface waters from the Delaware River, the review team concludes that the cumulative impact to surface-water quality in the Delaware River Basin from past and present actions and building and operating a new nuclear power plant at Site 7-1 would be MODERATE. However, the review team further concludes that a new plant's incremental contribution to this impact would not be significant.

Based on the proposed or possible projects listed in Table 9-15, additional impacts to groundwater quality are expected to be minimal. The two business parks may rely on groundwater for drinking water but would most likely be connected to the municipal water supply. Similarly, the business parks are expected to be connected to the municipal sewerage system and would not significantly impact groundwater quality. As discussed earlier, BMPs would be implemented and dewatering and pumping within the Site 7-1 area are unlikely to induce flow from an area of higher salinity into the Wenonah-Mount Laurel or PRM aquifers.

As discussed in Section 7.2, groundwater withdrawals within the geographic area of interest have noticeably altered the groundwater quality in localized areas where pumping occurs near aquifer recharge areas. Pumping near the PRM aquifer recharge areas is localized and not

likely to contribute to cumulative impacts near the site. Therefore, the review team concludes that the cumulative groundwater-quality impacts of past, present, and reasonably foreseeable future projects, as well as climate change, would be MODERATE, and a new plant's incremental contribution to the cumulative impact would not be significant.

9.3.3.3 Terrestrial and Wetland Resources

The following analysis includes potential impacts to terrestrial and wetland resources resulting from building activities and operations associated with a new nuclear power plant on Site 7-1. The analysis also considers other past, present, and reasonably foreseeable future actions that may impact terrestrial and wetland resources, including the other Federal and non-Federal projects listed in Table 9-15.

Site Description

Site 7-1 is located in Salem County, New Jersey. This is a flat greenfield site located 5 mi east of the Delaware River, which would act as the primary water source. The elevations on the site range from 15 to 35 ft above MSL. This site is a total of 987 ac in area (PSEG 2015-TN4280).

Site 7-1 is located in the Southern Piedmont Plains Landscape Region. This region contains important freshwater tidal waters and brackish waters of the upper estuary system of the Delaware River and Delaware River Estuary. The tidal freshwater marshes are considered among New Jersey's most rare and valuable habitat types. Additionally, the Southern Piedmont Plains contains important grassland components of the Delaware River Estuary system including fens, wet meadows, impounded agricultural lands, and upland agricultural lands. This zone is farmed extensively; however, the area still contains relatively large forest and wetland complexes in some locations. The terrestrial species of concern in the Southern Piedmont Plains are primarily found in wetland, forest, or grassland habitats (NJDEP 2008-TN3117).

The ecological conditions for Site 7-1 and the 6-mi vicinity are typical of the extensively farmed areas in the Southern Piedmont Plains. Most of the land is used for agriculture. The forested areas consist mainly of scattered woodlots and strips of trees along streams. Wetlands are mainly present in isolated low areas, and some are farmed. There are virtually no grasslands in the area. Offsite corridors for access roads, the rail spur, and water pipelines are largely restricted to the 6-mi vicinity, and the natural habitats within these corridors are similar to those found on Site 7-1 (PSEG 2015-TN4280).

Federally and State-Listed Species

No site-specific surveys for threatened and endangered species were conducted at Site 7-1. Information on protected and rare species that may occur in the area of Site 7-1 was obtained from NJDEP and the FWS ECOS. Four Federally listed species are known or believed to occur in the 6-mi vicinity of Site 7-1: the Federally listed swamp pink (*Helonias bullata*), bog turtle, northern long-eared bat (*Myotis septentrionalis*), and rufa red knot (*Calidris canutus rufa*). All four of the Federally listed species are listed as threatened. NJDEP considers all Federally listed species as endangered. In addition, 14 State-listed endangered species, 15 State-listed threatened species, and 76 species listed by NJDEP as species of special concern or regional priority wildlife species may occur in the area of Site 7-1 (FWS 2014-TN3333; NJDEP 2008-TN3117).

The NJDEP information shows that a total of nine listed animal species and one listed plant species have been recorded within about 1 mi of Site 7-1. The nearby Featherbed Lane WMA provides habitat for one additional species (Table 9-16) (PSEG 2015-TN4280). Documentation of the actual presence of any of these species on the site and along offsite corridors would require that detailed field surveys be conducted. NJDEP data also note the presence of two Natural Heritage Priority Sites in the area of Site 7-1 (Table 9-16). These are sites with specific habitats that contain protected and rare species. Additionally, there is one plant species, leatherwood (*Dirca palustris*), protected under the Highlands Water Protection and Planning Act (NJSA 13:20-1 et seq. –TN4310), that has the potential to be on Site 7-1 (PSEG 2015-TN4280).

Table 9-16. State and Federal Threatened, Endangered, and Rare Species Recorded in the Site 7-1 Area

Common Name	Scientific Name/Description	State or Regional Status-Rank	Federal Status
Plants			
Leatherwood	*Dirca palustris*	HL	
Birds			
Bald Eagle	*Haliaeetus leucocephalus*	E[(a)]/T[(b)]	
Bobolink	*Dolichonyx oryzivorus*	T[(a)]/SC[(b)]	
Cooper's Hawk	*Accipiter cooperii*	SC[(a)]	
Great Blue Heron	*Ardea herodias*	SC[(a)]	
Osprey	*Pandion haliaetus*	T[(a)]	
Upland Sandpiper	*Bartramia longicauda*	E[(a,b)]	
Grasshopper Sparrow	*Ammodramus savannarum*	T[(a)]/SC[(b)]	
Vesper Sparrow	*Pooecetes gramineus*	E[(a)]/SC[(b)]	
Reptiles			
Bog Turtle	*Glyptemys muhlenbergii*	E	T
Eastern Box Turtle	*Terrapene carolina carolina*	SC	
Natural Heritage Priority Sites			
Culliers Run	*Floodplain in rich wooded ravine*	B4	
Mannington Marsh	*Freshwater intertidal marsh*	B4	

(a) Breeding
(b) Nonbreeding
Abbreviations
HL = protected by Highlands Water Protection and Planning Act (NJSA 13:20-1 et seq. –TN4310) within Highlands Preservation Area
E = endangered species
T = threatened species
SC = special concern
B4 = moderate significance on global level

Source: PSEG 2015-TN4280.

Wildlife Sanctuaries, Refuges, and Preserves

There are a few wildlife sanctuaries, refuges, and preserves within the 6-mi vicinity of Site 7-1 (Figure 9-8) that have the potential to be affected by building and operating a new nuclear power plant (PSEG 2012-TN2389). This includes two WMAs and one preserve. A brief description of these areas is given below.

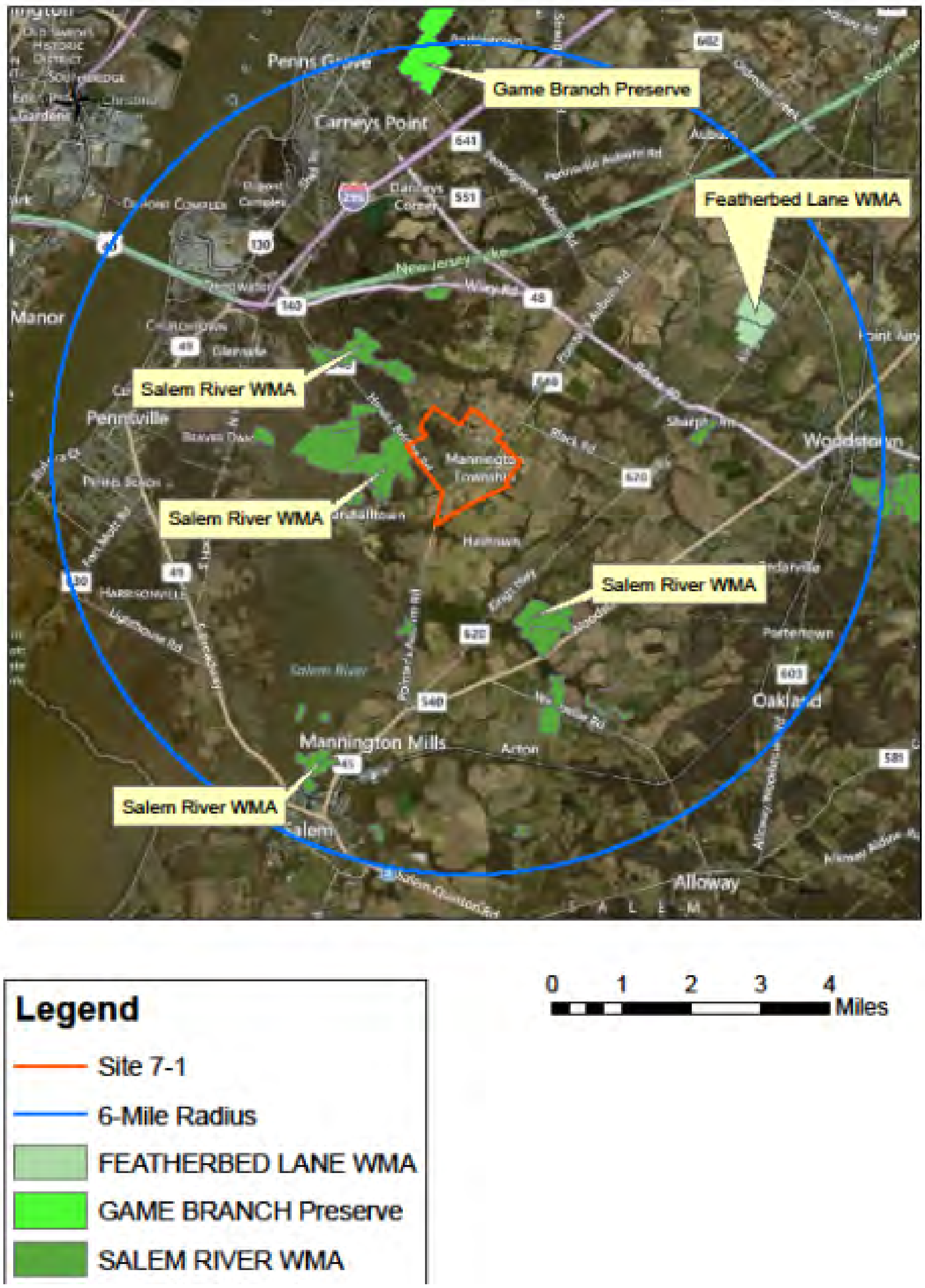


Figure 9-8. Wildlife Sanctuaries, Refuges, and Preserves Within the 6-mi Vicinity of Alternative Site 7-1 (Source: Modified from PSEG 2012-TN2389)

Salem River Wildlife Management Area

Salem River is a 3,225-ac WMA located in Carneys Point, Mannington, and Pilesgrove Townships, Salem County. This WMA has a parking area and viewing platform that overlooks an expansive marsh along Mannington Creek. The WMA provides foraging habitat for migratory waterfowl such as snow geese (*Chen caerulescens*), Ross's geese (*Chen rossii*), teal (*Anas sp.*), and other ducks. Additionally, it supports passerines and raptor species. Other wildlife that occur at this site include muskrats (*Ondatra zibethicus*), river otters (*Lontra canadensis*), and groundhogs (*Marmota monax*). Fishing and hunting are allowed on the WMA during designated seasons (NJWLT 2014-TN3200).

Featherbed Lane Wildlife Management Area

Featherbed Lane is a 190-ac WMA located in Pilesgrove Township, Salem County. Public access to this WMA is restricted to April 15 through September 1. Roadside bird watching is allowed on the area during this time period. The WMA contains habitat for the State-endangered vesper sparrow (*Pooecetes gramineus*), the State-threatened grasshopper sparrow (*Ammodramus savannarum*), bobolink (*Dolichonyx oryzivorus*), and upland sandpiper (*Bartramia longicauda*) (PSEG 2012-TN2389).

Game Branch Preserve

Game Branch is a 391-ac preserve located in Carneys Point and Oldman's Townships, Salem County. The preserve is one of the model holdings of the New Jersey Land Trust. It is a critical area for local and migratory wildlife. It has some of the most extensive wetland forests in the region. Game Branch Preserve is located less than 1 mi from the Delaware River and acts as an important stopover location for migratory songbirds. Areas of unfragmented forest provide nesting habitat for interior forest species including scarlet tanager (*Piranga olivacea*) and ovenbird (*Seiurus aurocapilla*). Shallow seasonal ponds are scattered throughout the forested wetlands. These vernal ponds provide habitat requirements for frogs and salamanders to breed. There are several old agricultural fields on the site that are managed specifically to provide wildlife habitat. The trust has cleared overgrown brush and replanted areas with warm-season grasses aimed at promoting northern bobwhite (*Colinus virginianus*) habitat using funds from the Natural Resources Conservation Service Wildlife Habitat Incentives Program (PSEG 2012-TN2389).

Building Impacts

Building a new nuclear power plant at Site 7-1 would have a direct impact (permanently and temporarily) on 432 ac of land. A total of 555 ac of land within the site boundaries would not be directly disturbed. However, certain building activities would result in indirect disturbance (noise, dust, etc.) to much of the area within the site boundaries. This could result in additional wildlife impacts in terms of affecting movements and causing further displacement from the site. The development of the access road, rail spur, and water pipeline corridors would result in the disturbance of an additional 246 ac of potential habitat. In total, 1,233 ac of potential habitat would be directly or indirectly impacted as a result of building a new nuclear power plant at Site 7-1. The total acreage of forest, wetlands, and grassland habitat on the site was estimated

based on GIS mapping data. Habitat disturbances associated with building a new nuclear power plant at Site 7-1 and the access road, rail spur, and water pipeline to support the plant include impacts to about 971 ac of planted/cultivated land, 14 ac of developed land, 46 ac of barren land, 116 ac of forestland, 1 ac of estuarine and marine deepwater areas, 8 ac of freshwater emergent wetland, 86 ac of freshwater forested/shrub wetland, and 19 ac of other wetlands (PSEG 2015-TN4280).

Site 7-1 could connect with the potential transmission line corridor that could be developed to address voltage and stability constraints within the PJM region (see Section 7.0). PSEG would need to develop a connector line that would extend 5.4 mi from Site 7-1 to the grid stability transmission line and disturb a total of 412 ac off the site. Habitat disturbances associated with building a new transmission line for Site 7-1 include about 141 ac of planted/cultivated land, 5 ac of developed land, 9 ac of barren land, 63 ac of forested land, 59 ac of estuarine and marine deepwater area, 70 ac of estuarine and marine wetland, 6 ac of freshwater emergent wetland, 90 ac of freshwater forested/shrub wetland, and 9 ac of other wetlands (PSEG 2015-TN4280).

The amount of habitat that would be potentially impacted by building a new nuclear power plant at Site 7-1 is minor in comparison with the acreage of similar habitat present in the 6-mi vicinity. There are about 41,353 ac of planted/cultivated land, 9,828 ac of developed land, 2,261 ac of barren land, 13,015 ac of forested land, 10,170 ac of estuarine and marine deepwater area, 5,197 ac of estuarine and marine wetland, 2,262 ac of freshwater emergent wetland, 12,610 ac of freshwater forested/shrub wetland, and 3,382 ac of other wetlands in the 6-mi vicinity of Site 7-1 (PSEG 2015-TN4280). In addition, onsite habitat is generally limited to areas that are relatively small and isolated from larger areas of habitat in the 6-mi vicinity. Therefore, the impacts on terrestrial and wetland habitats due to building activities are expected to be negligible.

There is the potential for impacts to open country bird species (e.g., bobolink, eastern meadowlark, grasshopper sparrow, and vesper sparrow) and those that frequent smaller woodlots (e.g., Cooper's hawk [*Accipiter cooperii*]). Inadvertent impacts to slower moving species (e.g., eastern box turtle [*Terrapene carolina carolina*]) are also a possibility. Such impacts would be expected to be minor for most species due to the relatively minimal impacts to natural habitats and the fact that there are extensive areas of similar habitats in the 6-mi vicinity. However, wetland and forested areas are considered important resources for Federally listed and proposed Federally listed species. The loss of about 114 ac of wetlands and 116 ac of forest could affect the Federally listed bog turtle and the proposed Federally listed northern long-eared bat. Impacts to these resources could warrant mitigation. Therefore, impacts to these listed species as a result of building a new nuclear power plant could be noticeable, but not destabilizing.

Both of the identified Natural Heritage Priority Sites are more than 1 mi from Site 7-1, and neither is crossed by any of the offsite corridors. Portions of Salem River WMA would border the western boundary of Site 7-1. It has not been determined whether building offsite support structures such as the transmission line, access road, rail spur, and water pipeline would affect the WMA. Additionally, wildlife species could be affected by the nearby building activities.

However, it is expected that neither the Natural Heritage Priority Sites nor the WMA would be significantly affected by building a nuclear power plant on Site 7-1.

It is expected that a project of this size would result in impacts to terrestrial and wetland resources, including habitat loss, fragmentation, and disturbance. Building a nuclear power plant would result in loss of available onsite habitat. Noise, lights, and dust during building activities could displace species in adjacent areas, reducing viable habitat. Less mobile species would be impacted the most by building a new nuclear power plant at Site 7-1, and some mortalities could occur. It is expected that most wildlife species would be capable of moving to habitat in adjacent areas. These displaced species may also experience further impacts, resulting from increased competition for more limited resources. Adjacent WMAs, preserves, and refuges could be affected by increased demand for limited resources as a result of species displacement. Habitat available on Site 7-1 is common to Salem County, and sufficient terrestrial and wetland habitat resources exist in the Southern Piedmont Plains. However, the loss of wetland and forest habitat important to Federally listed and proposed Federally listed species would be noticeable. Thus, the review team has determined that the impacts from building a new nuclear power plant at Site 7-1 would be noticeable, but not destabilizing.

Operational Impacts

Potential impacts to terrestrial and wetland resources that may result from operation of a new nuclear power plant at Site 7-1 include those associated with cooling towers, transmission system structures, maintenance of transmission line ROWs, and the presence of nuclear power plant facilities that permanently eliminate habitat (PSEG 2015-TN4280). Operational impacts would be similar to those described in Section 5.3.1, although there may be minor differences as a result of topography, climate, and elevation. The review team has determined that the operational impacts to terrestrial and wetland resources at Site 7-1 would be minimal.

Cumulative Impacts

Several past, present, and reasonably foreseeable future projects could affect terrestrial and wetland resources in ways similar to building and operating a new nuclear power plant at Site 7-1. Table 9-15 lists these projects, and a description of their contributions to cumulative impacts to terrestrial and wetland resources is provided below. The geographic area of interest for terrestrial and wetland resources is the 6-mi vicinity around site 7-1 shown in Figure 9.8.

The Piedmont Plains suffered nearly 50 percent of all development that occurred in New Jersey between 1984 and 1995. Grassland, wetland, upland forest, and estuarine emergent wetlands sustained the greatest losses. Although the area has suffered extensive losses due to development, large areas of smaller fragmented habitats exist (NJDEP 2008-TN3117). WMAs and parks in Table 9-15 are not expected to contribute to further adverse impacts to terrestrial and wetland resources.

Most of the projects listed in Table 9-15 are operational and have resulted in the conversion of natural areas to industrial and commercial development. These past actions have resulted in loss and/or fragmentation of natural habitat and displacement of wildlife. These projects include operational nuclear power plants located at the HCGS, SGS, Limerick Generating Station, and

Peach Bottom Atomic Power Station sites. Additionally, three operational fossil-fuel power plants and the Salem County solid-waste landfill would continue to contribute to cumulative impacts to terrestrial and wetland resources. The development and operation of these projects would continue to reduce, fragment, and degrade natural forest, open field, and wetland habitats in the Southern Piedmont Plains. Operational projects with tall structures, such as the cooling towers at HCGS, would cause avian and bat mortalities. However, the projects listed are spread throughout the region, and avian and bat mortalities as a result of collision with tall structures would not cause a noticeable effect to those populations.

Future residential development and further urbanization of the area would result in the continued increase in fragmentation and loss of habitat. NJLWD projects that the population of Salem County will increase by about 5 percent between 2010 and 2030 (NJLWD 2014-TN3332). Future urbanization in the area of Site 7-1 could result in further losses of agricultural lands, wetlands, and forested areas. Urbanization in the vicinity of Site 7-1 would reduce area in natural vegetation and open space and decrease connectivity between wetlands, forests, and other wildlife habitat. The loss of habitats as a result of urbanization would result in added pressures to the remaining habitat available for wildlife populations. However, it is not expected that these activities would substantially affect the overall availability of wildlife habitat or travel corridors near Site 7-1 or the general extent of forested areas in the 6-mi vicinity.

Other reasonably foreseeable projects planned in the area of Site 7-1 that could add to the cumulative impacts include a site-redevelopment project as the result of a Base Realignment and Closure (BRAC) for Camp Pedricktown and the USACE channel deepening project. The Camp Pedricktown redevelopment area is currently developed/disturbed and, therefore, would not further impact any terrestrial and wetland resources. The USACE channel deepening project involves dredging and deepening portions of the main channel of the Delaware River (USACE 2011-TN2262). Terrestrial and wetland resources could be affected by the disposal of dredging materials, which could potentially require new disposal facilities. However, the USACE NEPA documentation for the channel deepening project concludes that there are sufficient dredge disposal areas in the region and there would be no significant impacts from the project (USACE 1997-TN2281; USACE 2009-TN2663; USACE 2011-TN2262).

The third project with the potential to affect terrestrial and wetland resources is the proposed transmission line corridor being developed to address voltage and stability constraints within the PJM region. In its ER (PSEG 2015-TN4280), PSEG conducted a study of a hypothetical 5-mi-wide macro-corridor known as the WMC and transmission line ROW that extends 55 mi from the existing PSEG property to Peach Bottom Substation in Pennsylvania. The transmission line ROW within the corridor is expected to be 200 ft wide. The development of the transmission line corridor would cause disturbances to more than 1,500 ac of land. Habitats that could be affected include barren land, deciduous forests, evergreen forests, mixed forest, agricultural land, woody wetlands, and emergent wetlands (PSEG 2015-TN4280). The exact amounts of the resources are not known, and it is expected that the project would cause fragmentation and degradation of terrestrial and wetland resources. However, the corridor would be expected to follow existing ROWs to the extent practicable. A new transmission line ROW would cause wildlife mortalities as a result of operations and maintenance. However, mortalities would not be expected to have a noticeable impact on wildlife populations, and sufficient terrestrial and wetland habitats exist elsewhere in the Southern Piedmont Plains. PSEG identified more than

27,000 ac of wetland and 36,000 ac of forestland resources in the 5-mi-wide corridor that could be traversed by the potential new transmission line ROW. It is unknown exactly how much of these wetlands and forestlands would be affected by the ROW, and mitigation may be warranted. The review team has determined that as a result of potential losses of wetland resources, the impact of the new transmission line ROW to terrestrial and wetland resources would be noticeable.

The report on climate change impacts in the United States provided by GCRP (2014-TN3472) summarizes the projected impacts of future climate changes in the United States. The report divides the United States into nine regions. Site 7-1 is located in the Northeast region. The GCRP climate models for this region project temperatures to rise over the next several decades by 4.5°F to 10°F if emissions continue or 3°F to 6°F if emissions are reduced substantially. Frequency, intensity, and duration of heat waves are projected to increase under both of the warming scenarios but with larger increases under the continuing emissions scenario. Winters are projected to be much shorter with fewer cold days and more precipitation. With higher temperatures, and earlier winter and spring snow melt, seasonal drought risk is projected to increase in summer and fall (GCRP 2014-TN3472). Increased frequency of summer heat stress can also impact crop yields and livestock productivity in the Northeast region. New Jersey is projected to experience 60 additional days above 90°F by mid-century under the continuing emissions scenario. Sea level is projected to rise more than the global average due to land subsidence, with more frequent severe flooding and heavy downpours. These projected changes could potentially alter wildlife habitat and the composition of wildlife populations. Large-scale shifts in the ranges of wildlife species and the timing of seasons and animal migration that are already occurring are very likely to continue.

The potential cumulative impacts to terrestrial and wetland resources from building and operating a new nuclear power plant on Site 7-1, in combination with the other activities described above, would noticeably alter terrestrial and wetland resources. These activities would result in the loss or modification of terrestrial and wetland habitats, which could potentially affect important species that live in or migrate through the area. For these reasons, the review team has concluded that impacts to terrestrial and wetland resources from building and operating a new nuclear power plant at Site 7-1 in conjunction with other past, present, and reasonably foreseeable future actions would be noticeable. Building and operating a new nuclear power plant at Site 7-1 would contribute to the noticeable impacts.

Summary

Potential impacts to terrestrial and wetland resources were evaluated based on information provided by PSEG, the conceptual layout of a new nuclear power plant at Site 7-1, and an independent review by the review team. Permanent impacts to terrestrial and wetland habitat and wildlife would result in some localized effects on these resources. However, these resources are common to the area, and impacts would be minimal. Any terrestrial and wetland resources temporarily disturbed by building a new nuclear power plant are expected to return to predisturbed conditions. The potential loss of habitat important to Federally listed species would be a noticeable impact, but would not be destabilizing. Operational impacts to terrestrial and wetland resources would be similar to those at the PSEG Site. Therefore, the conclusion of the review team is that cumulative impacts on terrestrial and wetland habitat and wildlife, including

threatened and endangered species, would be noticeable in the surrounding landscape and therefore MODERATE. The MODERATE impact level is based on the potential loss and fragmentation of habitat important to Federally listed species. Building and operating a new nuclear power plant at Site 7-1 would be a significant contributor to the cumulative impact.

9.3.3.4 Aquatic Resources

The following impact analysis includes impacts from building activities and operations on aquatic ecology resources at Site 7-1. The analysis also considers cumulative impacts from other past, present, and reasonably foreseeable future actions that could affect aquatic resources, including the other Federal and non-Federal projects listed in Table 9-15. In developing this EIS, the review team relied on reconnaissance-level information to perform the alternative site evaluation in accordance with ESRP 9.3 (NRC 2000-TN614). Reconnaissance-level information is data that are readily available from regulatory and resources agencies (e.g., NJDEP, NMFS, and FWS) and other public sources such as scientific literature, books, and Internet websites. It can also include information obtained through site visits (NRC 2012-TN2498; NRC 2012-TN2499; NRC 2012-TN2855) and documents provided by the applicant.

Affected Environment

The affected aquatic environment consists of the Delaware River Estuary in the vicinity of Delaware RM 67.9 and numerous salt marsh creek systems and streams on and near Site 7-1 (S&L 2010-TN2671). The water withdrawal rate from the Delaware River Estuary for Site 7-1 would be the same as for a new nuclear power plant at the PSEG Site (78,196 gpm) because Site 7-1 is located in the same DRBC water-quality zone. Water availability issues would also be the same as with the PSEG Site in that an additional 6.9 percent of the Merrill Creek reservoir allocation during drought conditions would be needed, as described in Section 5.2.2. There are no known exceptional aquatic resources at Site 7-1 (PSEG 2015-TN4280).

Commercial/Recreational Species

Site 7-1 has the same species as those listed for the PSEG Site (Section 2.4.2.3). Commercial fisheries in the Delaware River Estuary and in offshore Atlantic waters for the Delaware River Estuary include American Eel, American Shad (*Alosa sapidissima*), Atlantic Croaker (*Micropogonias undulatus*), Atlantic Menhaden (*Brevoortia tyrannus*), Black Drum (*Pogonias cromis*), Black Sea Bass (*Centropristis striata*), Bluefish (*Pomatomus saltatrix*), Butterfish (*Peprilus triacanthus*), Channel Catfish, Conger Eel (*Conger oceanicus*), Northern Kingfish (*Menticirrhus saxatilis*), Northern Searobin (*Prionotus carolinus*), Scup (*Stenotomus chrysops*), Silver Hake (*Merluccius bilinearis*), Spot (*Leiostomus xanthurus*), Striped Bass, Summer Flounder (*Paralichthys dentatus*), Weakfish (*Cynoscion regalis*), White Perch, Windowpane Flounder (*Scophthalmus aquosus*), Winter Flounder (*Pseudopleuronectes americanus*), blue crab (*Callinectes sapidus*), eastern oyster (*Crassostrea virginica*), horseshoe crab (*Limulus polyphemus*), knobbed whelk (*Busycon carica*), channeled whelk (*Busycotypus canaliculatus*), and the northern quahog clam (*Mercenaria mercenaria*). All of these species are also considered recreationally important, with the exception of American Shad, Atlantic Menhaden, Butterfish, Conger Eel, Silver Hake, Windowpane Flounder, eastern oyster, horseshoe crab, knobbed whelk, channeled whelk, and northern quahog clam, and are described in detail in

Section 2.4.2.3. Note that since 2008 there has been a moratorium in place on the harvest of horseshoe crabs in New Jersey (ASMFC 2014-TN3511).

Non-Native and Nuisance Species

Site 7-1 has the same potential for nuisance species as indicated for the PSEG Site (Section 2.4.2.3). These include the Asian shore crab (*Hemigrapsus sanguineus*), Chinese mitten crab (*Eriocheir sinensis*), Northern Snakehead, and Flathead Catfish.

Essential Fish Habitats

The Site 7-1 water intake and discharge areas on the Delaware River Estuary are designated as essential fish habitat (EFH) for many species by the Mid-Atlantic Regional Fishery Management Council, and the NMFS considers the estuarine portion of the Delaware River and tidal waters near the PSEG Site to be EFH for 15 species (PNNL 2013-TN2687; NMFS 2013-TN2804), as described in Section 2.4.2.3. Due to proximity of Site 7-1 to the PSEG Site, EFH would be expected to be similar for Site 7-1.

Federally and State-Listed Species

There are no critical habitats designated by NMFS or FWS in the vicinity of Site 7-1 (NMFS 2013-TN2614; FWS 2013-TN2147). Listed species found near the proposed water intake and discharge structures, near the possible barge facility, and along the proposed transmission line corridor are listed in Table 9-17 (NMFS 2013-TN2804).

Table 9-17. Federally and State-Listed Aquatic Species in the Delaware River Estuary Near Site 7-1

Species Name	Common Name	Federal Status[a]	State Status[b,c]
Caretta caretta	Loggerhead sea turtle[d]	Threatened	Endangered
Chelonia mydas	Atlantic green sea turtle[e]	Endangered	Endangered[b] Threatened[c]
Lepidochelys kempii	Kemp's ridley sea turtle	Endangered	Endangered
Acipenser brevirostrum	Shortnose Sturgeon	Endangered	Endangered
Acipenser oxyrinchus oxyrinchus	Atlantic Sturgeon[f]		Endangered

Sources:
(a) NMFS 2013-TN2614.
(b) DNREC 2013-TN3067.
(c) NJDEP 2012-TN2186; NJDEP 2013-TN2722.
(d) Northwest Atlantic distinct population segment (DPS).
(e) Proposed DPS for North Atlantic (T) (80 FR 15271-TN4272).
(f) Gulf of Maine DPS (T), New York Bight DPS (E), Chesapeake Bay DPS (E), Carolina DPS (E), and South Atlantic DPS (E) (77 FR 5880-TN2081; 77 FR 5914-TN4365).

The Kemp's ridley sea turtle (*Lepidochelys kempii*) is listed as Federally and State endangered. The Federally threatened Northwest Atlantic distinct population segment (DPS) of the loggerhead sea turtle (*Caretta caretta*) is listed as State endangered for both New Jersey and Delaware. The Atlantic green sea turtle (*Chelonia mydas*) is listed as endangered at both the Federal and State of Delaware levels and is listed as threatened in the State of New Jersey. All sea turtles have certain life-history similarities in that females swim ashore to sandy beaches

and deposit eggs in nesting pits that are covered to allow incubation. Juveniles hatch, struggle out of the sandy nest, and make their way to their respective ocean habitats. Although there are no known records of sea turtles nesting along Delaware Bay beaches; sea turtles have been observed to forage in Delaware Bay waters.

Adult Shortnose Sturgeon use freshwater for spawning and estuarine and marine habitats for feeding. Juveniles migrate downriver to estuarine waters and may go back and forth between freshwater and estuarine habitats for several years before maturing to adults. Adults sometimes migrate to marine habitats for feeding but live the majority of their life cycle in estuarine habitats (Rohde et al. 1994-TN2208; NOAA 2012-TN2173). Migration to spawning habitat occurs in late winter and spring, and adults return to estuarine waters in May and June (Gilbert 1989-TN2149). Spawning occurs in freshwaters characterized by low-to-moderate velocities and over substrates that include clay, sand, gravel, and woody debris. Sturgeon feed on benthic invertebrates such as snails, insect larvae, crustaceans, and worms (Gilbert 1989-TN2149). Shortnose Sturgeon occur in the Delaware River system (NOAA 2012-TN2173). A Shortnose Sturgeon was collected in a bottom trawl from the Delaware River Estuary just downriver of the PSEG Site in 2004 (PSEG 2005-TN2566). Two Shortnose Sturgeon were collected in 2008 and one in 2010 from bottom trawl sampling between Delaware River Kilometer (RKM) 100 and RKM 120 (RM 62.1 and RM 74.6), which is within the vicinity of the proposed in-water installation and potential dredging activities for Site 7-1 (PSEG 2009-TN2513; PSEG 2011-TN2571).

Atlantic Sturgeon share many life-history characteristics with the Shortnose Sturgeon in that adults migrate to freshwater to spawn and feed on benthic invertebrates such as worms, crustaceans, and aquatic insects (Gilbert 1989-TN2149). Unlike Shortnose Sturgeon, adult Atlantic Sturgeon prefer more marine habitats and make extensive migrations away from natal estuaries beginning as subadults (Gilbert 1989-TN2149). Historically, the Delaware River supported the largest population of Atlantic Sturgeon along the Atlantic coast (Secor and Waldman 1999-TN2207). Tagging studies in 2005 and 2006 indicated that Atlantic Sturgeon followed migration patterns similar to Shortnose Sturgeon with spawning potentially occurring mid-to-late June in the upper tidal Delaware reaches between Philadelphia, Pennsylvania, and Trenton, New Jersey (Simpson and Fox 2007-TN2194). Gill net surveys by the Delaware Division of Fish and Wildlife collected more than 1,700 juveniles near Artificial Island and the Cherry Island Flats (downriver of Site 7-1) between 1991 and 1998 (ASSRT 2007-TN2082). A single Atlantic Sturgeon was collected in 2004 and 2009 in bottom trawl sampling in Delaware River Estuary waters between RKM 100 and RKM 120 (RM 62.1 and RM 74.6), which is within the vicinity of the proposed in-water installation and potential dredging activities for Site 7-1 (PSEG 2005-TN2566; PSEG 2010-TN2570).

Three New Jersey threatened freshwater mussel species may occur in the vicinity of Site 7-1: the tidewater mucket and triangle floater (described in Section 9.3.2.4) and the eastern pondmussel (*Ligumia nasuta*) (described below). They are listed as occurring in Salem County, New Jersey (NatureServe 2012-TN2182; NatureServe 2012-TN2183; NatureServe 2012-TN2184; respectively). However, there are no State-listed occurrences of freshwater mussel species within a 1-mi radius of either the Site 7-1 intake (NJDEP 2013-TN2722) or the Site 7-1 location (NJDEP 2013-TN3567).

The eastern pondmussel can be found in the Delaware River in New Jersey and is associated with tidewater tributaries where the substrate is characterized by silt and sand. The host fish species for the eastern pondmussel is unknown (NJDEP 2013-TN2188). The eastern pondmussel is State-listed as threatened in New Jersey (NJDEP 2012-TN2186) and endangered in Delaware (DNREC 2013-TN3067). Populations of eastern pondmussel occur in Burlington, Camden, Cumberland, Gloucester, and Salem Counties in southern New Jersey and Sussex County in Delaware (NatureServe 2012-TN2184).

Field studies would be required to definitively determine whether any rare or protected species are present in streams in the project area. Federally endangered Shortnose and Atlantic Sturgeon are known to occur near the proposed areas for in-water installation and potential dredging activities for Site 7-1.

Building Impacts

Building the plant structures, roads, and transmission line and switchyard would disturb streams on the site and in offsite corridors. A total of 8,967 linear ft of streams would be affected by building activities on Site 7-1: the access road, rail spur, and water pipeline corridors (PSEG 2015-TN4280). In addition to buildings and other structures, buried water intake and discharge pipes would run 5.1 mi from the Delaware River Estuary to the site. The potential to affect almost 9,000 ft of streams represents 0.3 percent of the total length of streams within 6 mi of the site. A new transmission corridor and switchyard installation could affect an estimated 30,936 ft of streams, which represents 1.1 percent of the total stream lengths in the geographic area (S&L 2010-TN2671). However, potential impacts to streams from transmission corridor installation could be avoided or minimized by final corridor placement and use of BMPs to reduce erosion and sedimentation effects from building activities (PSEG 2015-TN4280).

The installation of the water intake structures and possibly a barge facility with a turning basin would result in disturbance of benthic habitat in the Delaware River Estuary. Dredging would disturb about 7 ac of bottom habitat (about 100,000 yd^3 dredged) for the intake structure and possibly 67 ac (possibly 1,143,000 yd^3 dredged) for the barge facility (S&L 2010-TN2671). A barge inlet channel would not be required. Installation and site-preparation activities could temporarily affect water quality but would require Federal and State permitting and use of BMPs to minimize and mitigate the temporary and localized effects. Effects on aquatic organisms are expected to be minimal and temporary because adjacent habitat is accessible and mobile aquatic organisms such as fish and most macroinvertebrates would be able to avoid or move away from the affected area during intake installation activities, but effects could be greater if the installation of a barge facility with a turning basin is required. However, the impacts of building a new nuclear power plant at Site 7-1 on the aquatic ecology of the Delaware River Estuary and streams on the site and in pipeline corridors would be minimal.

Operational Impacts

During operation of a new nuclear power plant at Site 7-1, there would be no direct discharges and few impacts to small streams on the site. Operation of the cooling and service water systems would require water to be withdrawn from and discharged back to the Delaware River Estuary, as described for a new nuclear power plant at the PSEG Site. Aquatic impacts

associated with impingement and entrainment of aquatic biota in the Delaware River Estuary and discharge of cooling water to the Delaware River Estuary could occur. Because the specifications associated with the water intake structure include a closed-cycle cooling system designed to meet the EPA Phase I regulations for new facilities (66 FR 65256-TN243), the maximum through-screen velocity at the water intake structure would be less than 0.5 fps. Thus, if a new nuclear power plant is built at Site 7-1, the anticipated impacts to aquatic communities from impingement and entrainment in the Delaware River Estuary are not expected to be different from those described in the analysis presented in Section 5.3.2 for the PSEG Site and are expected to be minimal. Operational impacts associated with water quality and discharge cannot be determined without additional detailed analysis but are also expected to be similar to the effects described for the PSEG Site. Maintenance activities on the site and in offsite corridors would follow BMPs required by Federal and State permits to minimize impacts on aquatic resources. Consequently, impacts on aquatic ecology due to project operations at Site 7-1 are expected to be minor.

Cumulative Impacts

The geographic area of interest for aquatic resources is the Delaware River Estuary. Past alteration and degradation of the Delaware River Estuary, as described in Sections 2.4.2.1 and 7.3.2, have had long-term noticeable and sometimes destabilizing consequences on the aquatic resources within the Delaware River Basin and continue to be the subject of numerous restoration activities in targeted portions of the area. For assessment of cumulative impacts for Site 7-1, the ROI includes a 6-mi radius of water resources around the site and a 6-mi radius around the point of the water intake and discharge structures on the Delaware River Estuary.

The non-nuclear plant projects listed in Table 9-15 may result in alterations to surface-water drainage pathways and water bodies. It is not expected that these projects would have noticeable effects on water quality within the vicinity of Site 7-1 because they would need Federal, State, and local permits that require implementation of BMPs. The past, current, and future operation of SGS and HCGS will result in continued losses of aquatic species through impingement and entrainment at the water intake systems and alteration of thermal profiles in the immediate Delaware River Estuary area located near these facilities. Ongoing restoration efforts through the PSEG Estuary Enhancement Program (EEP) will continue to provide mitigation for losses by increasing available habitat for early life stages of aquatic organisms and restoring previously fragmented habitats. A grid stability transmission line may be necessary for operation of a new nuclear power plant at Site 7-1 and would be similar to that described for the PSEG Site (Section 7.3.2).

Anthropogenic activities such as residential or industrial development near the vicinity of a new nuclear power plant could present additional constraints on aquatic resources. It is not expected that these projects would have noticeable effects on water quality within the vicinity of Site 7-1 because they would need Federal, State, and local permits that require implementation of BMPs. The review team is also aware of the potential for climate change to affect aquatic resources; however, the potential impacts of climate change on aquatic organisms and habitat in the geographic area of interest are not precisely known. In addition to rising sea levels, climate change could lead to regional increases in the frequency and intensity of extreme precipitation events, increases in annual precipitation, and increases in average temperature

(GCRP 2014-TN3472). Such changes in climate could alter aquatic community composition on or near Site 7-1 through changes in species diversity, abundance, and distribution. Elevated water temperatures, droughts, and severe weather phenomena could adversely affect or severely reduce aquatic habitat, but specific predictions of aquatic habitat changes in this region due to climate change are inconclusive at this time. The level of impact resulting from these events would depend on the intensity of the perturbation and the resiliency of the aquatic communities.

Summary

Impacts on aquatic ecology resources are estimated based on the information provided by PSEG, NMFS, the State of New Jersey, and the review team's independent review. Properly siting the associated transmission line and switchyard; avoiding habitat for protected species; minimizing interactions with water bodies and watercourses along the corridors; and use of BMPs during water intake and discharge structure installation, possible installation of a barge facility with a turning basin, transmission line corridor preparation, and tower placement would minimize building and operation impacts. The review team concludes that the cumulative impacts on most aquatic resources in the Delaware River Estuary, including Federally and State threatened and endangered species, of building and operating a new nuclear power plant at Site 7-1, combined with other past, present, and future activities, would be MODERATE to LARGE, but the incremental contribution to this impact from a new nuclear power plant would not be a significant contributor to the cumulative impact.

9.3.3.5 Socioeconomics

As discussed in Section 9.3.3, Site 7-1 is located in Salem County, New Jersey. The economic impact area for Site 7-1 would be the same as for the PSEG Site. Site 7-1 is a greenfield site located 5 mi north of the town of Salem and 4 mi east of the town of Pennsville (PSEG 2010-TN257).

The review team's baseline discussion focuses on the 50-mi region surrounding Site 7-1. As discussed in Section 2.5, the review team expects that construction and operations workers for Site 7-1 would likely settle in the same areas as those for the PSEG Site. Therefore, the review team focuses on Salem, Cumberland, and Gloucester Counties in New Jersey and New Castle County in Delaware for the majority of impacts. These four counties compose the economic impact area for Site 7-1.

Based on experience with construction of SGS and HCGS, PSEG believes about 84.5 percent of the workforce required to build a new nuclear power plant would come from within the 50-mi region surrounding the proposed site. PSEG assumes the remaining 15.5 percent of workers would relocate to the region from outside and would choose to reside in the same four counties that house the majority of the operations workers. The review team, as discussed in Sections 4.4 and 5.4, found similar estimates. Thus, both adverse and beneficial socioeconomic impacts of building and operating a new nuclear power plant would not be noticeable except in these four counties. As discussed in Section 2.5, the review team finds the assumptions to be reasonable.

Physical and Aesthetic Impacts

Physical impacts include impacts on workers and the general public, noise, air quality, buildings, roads, and aesthetics. The physical impacts on workers would be similar to those described for the PSEG Site. The primary differences would be due to the presence of the HCGS and SGS workforces near the PSEG Site.

Site 7-1 is within 0.5 mi of about 40 houses and near an active church and cemetery (PSEG 2015-TN4280). The site is also about 1 mi from the Salem River WMA. Site 7-1 would retrieve its cooling water from the Delaware River, requiring a 5.1-mi-long water pipeline. PSEG would also build a 6.9-mi-long rail spur and a 3.3-mi-long road. Because the site is a greenfield site, PSEG estimates that three new 500-kV transmission lines, constructed parallel to each other, would need to be constructed over 5.4 mi. PSEG indicates that this transmission line would pass through 1 mi of the Supawna Meadows National Wildlife Refuge (NWR) and would be adjacent to the Salem River WMA (PSEG 2010-TN257; PSEG 2015-TN4280). Even with mitigation measures similar to those discussed in Section 4.4.1, during the building phase these areas would receive adverse physical impacts from noise, vibration, and fugitive dust. Aesthetic impacts from building and operations at Site 7-1 would be similar to those discussed in Sections 4.4.1.6 and 5.4.1.6. The primary differences would be due to the presence of HCGS and SGS near the PSEG Site and the proximity of the Delaware River to the PSEG Site. Because Site 7-1 is a greenfield site, it would create new infrastructure in previously undisturbed rural areas and a transmission line passing through an NWR. Consequently, the review team expects the physical impacts from building and operations to be noticeable and locally destabilizing.

Demography

Section 2.5.1 discusses the baseline demographic information in the economic impact area and region. Site 7-1 is located in the same county as the PSEG Site and has the same economic impact area as the PSEG Site. The review team predicts the same workforce requirements and in-migrating worker housing scenario as discussed in Sections 4.4.2 and 5.4.2. The review team found that building- and operations-related impacts on demography would be minimal in the economic impact area and the region.

Economic and Tax Impacts

Section 2.5.2.1 discusses the baseline economy and Section 2.5.2.2 discusses the tax structure in the economic impact area and region. Site 7-1 is located in the same county as the PSEG Site and has the same economic impact area as the PSEG Site. For the purposes of the analysis of impacts to the local economy and tax revenues from the building and operations of a new nuclear power plant at Site 7-1, the review team predicts economic and tax impacts similar to those discussed in Sections 4.4.3 and 5.4.3. The review team found that building- and operations-related impacts on the local economy and local tax revenues would range from minimal and beneficial in the region and economic impact area to a major, beneficial impact to Salem County.

Infrastructure and Community Service Impacts

This section provides the estimated impacts on infrastructure and community services, including transportation, recreation, housing, public services, and education.

Traffic

Section 2.5.2.3 discusses the local roadways and transportation characteristics in the economic impact area and region. Sections 4.4.4.1 and 5.4.4.1 discuss the traffic impacts around the PSEG Site. Road access to the Site 7-1 area is provided primarily by New Jersey Route 540, which is a wide two-lane highway. The current vehicle count on the road is 5,406 vehicles. Road access to the site itself is provided by either County Road 631 or County Road 646. County Road 631 is a narrow two-lane road, and County Road 645 is a wide two-lane highway (PSEG 2015-TN4280). The site is about 2 mi from Interstate 295 and the New Jersey Turnpike via New Jersey Route 540. The nearest rail spur is about 6 mi east of the site, and barge access would be provided by the Salem River, about 3 mi southwest of the site. The site would require about 2 mi of roadway improvements (PSEG 2010-TN257). Due to the size of the workforce for building and the similarity of the roads and their level of service (LOS) values compared to the PSEG Site, the review team expects a noticeable but not destabilizing impact from traffic. Because the workforce for operations would be smaller (even during outages), the review team expects traffic impacts to be minimal.

Recreation

Section 2.5.2.4 discusses the recreational activities in the economic impact area and region. As discussed in Sections 4.4.4.2 and 5.4.4.2, the review team does not expect any stresses to be placed upon the capacity of the recreational resources in the PSEG Site's economic impact area and region from new in-migrating workers and their families. This would also be true for Site 7-1's recreational impacts. The Salem River WMA would receive aesthetic and physical impacts from building and operations due to its location near the site and transmission line corridor. The Supawna Meadows NWR would receive impacts from 1 mi of transmission lines passing through it. Recreational resources near Site 7-1 would receive a noticeable and potentially destabilizing recreation-based aesthetic impact from building and operational activities and a noticeable impact from access delays from peaking building traffic (PSEG 2010-TN257; PSEG 2015-TN4280).

Housing

Section 2.5.2.5 discusses the baseline housing market in the economic impact area and region. Site 7-1 is located in the same county as the PSEG Site and has the same economic impact area as the PSEG Site. For the purposes of the analysis of impacts to the local housing market from the building and operations of a new nuclear power plant at Site 7-1, the review team predicts housing impacts similar to those discussed in Sections 4.4.4.3 and 5.4.4.3. The primary difference would be that many of the 17 houses within the conceptual site boundaries would have to be removed to build and operate a new nuclear power plant (PSEG 2015-TN4280). However, any taking related to a new nuclear power plant would have to be performed with an equitable compensation, which would render minimal any potential impact

from that taking. The review team found that building- and operations-related impacts on the local housing market would be minimal in the economic impact area and the region.

Public Services

Section 2.5.2.6 discusses the baseline public services information in the economic impact area. This includes water and wastewater, police, fire, medical services, and social services. Site 7-1 is located in the same county as the PSEG Site and has the same economic impact area as the PSEG Site. For the purposes of the analysis of impacts to the local public services infrastructure from the building and operations of a new nuclear power plant at Site 7-1, the review team predicts impacts similar to those discussed in Sections 4.4.4.4 and 5.4.4.4. The review team found that building- and operations-related impacts on the local public services infrastructure would be minimal in the economic impact area and the region.

Education

Section 2.5.2.6 discusses baseline education information in the economic impact area. Site 7-1 is located in the same county as the PSEG Site and has the same economic impact area as the PSEG Site. For the purposes of the analysis of impacts to the local education services from the building and operations of a new nuclear power plant at Site 7-1, the review team predicts impacts similar to those discussed in Sections 4.4.4.5 and 5.4.4.5. The review team found that building- and operations-related impacts on the local education services would be minimal in the economic impact area and the region.

Cumulative Impacts

As discussed above, the economic impact area for Site 7-1 is Salem, Cumberland, and Gloucester Counties in New Jersey and New Castle County in Delaware. The review team discusses information pertaining to these areas in Sections 2.5 and 7.4.1. Table 9-15 lists the past, present, and reasonably foreseeable future activities associated with Site 7-1. Building and operating a new nuclear power plant at Site 7-1 could result in cumulative impacts on the demographics, economy, and community infrastructure of the economic impact area counties in conjunction with those reasonably foreseeable actions.

Within the economic impact area, the project with the greatest potential to affect cumulative socioeconomic impacts would be the continued operation of the three nuclear power units at SGS and HCGS. The other projects involve continuation of development in the economic impact area and are included in County comprehensive plans and in other public agency planning processes. According to Section 2.5.1.3, about 1,300 people are employed at HCGS and SGS, and the majority of the workforce lives in the four counties in the economic impact area. Each reactor has outages that employ a further 1,034 to 1,361 workers for about a month on a staggered 18- to 24-month schedule (about one outage every 6 months at the site). Operations at HCGS and SGS also contribute to economic activity and tax revenue to the local communities. These characteristics are discussed further in Section 2.5 and in the HCGS and SGS License Renewal EIS (NRC 2011-TN3131).

An outage could take place at the HCGS/SGS site during peak building at Site 7-1. The review team considers this potential occurrence in Section 7.4. The majority of traffic impacts discussed in Section 7.4 would occur where the HCGS/SGS workforce, the HCGS/SGS outage workforce, and the PSEG Site building workforces merge in and around Salem City (PSEG 2013-TN2525). Because Site 7-1 is north of Salem City and closer to major interstates, the review team determined that the potential for cumulative traffic impacts beyond those discussed in Section 7.4 is minimal.

The operating licenses for SGS 1 and 2 and HCGS expire in 2036, 2040, and 2046, respectively. Salem County would see losses in property tax revenue, PSEG purchases of supplies and materials, and employment. However, this loss would be partially offset by the continued operations at Site 7-1 compared to the baseline discussed in Section 2.5.

Based on the above considerations, PSEG's ER (PSEG 2015-TN4280), and the review team's independent evaluation, the review team concludes that cumulative socioeconomic impacts from building and operations at Site 7-1 would not noticeably contribute to the existing cumulative socioeconomic effects compared to those already discussed earlier in this section.

The cumulative effects on demography, housing, public services, and education would all be SMALL in the region and economic impact area. Salem County would receive a MODERATE impact on traffic from building activities and a SMALL traffic impact from operations. Cumulative physical, aesthetic, and recreation impacts from building and operations at Site 7-1 would be MODERATE to LARGE within Salem County and SMALL everywhere else in the region and economic impact area. The cumulative impacts to the economy and the tax base would be SMALL and beneficial throughout the region and economic impact area, with the exception of a LARGE and beneficial impact to Salem County's economy and tax base.

Summary of Socioeconomic Impacts

Based on information provided by PSEG, a review of existing reconnaissance-level documentation, and its own independent evaluation, the review team concluded that the cumulative impacts of building and operations activities on physical resources would be SMALL, with the exception of a LARGE impact to aesthetic resources. The LARGE impact to aesthetic resources is because Site 7-1 is a greenfield site and the proposed action would create new infrastructure in previously undisturbed rural areas and a transmission line passing through an NWR. The cumulative impacts on taxes and the economy would be SMALL and beneficial throughout the region, except for a MODERATE and beneficial income tax impact to the State of New Jersey and a LARGE and beneficial economic and tax impact to Salem County. The cumulative impacts on infrastructure and community services would be SMALL throughout the region with the exception of a MODERATE impact from traffic to Salem County during building activities and a LARGE impact to recreation-based aesthetics. Based on the above considerations, the review team concludes that cumulative socioeconomic impacts from building and operations at Site 7-1 (with the exception of the physical impacts and the beneficial impact to taxes and economy) would not noticeably contribute to the existing cumulative socioeconomic effects compared to those already discussed earlier in this section.

9.3.3.6 Environmental Justice

The economic impact area for Site 7-1 includes Salem, Gloucester, and Cumberland Counties in New Jersey and New Castle County in Delaware. Because of the proximity of Site 7-1 to the PSEG Site (about 12 mi), the review team determined that the analysis of populations for the PSEG Site was a close approximation of an independent assessment of Site 7-1 according to the methodology described in Section 2.6.1. Therefore, the review team used the distribution of minority and low-income populations around the PSEG Site to determine minority and low-income population distributions around Site 7-1. This distribution is discussed in detail in Section 2.6. The closest minority groups to Site 7-1 are located to the north about 4 mi away in Pennsville, to the west about 5 mi away in Salem, and to the east about 5 mi away in Carneys Point. The closest low-income populations of interest to Site 7-1 are located to the south in Salem and Carneys Point (PSEG 2012-TN2450). The review team found no indication of subsistence activities in the economic impact area. As discussed in Sections 2.5 and 2.6, the majority of migrant populations are outage workers at HCGS and SGS. The closest high-density communities are in Salem and Penns Grove, north of Carneys Point (Salem County 2010-TN2486).

Within a mile west of the power block area of Site 7-1 and near the proposed water pipeline route, an active, predominantly African-American, church exists. Due to its proximity to Site 7-1, the greenfield characteristics of Site 7-1, and the proximity of the proposed pipeline to the church, disproportionately high and adverse impacts may occur for the church and its congregation. As discussed in Section 9.3.3.7, this church is also potentially eligible for listing in the NRHP. In addition, the proposed water pipeline could traverse an aggregate minority census block group in Pennsville near the Delaware River, which could impose disproportionately high and adverse impacts to that block group.

As discussed in Section 9.3.3.5, the review team expects that building and operating a new nuclear power plant at Site 7-1 would have some adverse physical and aesthetic impacts on the local population. However, due to the proximity of the predominantly African-American church to the site and pipeline, and the pipeline traversing an aggregate minority block group near Pennsville, the review team found the presence of environmental and physical pathways such that there could be disproportionately high and adverse impacts in the economic impact area around Site 7-1 during building and operations. For the rest of the economic impact area and region, the review team expects environmental justice impacts similar to those at the PSEG Site.

Cumulative Impacts

Based on the analysis above and the discussion of cumulative impacts in Section 9.3.3.5, the review team found potential environmental and physical pathways such that there could be disproportionately high and adverse impacts in the economic impact area around Site 7-1 during building and operations due to the pipeline traversing an aggregate minority block group near Pennsville and near a predominantly African-American church. The review team did not identify any pathways for environmental justice impacts from the continued operations at HCGS and SGS.

9.3.3.7 Historic and Cultural Resources

The following impact analysis includes impacts from building and operating a new nuclear power plant at Site 7-1 in Salem County, New Jersey. Site 7-1 is 5 mi east of the Delaware River. The analysis also considers other past, present, and reasonably foreseeable future actions that could impact cultural resources and historical properties, including the Federal and non-Federal projects listed in Table 9-15. For the analysis of impacts on cultural resources and historical properties at Site 7-1, the geographic area of interest is considered to be the APE that would be defined for this proposed undertaking. This includes the physical APE, defined as the area directly affected by the site development, operation activities at the site, and transmission lines, and the visual APE. The visual APE is defined as the additional 4.9-mi radius around the physical APE. The 4.9-mi radius was chosen by the New Jersey SHPO as the appropriate distance for consideration of visual resources near the PSEG Site and was therefore applied to the alternative sites (AKRF 2012-TN2876).

Reconnaissance-level activities in this cultural resource review have a particular meaning. For example, these activities include preliminary field investigations to confirm the presence or absence of cultural resources. In developing this EIS, the review team relies upon reconnaissance-level information to perform alternative site evaluation. Reconnaissance-level information consists of data that are readily available from agencies and other public sources. It can also include information obtained through visits to the alternative site area. The following information was used to identify the cultural resources and historical properties at Site 7-1:

- the PSEG ER (PSEG 2015-TN4280), *Field Verification of Key Resources at PSEG Alternative Sites* (AKRF 2011-TN2869), and
- New Jersey SHPO archaeological site files.

Affected Environment

Site 7-1 is a greenfield site located in Salem County in southwestern New Jersey. Historically, Site 7-1 has been used for agricultural purposes. Site 7-1 encompasses a total of 987 ac. The location would require 3.3 mi of new roads, a 6.9-mi railroad spur, a 5.1-mi-long makeup water pipeline, and three new 500-kV transmission lines covering a total distance of 96 mi. The current major industry in Salem County is agriculture. There are 23 properties located in Salem County, New Jersey, listed on the NRHP (NPS 2013-TN2400). The closest listed property to Site 7-1 is the Salem County Alms House and Insane Asylum (within 1,000 ft of the rail spur that would need to be constructed if a new nuclear power plant were to be built at Site 7-1).

Three archaeological sites are recorded within 1 mi of Site 7-1. These include prehistoric sites 28-SA-73, 28-SA-13, and 28-SA-137. Of these three archaeological sites, Site 28-SA-73, is the closest to the proposed Site 7-1. Site 28-SA-73 is located 0.4 mi from Site 7-1. The other two archaeological sites are about 0.75 mi from Site 7-1. Three additional archaeological sites (28-SA-119, 28-SA-176, and 28-SA-61) are in the immediate vicinity of the offsite infrastructure corridors. All three of these latter archaeological sites date to the prehistoric era.

There are 26 previously identified architectural resources within 4.9 mi of Site 7-1 and the conceptual corridors. Resources include residences, historic districts, churches, and municipal

buildings. There are six architectural resources identified within 1 mi of Site 7-1 and the conceptual infrastructure corridors. These resources include the South Woodstown Historic District, three residential buildings, one farmstead, and the Finn's Point Rear Range Light. A review of architectural resources in the immediate vicinity of Site 7-1 identified six additional architectural resources within 1,000 ft of Site 7-1 that could potentially be eligible for listing on the NRHP (AKRF 2011-TN2869). These resources include two farm houses, a residence, and a church and associated cemetery. Two additional residential buildings with potential for listing on the NRHP were identified within 1 mi of Site 7-1. Another 23 structures and architectural features that have the potential for NRHP listing were identified between 1 and 4.9 mi of Site 7-1.

Building Impacts

Additional inventories of cultural resources would likely be needed for any portion of Site 7-1 not previously surveyed. Other lands that might be acquired to support the plant (e.g., for roads and pipeline corridors) would also likely require a survey to identify potential historic and cultural resources and mitigation measures to offset the potential adverse effects of ground-disturbing activities. The types of cultural resource and historical property impacts resulting from construction and operation of new nuclear units would consist of alterations to archaeological sites from ground-disturbing activities and visual alteration of the settings for historic structures. In some cases vibrations from construction equipment could affect historic structures.

Visual impacts from the building of the 590-ft-tall cooling towers would impact the historic properties within the viewshed. Because the site is not next to an existing plant with a similar cooling tower, the viewscape would be significantly altered.

There are no existing transmission corridors connecting directly to Site 7-1 (PSEG 2015-TN4280). Three new transmission line corridors would be needed to connect Site 7-1 to existing lines. There are no NRHP-listed or known historic or prehistoric sites in the area where the transmission line would be routed. In the event that Site 7-1 was chosen for the proposed project, the review team assumes that the transmission service provider for this region would conduct cultural resource surveys for all areas needed for the transmission lines. If NRHP-eligible resources are identified, then efforts to avoid, minimize, or mitigate impacts would be developed in consultation with the New Jersey SHPO and any interested parties as required under Section 106 of the NHPA (54 USC 3001010 et seq. -TN4157). In addition, visual impacts from transmission lines could result in significant alterations to the visual landscape within the geographic area of interest. Building impacts are expected to range from noticeable to potentially destabilizing because significant (i.e., NRHP-listed) resources are in close proximity to Site 7-1. It is unlikely that no impacts to historic and cultural resources would result from building a plant at Site 7-1.

Operational Impacts

Operational impacts from a new plant located at Site 7-1 would be expected to be minimal with the exception of visual impacts. Most impacts to cultural resources would occur during preconstruction and construction. The visual impacts to historic properties from the operation of the cooling tower would be noticeable.

Cumulative Impacts

Cumulative impacts would result from non-NRC-licensed activities associated with construction of the transmission lines and pipelines. These impacts would depend on the locations of the various activities and the nature, number, and significance of cultural resources present. Existing information suggests that the region surrounding Site 7-1 contains intact historic and cultural resources. It is possible that currently unknown cultural resources might be found in close proximity to areas needed for the transmission lines and pipelines, so the transmission service provider for this region would need to conduct cultural resource surveys for all areas needed for the transmission lines if this site is selected. Based on the likelihood for visual impacts to the known historic properties in the area, the cumulative effect would be noticeable. However, if cultural resources are found and cannot be avoided, the effect could be destabilizing.

Summary

Cultural resources are nonrenewable; therefore, the impact of destruction of cultural resources is cumulative. Based on the reconnaissance-level information collected for this EIS, the review team concludes that the cumulative impacts on historic and cultural resources of building and operating new nuclear units at Site 7-1 would be MODERATE. This impact-level determination reflects that cultural resources with the potential for meeting NRHP criteria are found in close proximity to the boundaries of the proposed plant at Site 7-1, making complete avoidance unlikely. The incremental contribution from building and operating a new plant at Site 7-1 would be a significant contributor to the cumulative impact.

9.3.3.8 Air Quality

Criteria Pollutants

The air-quality impacts of building and operating a new nuclear power plant and offsite facilities at Site 7-1 would be similar to the impacts expected at the PSEG Site and Site 7-2 because all three sites are located in Salem County. Salem County is in the Philadelphia–Wilmington–Atlantic City (PA-NJ-MD-DE) nonattainment area for 8-hour ozone NAAQSs (40 CFR Part 81-TN255) and administratively in the Metropolitan Philadelphia Interstate Air Quality Control Region (AQCR) (40 CFR 81.15 [TN255]). With the exception of the 8-hour ozone NAAQSs, air quality in Salem County is in attainment with or better than national standards for criteria pollutants. An applicability analysis would need to be performed if a nuclear power plant was built at Site 7-1 per 40 CFR Part 93, Subpart B (TN2495), to determine whether a general conformity determination was needed.

As discussed in Section 4.7, emissions of criteria pollutants from building a nuclear power plant are expected to be temporary and limited in magnitude. Emissions from these activities would be primarily the fugitive dust from ground-disturbing activities and engine exhaust from heavy equipment and vehicles. These impacts would be similar to the impacts associated with any large construction project. During building activities, a New Jersey State Air Quality Permit would be required that would prescribe emissions limits and mitigation measures to be implemented. The applicant also plans to implement a fugitive dust control program (PSEG 2015-TN4280).

Section 5.7 discusses air-quality impacts during operations. Emissions during operations would primarily be from operation of the cooling towers, auxiliary boilers, diesel generators and/or gas turbines, and commuter traffic. Stationary sources such as the diesel generators and/or gas turbines (operating infrequently) and auxiliary boilers (operating mostly during the winter months) would be operated according to State and Federal regulatory requirements.

A Title V operating permit administered through the State of New Jersey would ensure compliance with NAAQSs and other applicable regulatory requirements and prescribe mitigation measures to ensure compliance. There are 13 major sources of air emissions in Salem County with existing Title V operating permits (EPA 2013-TN2504). These existing sources include the energy and industrial projects listed in Table 9-15. The existing energy and industrial projects and the planned development and transportation projects would contribute to air-quality impacts in Salem County. However, the impacts on air quality in the county from emissions from Site 7-1 would be temporary and not noticeable when combined with other past, present, and reasonably foreseeable future projects. The cumulative air-quality impacts of building and operating a new nuclear power plant at Site 7-1 would be minor.

Greenhouse Gases

The cumulative impacts of GHG emissions related to nuclear power are discussed in Section 7.6. The impacts of the emissions are not sensitive to the location of the source. Consequently, the discussion in Section 7.6 would be applicable to a nuclear power plant located at Site 7-1. The review team concludes that the national and worldwide cumulative impacts of GHG emissions are noticeable but not destabilizing. The review team further concludes that the cumulative impacts would be noticeable but not destabilizing, with or without the GHG emissions of a nuclear power plant at Site 7-1.

Summary

The review team concludes that the cumulative impacts from other past, present, and reasonably foreseeable future actions on air-quality resources in the geographic areas of interest would be SMALL for criteria pollutants and MODERATE for GHG emissions. The incremental contribution of impacts on air-quality resources from building and operating a new nuclear power plant at Site 7-1 would not be a significant contributor to the cumulative impact for both criteria pollutants and GHG emissions.

9.3.3.9 Nonradiological Health

The following impact analysis considers nonradiological health impacts on the public and workers from building activities and operations at a new nuclear power plant at Site 7-1, which is located in Mannington Township, Salem County, New Jersey (about 15 mi north-northeast of the PSEG Site). The analysis also considers other past, present, and reasonably foreseeable future actions that could affect nonradiological health, including other Federal and non-Federal projects and those projects listed in Table 9-15 within the geographic area of interest. The building-related activities that have the potential to affect the health of members of the public and workers include exposure to dust and vehicle exhaust, occupational injuries, noise, and the transport of construction materials and personnel to and from the site. The operation-related

activities that have the potential to affect the health of members of the public and workers include exposure to etiological agents, noise, and EMFs and transport of workers to and from the site.

Most of the nonradiological impacts of building and operation (e.g., noise, etiological agents, and occupational injuries) would be localized and would not have significant impact at offsite locations. However, activities such as vehicle emissions from transport of personnel to and from the site would encompass a larger area. Therefore, for nonradiological health impacts associated with the influence of vehicle and other air emissions sources, the geographic area of interest for cumulative impacts analysis includes projects within a 50-mi radius of Site 7-1. For cumulative impacts associated with transmission lines, the geographical area of interest is the transmission line corridor. These geographical areas are expected to encompass areas where cumulative impacts to public and worker health could occur in combination with any past, present, or reasonably foreseeable future actions.

Building Impacts

Nonradiological health impacts on the construction workers from building a new nuclear power plant at Site 7-1 would be similar to those from building a new plant at the PSEG Site, as evaluated in Section 4.8. They include occupational injuries, noise, odor, vehicle exhaust, and dust. Applicable Federal, State, and local regulations on air quality and noise would be complied with during the plant construction phase. Site 7-1 does not have any characteristics that would be expected to lead to fewer or more construction accidents than would be expected for the PSEG Site. Transportation of personnel and construction materials at Site 7-1 would result in minimal nonradiological health impacts. Site 7-1 is in a greenfield area, and construction impacts would likely be minimal on the surrounding areas, which are classified as low-population areas.

Operational Impacts

Nonradiological health impacts on the occupational health of workers and members of the public from operation of a new nuclear power plant at Site 7-1 would be similar to those evaluated in Section 5.8 for a new plant at the PSEG Site. Occupational health impacts on workers (e.g., falls, electric shock, or exposure to other hazards) at Site 7-1 would likely be the same as those evaluated for workers at a new plant at the PSEG Site. Discharges to the Delaware River would be controlled by NPDES permits issued by NJDEP. The growth of etiological agents would not be significantly encouraged at Site 7-1 because of the temperature attenuation in the length of the pipe required for a discharge system. Noise and EMF exposure would be monitored and controlled in accordance with applicable OSHA regulations. Effects of EMFs on human health would be controlled and minimized by conformance with NESC criteria. Nonradiological impacts of traffic during operations would be less than the impacts during building. Mitigation measures used during building to improve traffic flow would also minimize impacts during operation of a new plant.

Cumulative Impacts

Past and present actions within the geographic area of interest that could contribute to cumulative nonradiological health impacts include the energy projects in Table 9-15, as well as vehicle emissions and existing urbanization. Reasonably foreseeable future projects in the geographical area of interest that could contribute to cumulative nonradiological health impacts include expansion of natural-gas pipelines, improvement and new construction for roadways and interstates, future transmission line development, and future urbanization. The review team is also aware of the potential climate changes that could affect human health and used a recent compilation of the state of knowledge in this area (GCRP 2014-TN3472) in the preparation of this EIS. Projected changes in climate for the region include an increase in average temperature, increased likelihood of drought in summer, more heavy downpours, and an increase in precipitation, especially in the winter and spring, which may alter the presence of microorganisms and parasites. In view of the water source characteristics, the review team did not identify anything that would alter its conclusion regarding the presence of etiological agents or change in the incidence of waterborne diseases.

Summary

Based on the information provided by PSEG and the review team's independent evaluation, the review team expects that the impacts on nonradiological health from building and operating a new nuclear power plant at Site 7-1 would be similar to the impacts evaluated for the PSEG Site. Although there are past, present, and future activities in the geographical area of interest that could affect nonradiological health in ways similar to the building and operation of a new plant at Site 7-1, those impacts would be localized and managed through adherence to existing regulatory requirements. Similarly, the impacts on public health of a new nuclear power plant operating at Site 7-1 would be expected to be minimal. The review team concludes, therefore, that the cumulative impacts on nonradiological health of building and operating a new nuclear power plant at Site 7-1 would be SMALL.

9.3.3.10 Radiological Impacts of Normal Operations

The following impact analysis includes radiological impacts to the public and workers from building activities and operations for a new nuclear power plant at Site 7-1, which is located in Mannington Township, Salem County, New Jersey (about 15 mi north-northeast of the PSEG Site). The analysis also considers other past, present, and reasonably foreseeable future actions that could affect radiological health, including other Federal and non-Federal projects and the projects listed in Table 9-15. As described in Section 9.3.3, Site 7-1 is a greenfield site; there are currently no nuclear facilities on the site. The geographic area of interest is the area within a 50-mi radius of Site 7-1. Other nuclear reactor sites that potentially affect the radiological health within this geographic area of interest are HCGS, SGS Units 1 and 2, Limerick Generating Station Units 1 and 2, and Peach Bottom Atomic Power Station Units 2 and 3. The Shieldalloy radioactive materials decommissioning site in Newfield, New Jersey, is also within 50 mi of Site 7-1. In addition, medical, industrial, and research facilities that use radioactive materials are likely to be within 50 mi of Site 7-1.

The radiological impacts of building and operating a new nuclear power plant at Site 7-1 include doses from direct radiation and liquid and gaseous radioactive effluents. These pathways would result in doses to people and biota other than humans off the site that would be well below regulatory limits. The impacts are expected to be similar to those at the PSEG Site.

The radiological impacts of HCGS, SGS Units 1 and 2, Limerick Generating Station Units 1 and 2, and Peach Bottom Atomic Power Station Units 2 and 3 include doses from direct radiation and liquid and gaseous radioactive effluents. These pathways result in doses to people and biota other than humans off the site that are well below regulatory limits as demonstrated by the ongoing radiological environmental monitoring program conducted around HCGS, SGS Units 1 and 2, Limerick Generating Station Units 1 and 2, and Peach Bottom Atomic Power Station Units 2 and 3. The NRC staff concludes that the dose from direct radiation and effluents from medical, industrial, and research facilities that use radioactive material would be an insignificant contribution to the cumulative impact around Site 7-1. This conclusion is based on data from the radiological environmental monitoring programs conducted around currently operating nuclear power plants. Based on the information provided by PSEG and the NRC staff's independent analysis, the NRC staff concludes that the cumulative radiological impacts from building and operating a new nuclear power plant and other existing and planned projects and actions in the geographic area of interest around Site 7-1 would be SMALL.

9.3.3.11 Postulated Accidents

The following impact analysis includes radiological impacts from postulated accidents from the operation of a new nuclear power plant at Site 7-1 in Salem County, New Jersey. The analysis also considers other past, present, and reasonably foreseeable future actions that could affect radiological health from postulated accidents, including other Federal and non-Federal projects and those projects listed in Table 9-15 within the geographic area of interest. As described in Section 9.3.3, Site 7-1 is a greenfield site, and there are currently no nuclear facilities on the site. The geographic area of interest considers all existing and proposed nuclear power plants that have the potential to increase the probability-weighted consequences (i.e., risks) from a severe accident at any location within 50 mi of this site. Existing facilities potentially affecting radiological accident risk within this geographic area of interest are HCGS Unit 1, SGS Units 1 and 2, Oyster Creek Nuclear Generating Station, Limerick Generating Station Units 1 and 2, Peach Bottom Atomic Power Station Units 2 and 3, Three Mile Island Nuclear Station Unit 1, and Calvert Cliffs Nuclear Power Plant Units 1 and 2.

As described in Section 5.11, the NRC staff concludes that the environmental consequences of DBAs at the PSEG Site would be minimal for a US-APWR, two AP1000s, a U.S. EPR, or an ABWR. DBAs are addressed specifically to demonstrate that any of these four reactor designs is sufficiently robust to meet the NRC safety criteria. The reactor designs are independent of site conditions, and the meteorological conditions at the alternative sites and the PSEG Site are similar; therefore, the NRC staff concludes that the environmental consequences of DBAs at Site 7-1 would be SMALL.

Because the meteorology, population distribution, and land use for Site 7-1 are expected to be similar to the PSEG Site, risks from a severe accident for a new reactor located at Site 7-1 are

expected to be similar to those analyzed for the proposed PSEG Site. These risks for the PSEG Site are presented in Tables 5-30 and 5-31 and are well below the mean and median values for current-generation reactors. In addition, as discussed in Section 5.11.2.1, estimates of average individual early fatality and latent cancer fatality risks are well below Commission safety goals (51 FR 30028-TN594). For existing plants within the geographic area of interest (i.e., whose 50-mi radius overlaps with the 50-mi radius around the PSEG Site), namely HCGS Unit 1, SGS Units 1 and 2, Oyster Creek Nuclear Generating Station, Limerick Generating Station Units 1 and 2, Peach Bottom Atomic Power Station Units 2 and 3, Three Mile Island Nuclear Station Unit 1, and Calvert Cliffs Nuclear Power Plant Units 1 and 2, the Commission has determined the probability-weighted consequences of severe accidents to be small (10 CFR Part 51, Appendix B, Table B-1 [TN250]). Because of the NRC safety review criteria, it is expected that risks for any new reactors at any other locations within the geographic area of interest for Site 7-1 would be well below the risks for current-generation reactors and would meet Commission safety goals. The severe accident risk due to any particular nuclear power plant becomes smaller as the distance from that plant increases. However, the combined risk at any location within 50 mi of Site 7-1 would be bounded by the sum of risks for all these operating nuclear power plants and would still be low.

The postulated accident risk due to any particular nuclear power plant decreases as the distance from that plant increases. However, the combined risk at any location within 50 mi of Site 7-1 would be bounded by the sum of risks for all of these operating and proposed nuclear power plants. Even though there would be potentially several plants included in the combination, this combined risk would still be low. On this basis, the NRC staff concludes that the cumulative risks of postulated accidents at any location within 50 mi of Site 7-1 would be SMALL.

9.3.4 Site 7-2

This section covers the review team evaluation of the potential environmental impacts of siting a new nuclear power plant at the site designated as Site 7-2 in Salem County, New Jersey, located about 12 mi east-northeast of the PSEG Site (see Figure 9-1). Site 7-2 is a greenfield site that is not owned by PSEG. The site is located about 12 mi from the Delaware River, which would be the source of cooling water for new nuclear units at this site. The site has a total area of 996 ac.

As indicated by PSEG, the use of Site 7-2 would require infrastructure upgrades and improvements, as follows (PSEG 2015-TN4280).

- Portions of the public roads that currently provide access to the site would need to be relocated around plant facilities and/or improved to increase their load-carrying capacity. An estimated total of 2.2 mi of road building would be required, and the ROW width would be 150 ft.
- A new rail spur would be required to allow delivery of materials and equipment to the site. PSEG has identified a conceptual route and alignment for this new rail spur that would be 5.4 mi long and would require a ROW width of 150 ft.

- A new water supply pipeline would need to be installed to withdraw water from the Delaware River. A new discharge pipeline would also need to be installed to convey blowdown and wastewater to the Delaware River. PSEG assumed the two new pipelines would be installed parallel to each other and within the same 100-ft-wide ROW. The estimated length of the route is 12.9 mi.
- An existing 500-kV transmission line crosses the site, and this existing line would be used for a two-circuit connection for the new facilities at the site; however, a portion of the existing transmission line would have to be rerouted to avoid plant facilities.
- A third, new connection from Site 7-2 to the transmission system would be required. This new transmission line would be installed within a 200-ft ROW, and the route would be 4.1 mi long.
- A new switchyard would be required at the connection of the above new transmission line and the existing transmission line system. PSEG assumed this new switchyard would be located on 25 ac.

The following sections include a cumulative impact assessment conducted for each major resource area. The assessment considered the specific resources and components that could be affected by the incremental effects of a new nuclear power plant at Site 7-2, including impacts of the NRC-authorized construction and operations and impacts of preconstruction activities. Also included in the assessment are past, present, and reasonably foreseeable future Federal, non-Federal, and private actions in the same geographical area that could have meaningful cumulative impacts when considered together with a new nuclear power plant if such a plant were to be built at Site 7-2. Other actions and projects considered in this cumulative analysis are listed in Table 9-18.

Table 9-18. Projects and Other Actions Considered in the Cumulative Impacts Analysis for Site 7-2

Project Name	Summary of Project	Location	Status
Nuclear Projects			
Hope Creek Generating Station, Unit 1	The station consists of a single operating boiling water reactor (BWR) rated at 3,840 MW(t), adjacent to the Salem units	13.6 mi west of Site 7-2	Operational, licensed through April 11, 2046 (NRC 2012-TN2626)
Salem Generating Station, Units 1 and 2	The station consists of two operating pressurized water reactors (PWRs) rated at 3,459 MW(t) each, adjacent to the Hope Creek unit	13.6 mi west of Site 7-2	Operational, licensed through August 13, 2036, and April 18, 2040 (NRC 2012-TN2626)
Oyster Creek Nuclear Generating Station	The station consists of a single operating BWR rated at 1,930 MW(t)	60 mi northeast of Site 7-2	Operational, licensed through April 9, 2029 (NRC 2012-TN2626). However, Exelon plans to shut the plant down in 2019 (Exelon 2013-TN2521)

Table 9-18. (continued)

Project Name	Summary of Project	Location	Status
Limerick Generating Station, Units 1 and 2	The station consists of two operating BWRs rated at 3,515 MW(t) each	52 mi north of Site 7-2	Operational, licensed through October 26, 2024, and June 22, 2029 (NRC 2012-TN2626)
Peach Bottom Atomic Power Station, Units 2 and 3	The station consists of two operating BWRs rated at 3,514 MW(t) each and one permanently shutdown unit (Unit 1)	53 mi west of Site 7-2	Operational, licensed through August 8, 2033, and July 2, 2034 (NRC 2012-TN2626)
Three Mile Island Nuclear Station, Unit 1	The station consists of a single operating PWR rated at 2,568 MW(t) and one permanently shutdown unit (Unit 2)	86 mi northwest of Site 7-2	Operational, licensed through April 19, 2034 (NRC 2012-TN2626)
Calvert Cliffs Nuclear Power Plant Units 1 and 2	The station consists of two operating PWRs rated at 2,737 MW(t) each	94 mi south-southwest of Site 7-2	Operational, licensed through July 31, 2034, and August 13, 2036 (NRC 2012-TN2626)
Energy Projects			
Deepwater Energy Center	158-MW two-unit natural-gas peaking facility	10 mi northwest of Site 7-2	Operational (EPA 2013-TN2504)
Carneys Point Generating Plant	Cogeneration power plant	17 mi northwest of Site 7-2	Operational (EPA 2013-TN2504)
Pedricktown Combined Cycle Cogeneration Plant	120-MW peaking facility	20 mi north of Site 7-2	Operational (EPA 2013-TN2504)
Grid stability transmission line for Artificial Island	Line needed to support the grid in the area around the island. No specific route is known. Review team assumes a line west to the Peach Bottom substation	13.6 mi west of Site 7-2	Proposals requested by PJM Interconnection, LLC (PSEG 2013-TN2669)
New Developments/Redevelopment			
Millville Municipal Airport Improvements	Infrastructure upgrades	16.8 mi southeast of Site 7-2	Funding acquired (Menendez 2013-TN2666)
Camp Pedricktown Redevelopment	Site redevelopment due to Base Realignment and Closure	17.8 mi northwest of Site 7-2	In progress (Davis 2013-TN2533)
Parks and Recreation Activities			
Mad Horse Creek Wildlife Management Area	Restoration of about 200 ac	9.8 mi southwest of Site 7-2	In progress (NJDEP 2013-TN2534)
Supawna Meadows National Wildlife Refuge	Roughly 3,000-ac refuge with some walking and boating trails	12 mi northwest of Site 7-2	Operational (FWS 2013-TN2530)
Fort Mott State Park	124-ac park built around a historical site	15 mi northwest of Site 7-2	Operational (NJDEP 2013-TN2532)

Table 9-18. (continued)

Project Name	Summary of Project	Location	Status
Parvin State Park	2,092-ac park with trails, camping, boating, fishing, and hunting	8.7 mi east of Site 7-2	Operational (NJDEP 2013-TN2531)
Glassboro Fish and Wildlife Management Area	2,393-ac wildlife management area with trails	16 mi northeast of Site 7-2	Operational (NJDEP 2013-TN2534)
Other parks, forests, and reserves	Numerous State and National parks, forests, reserves, and other recreational areas are located within a 50-mi region	Throughout 50-mi region	Parks are currently being managed by Federal, State, and/or local agencies
Other Actions/Projects			
USACE Delaware River Main Channel Deepening Project	Deepening of river channel; Reach C: Delaware RM 68 to 55; Reach D: Delaware RM 55 to 41	Reach C is 16 mi northwest of Site 7-2; Reach D is 14.3 mi west of Site 7-2	In progress (USACE 2013-TN2665)
Salem County Solid Waste Landfill	Regional landfill for solid waste	6.3 mi northwest of Site 7-2	Operational (SCIA 2013-TN2664)
Air emissions sources	Nearby air emissions sources include small-scale commercial facilities (emissions below reporting limits), on-road mobile sources (cars and trucks), non-road mobile sources (airplanes, boats, tractors, etc.), and industrial stationary point emissions sources(Mannington Mills Inc. flooring manufacturer, DuPont Dow Performance Elastomers, LLC synthetic rubber manufacturer)	Within Salem County	Ongoing
Surface-water withdrawals and discharges	Surface-water withdrawals for public water supply and other potable use and wastewater treatment plant discharges	Within 10 RM of the intake and discharge for Site 7-2	Significant surface-water withdrawals and discharges have been taking place for decades. Withdrawal rates are expected to continue at current rates or increase slightly in the future
Groundwater withdrawals	Groundwater withdrawals throughout the region supply the majority of freshwater needs. Major pumping centers in Salem, Gloucester, and Camden Counties in New Jersey and New Castle County in Delaware affect groundwater heads and groundwater flow paths throughout the region	Throughout region	Significant groundwater withdrawals have been taking place since the 1950s. Withdrawal rates are expected to continue at current rates or increase slightly in the future

Table 9-18. (continued)

Project Name	Summary of Project	Location	Status
Various hospitals and industries that use radioactive materials	Medical and other isotopes	Within 50 mi	Operational in nearby cities and towns
Future Urbanization	Construction of housing units and associated commercial buildings; roads, bridges, and rail; construction of water and/or wastewater treatment and distribution facilities and associated pipelines, as described in local land-use planning documents	Throughout region	Construction would occur in the future, as described in State and local land-use planning documents

9.3.4.1 Land Use

Affected Environment

As discussed in Section 9.3.4, Site 7-2 covers 996 ac in Alloway Township, Salem County, New Jersey (Figure 9-1). Existing land use at Site 7-2 is predominantly agricultural, with large areas planted in cultivated crops. Most of Site 7-2 is zoned for agricultural use, and soils classified as prime farmland or Farmland of Statewide Importance occur across much of the site (PSEG 2015-TN4280).

There are about 46 single-family houses, as well as a private school, located within the Site 7-2 boundaries. Also, although the site is located more than 6 mi from the nearest incorporated town, there are small groups of houses within 1 mi of the site. There are no significant industrial land uses on or in close proximity to Site 7-2 (PSEG 2015-TN4280).

According to 2012 State of New Jersey Department of Agriculture GIS mapping conducted by PSEG, there are no County Preserved Farmlands within the Site 7-2 boundaries. Also, there are no lands under DCRs within Site 7-2 (PSEG 2015-TN4280).

The offsite corridors for the access roads, rail spur, and water pipelines to Site 7-2, as well as the short connector transmission line from Site 7-2 to the grid, would be largely confined to the immediate site vicinity. Land uses within these corridors are similar to the site itself, with most of the land in agricultural use and residences scattered throughout the area. There are no significant industrial land uses within the offsite corridors (PSEG 2015-TN4280).

Building Impacts

According to PSEG, building a new nuclear power plant at Site 7-2 would directly disturb (temporarily and permanently) a total of 394 ac on the site. The remaining land within the Site 7-2 boundaries (602 ac) would not be directly disturbed, but access to this land would be controlled, and it would be unavailable for uses not related to a nuclear power plant. In addition, developing the access road, rail spur, and water pipeline corridors for Site 7-2 would disturb 294 ac off the site. Therefore, a total of 1,290 ac, not including transmission line corridors,

would be disturbed or made unavailable for uses not related to the new plant at Site 7-2. Land uses affected by building a nuclear power plant and support facilities at Site 7-2 include about 1,102 ac of planted/cultivated land, 11 ac of developed land, 29 ac of barren land, 95 ac of forest land, 7 ac of estuarine and marine deepwater area, 33 ac of estuarine and marine wetland, 5 ac of freshwater emergent wetland, 37 ac of freshwater forested/shrub wetland, and 6 ac of other wetlands (PSEG 2015-TN4280).

It is likely that a new nuclear power plant at Site 7-2 would connect with the potential transmission line corridor that could be developed to address voltage and stability constraints within the PJM region (see Section 7.0). However, PSEG would need to develop a connector transmission line from Site 7-2 to this new grid stability line. This 4.1-mi connector transmission line corridor would disturb about 105 ac of planted/cultivated land, 3 ac of developed land, 1 ac of barren land, 56 ac of forest land, 11 ac of freshwater forested/shrub wetland, and less than 1 ac of other wetlands (PSEG 2015-TN4280).

Site 7-2 has an existing site elevation between 120 and 140 ft above MSL. Because the existing site elevation would provide adequate final grade elevation to preclude flooding, PSEG has stated that no additional fill above existing grade elevation would be required. PSEG estimates the total fill quantity for Site 7-2 would be 3.5 million yd^3, with 0.9 million yd^3 of Category 1 fill and 2.6 million yd^3 of Category 2 fill. PSEG has stated the fill material for Site 7-2 could come from the same sources as the fill material for the PSEG Site (i.e., existing permitted borrow sites in New Jersey, Delaware, and Maryland). However, PSEG would likely conduct a new search for fill material sources if Site 7-2 were developed and would conduct testing to determine whether the material excavated from Site 7-2 could be reused as fill at the site (PSEG 2012-TN2282).

Overall, the land-use impacts of building a new nuclear power plant at Site 7-2 would be sufficient to alter noticeably, but not destabilize, important attributes of existing land uses at the site and in the vicinity. Building a new plant would directly disturb 394 ac of land and would eliminate access to and use of another 602 ac of land that currently supports productive agricultural and rural residential uses. Building the new access road, rail spur, and water pipeline corridors for Site 7-2 would disturb 294 ac of similar land uses off the site. Further, developing the new connector transmission corridor from Site 7-2 to the new grid stability lines would disturb an additional 168 ac of similar offsite land uses. Land uses in the vicinity of Site 7-2 include about 53,694 ac of planted/cultivated land, 3,783 ac of developed land, 1,869 ac of barren land, 28,083 ac of forest land, 138 ac of estuarine and marine deepwater area, 291 ac of estuarine and marine wetland, 768 ac of freshwater emergent wetland, 10,839 ac of freshwater forested/shrub wetland, and 1,052 ac of other wetland. Building a new nuclear power plant at Site 7-2 would permanently or temporarily disturb about 5 percent of the available estuarine and marine deepwater area and 11 percent of the available estuarine and marine wetland in the vicinity. Additionally, building a new plant on Site 7-2 would require that most of the 46 houses within the site boundaries be removed, that any residents be relocated, and that access to a private school be restricted (if not eliminated) (PSEG 2015-TN4280).

Based on the information provided by PSEG and the review team's independent review, the review team concludes the combined land-use impacts of preconstruction and construction activities on Site 7-2 would be noticeable. The review team reaches this conclusion because of

the conversion of existing estuarine and marine deepwater areas and estuarine and marine wetland land uses to heavy industrial and transmission corridor use, the relocation of 46 residences, and the restriction of access to a private school. These impacts would alter noticeably, but not destabilize, important attributes of existing land uses at the site and in the vicinity.

Operational Impacts

The land-use impacts of operating a new nuclear power plant at Site 7-2 would be smaller than the impacts of building, but they would still permanently eliminate almost all access to and use of 1,290 ac of land (not including transmission corridors) that supports productive agricultural uses, rural residential uses, and a private school. Most of the impacts would occur during the building of a new nuclear power plant, and operation of a plant is not expected to cause additional impacts. Additionally, there are sufficient agricultural and residential land-use resources available in the vicinity. Therefore, based on the information provided by PSEG and the review team's independent review, the review team concludes the land-use impacts of operating a new nuclear power plant at Site 7-2 would be negligible.

Cumulative Impacts

The geographic area of interest includes Salem County, New Jersey (in which Site 7-2 is located), and the other 24 counties located in the 50-mi region around the site. The 50-mi region includes counties in New Jersey, Delaware, Pennsylvania, and Maryland. The direct and indirect impacts to land use of building and operating a new nuclear power plant at Site 7-2 would be confined to Salem County, but the cumulative impacts to land use when combined with other actions (discussed below) would extend to other counties in New Jersey, Delaware, Maryland, and Pennsylvania.

Table 9-18 lists projects that, in combination with building and operating a new nuclear power plant at Site 7-2, could contribute to cumulative impacts in the region. One of the projects closest to Site 7-2 would be the continued operation of SGS and HCGS. In 2011, NRC issued new operating licenses for SGS Unit 1 (expires in 2036), SGS Unit 2 (expires in 2040), and HCGS (expires in 2046). The cumulative land-use impact would result from the combined commitment of land for a new plant at Site 7-2 (996 ac) with the land already dedicated to SGS and HCGS (734 ac). Although this would represent a relatively noticeable land-use impact in Salem County, the cumulative impact to land use in the 50-mi region would be negligible. None of the other nuclear projects listed in Table 9-18 are located within the 50-mi region.

Another project that would occur in relatively close proximity to Site 7-2 is the USACE Delaware River Main Channel Deepening Project. In this project, the USACE is conducting dredging operations to deepen a section of the Delaware River, including the portion of the river adjacent to the existing PSEG property (USACE 2011-TN2262). The primary land-use impact of this deepening project would be use of some existing CDFs along the Delaware River for the disposal of dredge materials. The total dredging operation would generate an estimated 16 million yd^3 of spoil material. NEPA documentation for the channel deepening project (USACE 1997-TN2281; USACE 2009-TN2663; USACE 2011-TN2262) concludes there would be no significant land-use impacts from the project.

A third project that could occur in close proximity to Site 7-2 is the potential transmission line corridor that could be developed to address voltage and stability constraints within the PJM region. In its ER (PSEG 2015-TN4280), PSEG identifies a new 5-mi-wide transmission macro-corridor known as the WMC ("West Macro-Corridor"). The WMC is 55 mi long and generally follows existing transmission line corridors from the PSEG property to the Peach Bottom Substation in Pennsylvania (PSEG 2015-TN4280). PSEG considers the WMC to be "the most effective route for addressing the regional voltage and stability constraints that PJM is trying to resolve" (PSEG 2013-TN2669).

However, in its ER (PSEG 2015-TN4280), PSEG cites a GIS analysis that assumes a 5-mi-wide hypothetical macro-corridor and a transmission line ROW width of 200 ft within the corridor. This PSEG analysis did not identify a specific 200-ft-wide ROW within the hypothetical corridor but calculated the amount of each land-use type that could be affected in a 200-ft-wide ROW based on each land-use type as a percentage of total land use within the corridor (PSEG 2015-TN4280). However, PJM has not selected a specific route for the potential new transmission line. The review team has determined, based on the analysis performed by PSEG and the land uses that could be affected, that a new transmission line could have a noticeable effect on land uses within the region.

Most of the other projects listed in Table 9-18 are not expected to create noticeable cumulative impacts to land use in the 50-mi region when combined with building and operating a new nuclear power plant at Site 7-2. The other energy projects listed in Table 9-18 (the closest being Deepwater Energy Center and Carneys Point Generating Plant) are all too far from Site 7-2 and from each other to create noticeable cumulative land-use impacts in the region. The new development/redevelopment projects listed (Millville Municipal Airport Improvements and Camp Pedricktown Redevelopment) also are too far from Site 7-2 to create noticeable cumulative land-use impacts in the region. The parks and recreation activities listed (the closest being Parvin State Park, Mad Horse Creek WMA, and Supawna Meadows NWR) are not expected to contribute to adverse land-use impacts, especially on the regional scale. Finally, the Salem County Solid Waste Landfill project listed in Table 9-18 is located too far from Site 7-2 to create noticeable cumulative land-use impacts in the region.

The GCRP report *Global Climate Change Impacts in the United States* (GCRP 2014-TN3472) summarizes the projected impacts of future climate changes in the United States. The report divides the United States into nine regions, and Site 7-2 is located in the Northeast region. The report indicates that climate change could increase precipitation, sea level, and storm surges in the Northeast region, thus changing land use through the inundation of low-lying areas that are not buffered by high cliffs. However, cliffs could experience increased rates of erosion as a result of frequent storm surges, flooding events, and sea-level rise. Forest growth could increase as a result of more CO_2 in the atmosphere. Existing parks, reserves, and managed areas would help preserve wetlands and forested areas to the extent that they are not affected by the same factors. In addition, climate change could reduce crop yields and livestock productivity, which might change portions of agricultural land uses in the region (GCRP 2014-TN3472). Thus, direct changes resulting from climate change could cause a shift in land use in the 50-mi region that would contribute to the cumulative impacts of building and operating a new nuclear power plant at Site 7-2.

Overall, when combined with other past, present, and reasonably foreseeable future actions, the cumulative land-use impacts of building and operating a new nuclear power plant at Site 7-2 (along with the new connector transmission line corridor) would be sufficient to alter noticeably, but not destabilize, important attributes of existing land uses in the geographic area of interest. Therefore, based on the information provided by PSEG and the review team's independent review, the review team concludes that the cumulative land-use impacts would be MODERATE. The incremental contribution of building and operating a new nuclear power plant at Site 7-2 would be a significant contributor to the cumulative impact.

9.3.4.2 Water Use and Quality

The following analysis includes impacts from building activities and operations at Site 7-2. The analysis also considers cumulative impacts from other past, present, and reasonably foreseeable future actions including the other Federal and non-Federal projects listed in Table 9-18 that could affect water use and quality.

Affected Environment

The potentially affected surface-water environment consists of the Delaware River Basin, which would be affected by water withdrawn from and wastewater discharged to the river. Site 7-2 is a 996-ac greenfield site in Salem County, New Jersey. The site is located on flat land 12 mi east of the Delaware River and about 15 mi east of the PSEG Site. Elevations across the site range from 120 to 140 ft MSL. As stated by PSEG in its ER, the Delaware River would be the primary source of water (PSEG 2015-TN4280). The Delaware River reach nearest to Site 7-2 lies in DRBC water-quality Zone 5, which is the same zone within which the PSEG Site is located.

Flow data for the Delaware River at USGS Gaging Station 01463500 at RM 131.0, near Trenton, New Jersey, are described in Section 2.3. This gaging station is located more than 80 mi upstream of the Site 7-2 conceptual water intake location at RM 48.4. The mean annual river flow at the Trenton gage is 12,004 cfs. Mean annual flow during the historic low-water period of 1961–1967 was 7,888 cfs, with the minimum monthly flow of 1,548 cfs recorded in July 1965.

As mentioned in Section 2.3, the Coastal Plain deposits dip and thicken to the southeast toward the coast. Site 7-2 is located east of the PSEG Site and, as a result, the hydrogeologic environment is somewhat different. Because it is a greenfield site located away from the river, there is no hydraulic fill or alluvium. Studies from NJGS (Sugarman 2001-TN3218) and USGS (Martin 1998-TN2259; dePaul et al. 2009-TN2948) indicate that in eastern Salem County the uppermost aquifer is the unconfined Kirkwood-Cohansey aquifer system and that this unit outcrops in the area just north and east of Site 7-2.

In its ER the applicant indicated that "plant groundwater requirements could be supplied by one or two wells drilled to the Kirkwood-Cohansey" aquifer system (PSEG 2015-TN4280). This aquifer system ranges from 20 to 350 ft thick (USGS 2013-TN3228). However, because Site 7-2 is located near the outcrop area of the Kirkwood-Cohansey aquifer system, the thickness is probably at the lower end of this range (Martin 1998-TN2259), and water quality may be poor due to the surface-water–freshwater/saltwater interface that is interpreted to occur

within the unit in areas west of the site (dePaul et al. 2009-TN2948). As a result, it is not likely that the aquifer is widely used in the area immediately surrounding Site 7-2, and pumping may induce flow of brackish water from the west.

USGS studies also indicate that the Vincentown is very thin or not present at Site 7-2 and that the Wenonah-Mount Laurel and the PRM aquifers are deeper at Site 7-2 than at the PSEG Site and are of varying quality. Salinity levels within the Wenonah-Mount Laurel aquifer are below the drinking water standard (250 mg/L). USGS indicates that the position of the 250 mg/L line of salinity concentration, which is located in southern Cumberland and Salem Counties, has extended to around 2 mi inland of the Delaware River (dePaul et al. 2009-TN2948). However, this is 8 mi southeast of Site 7-2. Salinity values within the upper and middle PRM aquifers are above the drinking water standard. Salinity within the lower PRM aquifer is reported to exceed 10,000 mg/L for chloride (dePaul et al. 2009-TN2948). As a result, it is likely that groundwater needed for construction and operation at Site 7-2 would be obtained from the Wenonah-Mount Laurel aquifer.

Building Impacts

Impacts to surface waters from building activities at Site 7-2 would be similar to those at the PSEG Site that may occur as a result of site-preparation and plant building activities. Potential impacts to surface waters would result from physical alteration of surface-water bodies because of installation of intake and discharge structures; alteration of land surface and surface-water drainage pathways; potential for increased runoff from the site area that may include additional sediment load and building-related pollutants; and potential for impacts to wetlands, floodplains, and surface-water bodies from building transmission lines. Additional disturbance to the shoreline and river bottom may occur from building a new barge docking facility, if needed. The offsite building activities to support a new nuclear power plant would include building the rail spur, access roads, and other offsite facilities including the new makeup water pipeline, the new blowdown pipeline, and a new transmission line from Site 7-2 to an existing 500-kV corridor.

PSEG has proposed in Section 9.3.2 of its ER (PSEG 2015-TN4280) to withdraw either surface water or groundwater for building activities. The review team assumes that water use for building activities at Site 7-2 would be similar to that for the PSEG Site. As estimated by PSEG in ER Section 4.2 (PSEG 2015-TN4280), water use to support concrete plant operations, dust suppression, and potable water would be 119 gpm. Because water quality in the Delaware River is brackish near Site 7-2, potable and sanitary use of the river water is not expected.

Dewatering of the plant area and the nuclear island foundation would also likely be required to limit inflow from the Kirkwood-Cohansey aquifer system during construction at Site 7-2. Because these units are unconfined and productive, it is assumed that dewatering flow rates would be reduced through the use of vertical low-permeability barriers, which would also limit the horizontal effects of dewatering. It is assumed that the extracted groundwater would be managed and disposed of in compliance with the permit requirements.

Impacts from groundwater use and dewatering during construction activities would be limited due to the temporary time frame of construction. In addition, construction-related pumping would be bounded by the impacts from pumping to support plant operations. Therefore, the

review team concludes that the groundwater-use impacts of building a new nuclear power plant at Site 7-2 would be minor.

During building, water-quality-related impacts would be similar to those expected for any other large project. Alterations to the Delaware River would occur during installation of the makeup water intake structure and the wastewater discharge structure. During installation of these structures, some additional turbidity in the river is expected because of the disturbance of bottom sediments. However, these sediments would be localized to the area needed to install the structures, and engineering measures would be in place as part of BMPs to minimize movement of the disturbed sediment beyond the immediate work area. These impacts also would be temporary and would not occur after the structures are installed. Because these activities would occur in waters of the United States, appropriate permits from USACE and NJDEP would be required. PSEG would be required to implement BMPs to control erosion and sedimentation as well as discharge of building-related pollutants to the Delaware River or to nearby water bodies. Because the effects from building-related activities would be minimized using BMPs, would be temporary and localized, and would be controlled under various permits, the review team concluded the impact from building-related activities on the water quality of the Delaware River and nearby water bodies would be minor.

During building, groundwater quality may be affected by leaching of spilled effluents into the subsurface. The review team assumes that the BMPs PSEG has proposed for the PSEG Site would also be in place at Site 7-2 during building activities, and therefore the review team concludes that any spills would be quickly detected and remediated. In addition, groundwater impacts would be limited to the duration of these activities and therefore would be temporary. Because any spills related to building activities would be quickly remediated under BMPs, the activities would be temporary, and pumping rates would be greater during operations than during building, the review team concludes that the groundwater-quality impacts from building at Site 7-2 would be minimal.

Operational Impacts

During operation of a new nuclear power plant at Site 7-2, surface water would be withdrawn from the Delaware River to provide makeup water to the plant CWS. Because water quality in the Delaware River near Site 7-2 is brackish, similar to that at the PSEG Site, it is assumed that the withdrawal rate and the consumptive water use at Site 7-2 would be the same as at the PSEG Site: 78,196 gpm (174.2 cfs) for withdrawal and 26,420 gpm (58.9 cfs) for consumptive use. As described in Section 5.2, applying an equivalent impact factor of 0.18 to account for the salinity of the withdrawn river water makes the water consumption equivalent to a freshwater consumption of 4,756 gpm (10.6 cfs). This equivalent freshwater consumptive use is 0.1 percent of the mean annual flow at Trenton, New Jersey, during the historic low-water period of 1961–1967 (7,888 cfs), and 0.7 percent of the minimum monthly flow (1,548 cfs) recorded in July 1965. Assuming similar tidal flows at Site 7-2 and at the proposed PSEG Site, the total consumptive losses associated with a new nuclear power plant at Site 7-1 would be less than 0.01 percent of the tidal flows. Because of the similarity of Site 7-2 to the PSEG Site, the review team determined that operational water-use impacts at Site 7-2 would be similar to those at the PSEG Site. The review team determined that PSEG would need to acquire an additional 465 ac-ft or 6.9 percent of allocated storage in the Merrill Creek reservoir to meet

instream flow targets during a DRBC-declared drought. Merrill Creek reservoir has a storage capacity of 46,000 ac-ft, far exceeding that needed to meet the 465 ac-ft exceedance. In addition, DRBC allows for temporary or permanent acquisition of releases from other owners of Merrill Creek reservoir storage (DRBC 2004-TN2278). For these reasons, the review team determined that surface-water use for operation of a new nuclear power plant would be met without a noticeable impact to the instream flow targets in the Delaware River. Therefore, the review team concludes that the surface-water-use impact of operating a new nuclear power plant at Site 7-2 would be minor.

Because Site 7-2 is located near the PSEG Site, Delaware River water quality, flow characteristics, and river cross section are expected to be similar to those at the PSEG Site. Therefore, the review team concludes that the incremental water-quality impacts from operation of a new nuclear power plant at Site 7-2 would be similar to those determined for the PSEG Site in Section 5.2.3 and that the surface-water-quality impacts from operation of a new nuclear power plant at Site 7-2 would be minor.

Groundwater withdrawal, as was indicated in ER Section 9.3.2 (PSEG 2015-TN4280), would be necessary to provide freshwater for plant uses, because Delaware River water is brackish in the Site 7-2 area. For the sake of consistency in comparison, it was assumed that the amount of groundwater withdrawal for general site purposes, including the potable and sanitary water system, demineralized water distribution system, fire protection system, and other miscellaneous systems at Site 7-2, would be the same as required at the PSEG Site. As discussed in ER Section 3.3 (PSEG 2015-TN4280), an average of 210 gpm and a maximum of 953 gpm would be required to provide freshwater for plant uses. This water could likely be supplied from pumping of groundwater from the Wenonah-Mount Laurel aquifer. According to USGS there are production wells to the north and west of the alternative site at distances of 8 and 10 mi, respectively (dePaul et al. 2009-TN2948). These wells withdrew more than 1 million gal per year (as of 2003) and depressed groundwater levels about 2 ft within a mile of the wells. If the groundwater needs of the plant were supplied by wells within the Wenonah-Mount Laurel aquifer, pumping rates would be greater than those discussed above and drawdowns would be greater and extend farther. These pumping impacts could extend to a wellhead protection area, which is located within 1 mi of the site according to ER Figure 2.3-20 (PSEG 2015-TN4280), but would not affect the aquifer beyond this localized area. Groundwater withdrawal would also be regulated by both the DRBC and the NJDEP. As a result, impacts to water use due to pumping of groundwater during operation would be minor.

During the operation of a new nuclear power plant at Site 7-2, impacts on groundwater quality could result from accidental spills. Because BMPs would be used to quickly remediate spills and no intentional discharge to groundwater would occur, the review team concludes that the groundwater-quality impacts from operations at Site 7-2 would be minimal. Groundwater withdrawal for operation of a new plant at Site 7-2 would likely be from the Wenonah-Mount Laurel aquifer. Although salinity is currently below drinking water standards in the area of Site 7-2, additional pumping may increase salinity somewhat within the aquifer. However, USGS results (Pope and Gordon 1999-TN3006) show that changes in aquifer salinity have been more responsive to historic sea levels than to regional groundwater withdrawals in the 20th century. In addition, groundwater is not likely used heavily in the area of Site 7-2.

Therefore, the review team concludes that groundwater-quality impacts from the operation of a new plant at Site 7-2 would be minor.

Cumulative Impacts

In addition to water-use and water-quality impacts from building and operations activities, this cumulative analysis considers past, present, and reasonably foreseeable future actions that could affect the same water resources. The actions and projects in the vicinity of Site 7-2 that are considered in this cumulative analysis are listed in Table 9-18.

The review team is aware of the potential climate changes that could affect the water resources available for cooling and the impacts of reactor operations on water resources for other users. Because Site 7-2 is located near the proposed PSEG Site, the potential changes in climate would be similar (GCRP 2014-TN3472). Therefore the review team concludes that the impact of climate change on water resources would be similar to the proposed site.

Cumulative Water-Use Impacts

Based on a review of the history of water use and water resources planning in the Delaware River Basin, the review team determined that past and present use of the surface waters in the basin has been noticeable, necessitating the consideration, development, and implementation of careful planning.

Of the projects listed in Table 9-18, consumptive water use of SGS and HCGS were considered by the review team in evaluating cumulative surface-water impacts. Because the water quality and potential consumptive water use of a new nuclear power plant at Site 7-2 would be similar to those at the PSEG Site, PSEG would need to acquire an additional 6.9 percent of its current allocation in the Merrill Creek reservoir. As stated in Section 5.2.2, the review team determined that obtaining this additional allocation was feasible and would ensure that a new plant could operate without noticeable impact to other water users, even under declared drought conditions, and without the need to release additional flows to meet instream flow targets in the Delaware River.

Mainly because of extensive past and present use of surface waters from the Delaware River, the review team concludes that the cumulative impact to surface-water use from past and present actions and building and operating a new nuclear power plant at Site 7-2 would be MODERATE. However, the review team further concludes that a new plant's incremental contribution to this impact would not be significant.

Of the projects listed in Table 9-18, regional groundwater withdrawal was considered by the review team in evaluating cumulative groundwater impacts. Other projects do not use groundwater or are too far from Site 7-2 to interact with groundwater use at the site. On a regional scale, pumping of the Wenonah-Mount Laurel aquifer has drawn down water levels more than 60 ft around high use areas such as Camden, but these effects do not extend to the Site 7-2 area (dePaul et al. 2009-TN2948). As discussed previously, drawdowns within the Wenonah-Mount Laurel aquifer are expected to be localized around the wells. As a result, the groundwater-use impact from building and operating a new nuclear power plant at Site 7-2

would be minor. Therefore, the review team concludes that the cumulative impact on groundwater use would be MODERATE. The new plant would not be a significant contributor to the cumulative impact.

Cumulative Water-Quality Impacts

As stated in Section 7.2.2.1, DRBC has implemented careful planning and regulation of water quality in the Delaware River Basin. Although there have been improvements in water quality (e.g., improved levels of dissolved oxygen) in the Delaware River Basin because of careful planning and management policies put in place by DRBC, the presence of toxic compounds leads to advisories for fish consumption (DRBC 2008-TN2277). In its review of the PSEG license renewal application for SGS and HCGS, the NRC staff concluded that water quality will likely continue to be adversely affected by human activities in the Delaware River Basin (NRC 2011-TN3131). The review team concludes that past and present actions in the Delaware River Basin have resulted in a noticeable impact to water quality.

The projects listed in Table 9-18 may result in alterations to land surface, surface-water drainage pathways, and water bodies. These projects would need Federal, State, and local permits that require implementation of BMPs. Therefore, the impacts to surface-water quality from these projects are not expected to be noticeable. The discharge for a plant at Site 7-2 would be located at Delaware RM 48.4, about 2.6 mi from the SGS discharge and within the SGS thermal plume HDA during the summer months. The area affected by the combined thermal plumes from SGS and a plant at Site 7-2 would be small and localized. In addition, the extent of largest excess temperatures from a new plant would be localized near the discharge outlet far from the areas of large excess temperatures at SGS. Also, while reviewing the NJPDES application for a new discharge to the Delaware River, DRBC and NJDEP would have the opportunity to designate an HDA for a new nuclear power plant and require discharge rules that would protect the aquatic environment. Therefore, the review team determined the cumulative impact of the combined discharges from SGS and a plant at Site 7-2 would not noticeably affect the Delaware River.

Because of extensive past and present use of surface waters from the Delaware River, the review team concludes that the cumulative impact to surface-water quality in the Delaware River Basin from past and present actions and building and operating a new nuclear power plant at Site 7-2 would be MODERATE. However, the review team further concludes that a new plant's incremental contribution to this impact would not be significant.

Based on the proposed or possible projects listed in Table 9-18, additional impacts to groundwater water quality are expected to be minimal. As discussed previously, BMPs would be implemented and dewatering and pumping within the Site 7-2 area is unlikely to induce flow from an area of higher salinity into the Wenonah-Mount Laurel aquifer.

As discussed in Section 7.2, groundwater withdrawals within the geographic area of interest have noticeably altered the groundwater quality in localized areas where pumping occurs near aquifer recharge areas. This is a concern at the proposed PSEG Site where pumping from the Wenonah-Mount Laurel aquifer may induce the flow of saline water from the overlying Vincentown aquifer. Because of the distance of Site 7-2 from the Delaware River, pumping from the Wenonah-Mount Laurel aquifer is not likely to contribute to cumulative impacts on

groundwater quality near Site 7-2. Therefore, the review team concludes that the cumulative groundwater-quality impacts of past, present, and reasonably foreseeable future projects, as well as climate change, would be MODERATE. The new plant would not be a significant contributor to the cumulative impact.

9.3.4.3 Terrestrial and Wetland Resources

The following analysis includes potential impacts to terrestrial and wetland resources resulting from building activities and operations associated with a new nuclear power plant on Site 7-2. The analysis also considers other past, present, and reasonably foreseeable future actions that may impact terrestrial and wetland resources, including the other Federal and non-Federal projects listed in Table 9-18.

Site Description

Site 7-2 is located in Salem County, New Jersey. This is a flat greenfield site located 12 mi east of the Delaware River, which would act as the primary water source. The elevations on this site range from 120 to 140 ft above MSL. The site has a total area of 996 ac (PSEG 2015-TN4280).

Site 7-2 is located in the Southern Piedmont Plains Landscape Region. This region contains important freshwater tidal waters and brackish waters of the upper estuary system of the Delaware River and Delaware River Estuary. The tidal freshwater marshes are considered to be among New Jersey's most rare and valuable habitat types. Additionally, the Southern Piedmont Plains contains important grassland components of the Delaware River Estuary system including fens, wet meadows, impounded agricultural lands, and upland agricultural lands. This area is farmed extensively, but still contains relatively large forest and wetland complexes in some locations. The terrestrial species of concern in the Southern Piedmont Plains are primarily found in wetland, forest, or grassland habitats (NJDEP 2008-TN3117).

The ecological conditions for Site 7-2 and the 6-mi vicinity are typical of the extensively farmed parts of the Southern Piedmont Plains. Most of the land is used for agriculture. The forested areas consist mainly of scattered woodlots and strips of trees along streams. Wetlands in this area are very small and restricted to isolated low areas. There are virtually no grasslands in the area. Offsite corridors for access roads, the rail spur, and water pipelines are largely restricted to the immediate site vicinity, and the natural habitats within these corridors are similar to those found on Site 7-2 (PSEG 2015-TN4280).

Federally and State-Listed Species

No site-specific surveys for threatened and endangered species were conducted at Site 7-2. Information on protected and rare species that may occur in the area of Site 7-2 was obtained from NJDEP and the FWS ECOS. There are four Federally listed species known to or believed to occur in the 6-mi vicinity of Site 7-2: the swamp pink (*Helonias bullata*), the bog turtle (*Glyptemys muhlenbergii*), the northern long-eared bat (*Myotis septentrionalis*), and the rufa red knot (*Calidris canutus rufa*). All four Federally listed species are listed as threatened. NJDEP considers all Federally listed species as endangered. In addition, 14 State-listed endangered species, 15 State-listed threatened species, and 76 species listed by NJDEP as being of

special concern or regional priority wildlife species may occur in the area of Site 7-2 (FWS 2014-TN3333; NJDEP 2008-TN3117).

The NJDEP information shows that a total of eight listed animal species and two listed plant species have been recorded within about 1 mi of Site 7-2 (Table 9-19) (PSEG 2015-TN4280). Documentation of the actual presence of any of these species on the site and along offsite corridors would require that detailed field surveys be conducted. NJDEP data also note the presence of two Natural Heritage Priority Sites in the area of Site 7-2. One site is 0.6 mi from Site 7-2, and the other is 0.8 mi from Site 7-2. These are sites with specific habitats that contain protected and rare species. Additionally, there is one State-listed endangered plant species, Chinquapin (*Castanea pumila*), protected under the Highlands Water Protection and Planning Act (NJSA 13:20-1 et seq. –TN4310), that has the potential of being on Site 7-2 (PSEG 2015-TN4280).

Table 9-19. State and Federal Threatened, Endangered, and Rare Species Recorded in the Site 7-2 Area

Common Name	Scientific Name/Description	State or Regional Status-Rank	Federal Status
Plants			
Chinquapin	*Castanea pumila*	E, LP, HL	
Swamp pink	*Helonias bullata*	E, LP, HL	T
Birds			
American Kestrel	*Falco sparverius*	T(a,b)	
Bald Eagle	*Haliaeetus leucocephalus*	E(a)/T(b)	
Cooper's Hawk	*Accipiter cooperii*	SC(a)	
Great Blue Heron	*Ardea herodias*	SC(a)	
Red-Headed Woodpecker	*Melanerpes erythrocephalus*	T(a,b)	
Wood Thrush	*Hylocichla mustelina*	SC(a)	
Amphibians			
Fowler's Toad	*Anaxyrus fowleri*	SC	
Reptiles			
Eastern Box Turtle	*Terrapene carolina carolina*	SC	
Natural Heritage Priority Sites			
Franks Cabin Site	*Narrow headwater stream corridor*	B3	
Pecks Corner	*Hardwood-evergreen swamp*	B5	

(a) Breeding
(b) Nonbreeding
Abbreviations
E = Endangered species
LP = Listed by Pinelands Commission as endangered or threatened within its jurisdiction
HL = Protected by Highlands Water Protection and Planning Act (NJSA 13:20-1 et seq. –TN4310) within Highlands Preservation Area
T = Threatened species
SC = Special concern
B3 = High significance on global level
B5 = General biodiversity interest on global level

Source: PSEG 2015-TN4280.

Wildlife Sanctuaries, Refuges, and Preserves

There are two WMAs within the 6-mi vicinity of Site 7-2 (Figure 9-9) that have the potential to be affected by building and operating a new nuclear power plant at Site 7-2 (PSEG 2012-TN2389). Brief descriptions of these areas are given below.

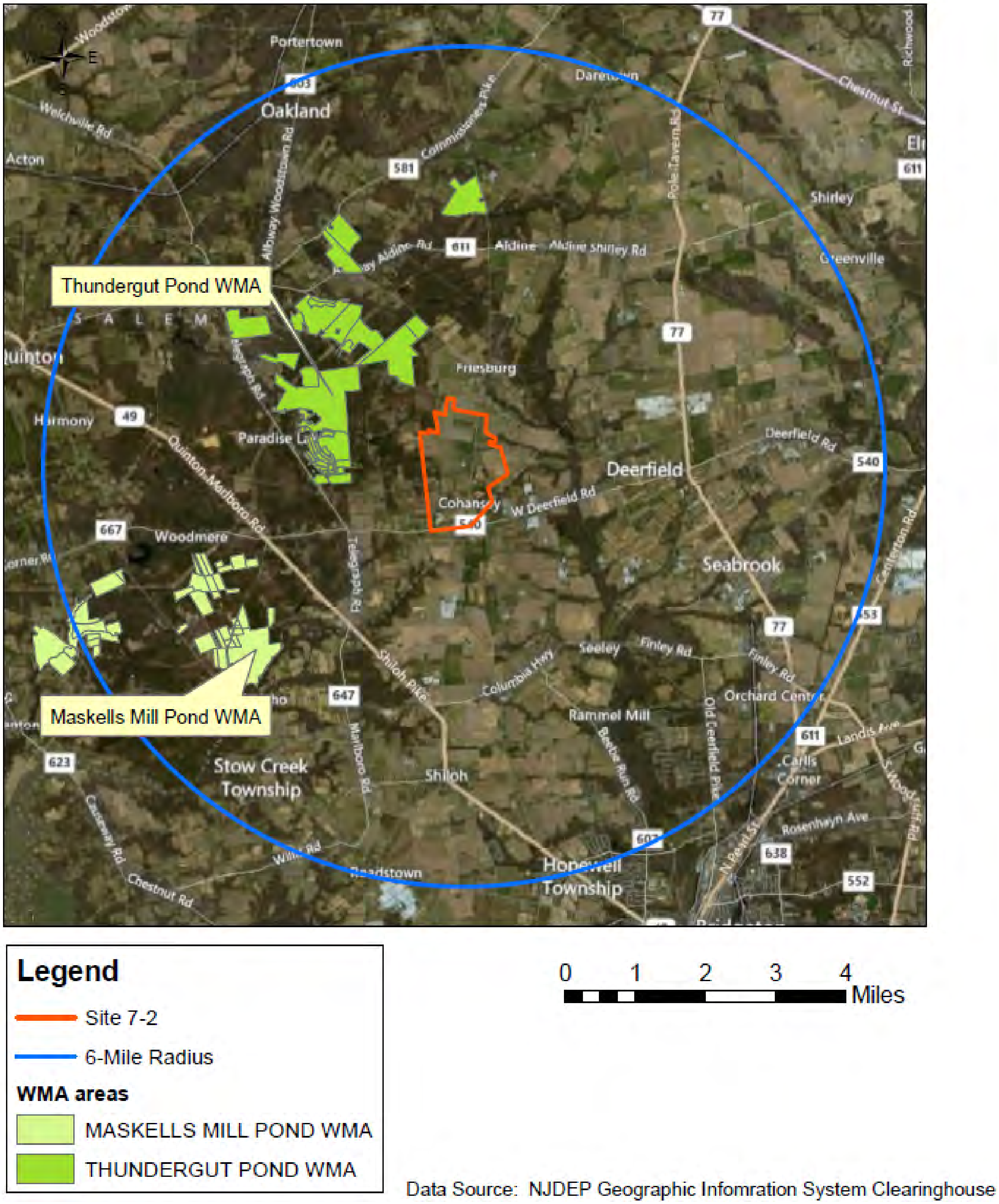


Figure 9-9. Wildlife Sanctuaries, Refuges, and Preserves within the 6-mi Vicinity of Alternative Site 7-2 (Source: Modified from PSEG 2012-TN2389)

Thundergut Pond Wildlife Management Area

This 2,169-ac WMA is located along the Deep Run River in Alloway Township, Salem County. The habitat on this WMA consists of mixed coniferous/deciduous forest and areas of deciduous wooded wetlands. No access is allowed to the onsite Sycamore Lake from January 1 through July 31 to afford protection for nesting bald eagles (*Haliaeetus leucocephalus*). This lake was constructed in 1955, is about 15 ac in size, and is used primarily for recreational purposes (e.g., fishing and boating) (PSEG 2012-TN2389).

Maskell's Mill Pond Wildlife Management Area

This 1,112-ac WMA is located in Lower Alloways Creek Township, Salem County. The site offers boat and canoe access to Maskell's Mill Pond. The southern arm of the pond is more secluded and contains a wooden bridge where visitors can access the area. Habitat in the WMA consists of deciduous oak-pine forest. It supports red-eared sliders (*Trachemys scripta elegans*), painted turtles (*Chrysemys picta*), and eastern box turtles (*Terrapene carolina carolina*). It also supports a diversity of birds, including bald eagle, prairie warbler (*Dendroica discolor*), scarlet tanager, wood thrush (*Hylocichla mustelina*), and northern bobwhite (NJWLT 2014-TN3204).

Building Impacts

Building a new nuclear power plant on Site 7-2 would directly impact (permanently and temporarily) 394 ac of land. A total of 602 ac of land within the site boundaries would not be directly disturbed. However, certain building activities would result in indirect disturbance (noise, dust, etc.) to much of the area within the site boundaries. This could result in additional wildlife impacts in terms of affecting movements and causing further displacement from the site. The development of the access road, rail spur, and water pipeline corridors would result in the disturbance of an additional 294 ac of potential habitat. In total, 1,290 ac of potential habitat would be directly or indirectly impacted as a result of building at Site 7-2. The total acreage of forest, wetlands, and grassland habitat on the site was estimated based on GIS mapping data. Terrestrial and wetland habitats that would be affected by building a new nuclear power plant and support facilities at Site 7-2 include about 1,102 ac of planted/cultivated land, 11 ac of developed land, 29 ac of barren land, 95 ac of forest land, 7 ac of estuarine and marine deepwater area, 33 ac of estuarine and marine wetland, 5 ac of freshwater emergent wetland, 37 ac of freshwater forested/shrub wetland, and 6 ac of other wetlands (PSEG 2015-TN4280).

A new nuclear power plant at Site 7-2 would likely connect with the potential transmission line corridor that could be developed to address voltage and stability constraints within the PJM region (see Section 7.0). However, PSEG would need to develop a connector transmission line from Site 7-2 to this new grid stability line. The line would be routed through a 200-ft corridor for 4.1 mi and would disturb about 105 ac of planted/cultivated land, 3 ac of developed land, 1 ac of barren land, 56 ac of forest land, 11 ac of freshwater forested/shrub wetland, and less than 1 ac of other wetlands (PSEG 2015-TN4280).

The amount of terrestrial and wetland habitat disturbed by building a new nuclear power plant on Site 7-2 would be minimal for most of the habitats available in the 6-mi vicinity. There are

about 53,694 ac of planted/cultivated lands, 1,869 ac of barren land, 28, 083 ac of forest, 768 ac of freshwater emergent wetland, 10,839 ac of freshwater forest/shrub wetland, and 1,052 ac of other wetland habitat available in the 6-mi vicinity. However, 5 percent of the 138 ac of estuarine and marine deepwater habitat available and 11 percent of the 291 ac of estuarine and marine wetland habitat available would be disturbed (PSEG 2015-TN4280). As a result, building a new nuclear power plant, support structures, and transmission line at Site 7-2 would have a noticeable impact on terrestrial and wetland resources.

There is the potential for impacts to open country bird species (e.g., American kestrel [*Falco sparverius*]) and those that frequent smaller woodlots (e.g., Cooper's hawk [*Accipiter cooperii*]). Fragmentation and loss of forested areas could also potentially impact species that are more area sensitive such as wood thrush. Inadvertent impacts to slower moving species (e.g., eastern box turtle) are also a possibility. Potential impacts to the Federally threatened swamp pink due to wetland disturbance are a possible concern. However, swamp pink occurs in palustrine forested wetlands with canopy closures of 20 to 100 percent (Section 2.4.1). Habitat for the swamp pink would not be expected at Site 7-2. However, wetland and forested areas are considered important resources for the Federally listed and proposed Federally listed species. The loss of about 87 ac of wetlands and 95 ac of forest could affect the Federally listed bog turtle and northern long-eared bat. Impacts to these resources may warrant mitigation. Therefore, impacts to important wildlife species as a result of building a new nuclear power plant at Site 7-2 could be noticeable, but not destabilizing.

Displaced wildlife species may be forced into the Franks Cabin and Pecks Corner sites and the Maskell's Mill Pond and Thundergut Pond WMAs as a result of building a new nuclear power plant at Site 7-2. Displaced wildlife species could place added pressure on terrestrial and wetland resources as a result of increased competition for limited resources. However, these sites would not be expected to be directly impacted by building a new nuclear power plant at Site 7-2.

It is expected that a project of this size would result in impacts to terrestrial and wetland resources, including habitat loss, fragmentation, and disturbance. Building a new nuclear power plant would result in the loss of available onsite habitat. Noise, lights, and dust during building activities could displace species in adjacent areas, reducing viable habitat. Less mobile species would be impacted the most by building at Site 7-2, and some mortality would be expected. More mobile wildlife species would be capable of moving to habitat in adjacent areas. These displaced species may experience impacts as a result of increased competition for more limited resources. Adjacent WMAs, preserves, and refuges could be affected by increased demand for limited resources as a result of species displacement. The habitat available at Site 7-2 is common to Salem County, and sufficient terrestrial and wetland resources exist in the Southern Piedmont Plains. However, the review team has determined that the impacts to terrestrial and wetland resources from building a new nuclear power plant at Site 7-2 would be noticeable as a result of the disturbance of a significant portion of wetlands in the 6-mi vicinity and the loss of wetland and forest habitat that is important to Federally listed and proposed Federally listed species.

Operational Impacts

Potential impacts to terrestrial and wetland resources that may result from operation of a new nuclear power plant at Site 7-2 include those associated with cooling towers, transmission system structures, maintenance of transmission line ROWs, and the presence of project facilities that permanently eliminate habitat (PSEG 2015-TN4280). Operational impacts would be similar to those described in Section 5.3.1, although there may be minor differences as a result of topography, climate, and elevation. The review team has determined that the operational impacts to terrestrial and wetland resources at Site 7-2 would be minimal.

Cumulative Impacts

Several past, present, and reasonably foreseeable future projects could affect terrestrial and wetland resources in ways similar to building and operating a new nuclear power plant at Site 7-2. Table 9-18 lists these projects, and descriptions of their contributions to cumulative impacts to terrestrial and wetland resources are provided below.

The Piedmont Plains suffered nearly 50 percent of all development that occurred in New Jersey between 1984 and 1995. Grassland, wetland, upland forest, and estuarine emergent wetlands sustained the greatest losses. Although the area has suffered extensive losses due to development, large areas of smaller fragmented habitats exist (NJDEP 2008-TN3117). The WMAs and parks listed in Table 9-18 are not expected to contribute to adverse impacts to terrestrial and wetland resources.

Most of the projects listed in Table 9-18 are operational and have resulted in the conversion of natural areas to industrial and commercial development. These past actions have resulted in loss and/or fragmentation of natural habitat and displacement of wildlife. These projects include operational nuclear power plants located at HCGS and SGS. Additionally, three operational fossil-fuel power plants, Camp Pedricktown Redevelopment, and the Salem County Solid Waste Landfill would continue to contribute to cumulative impacts to terrestrial and wetland resources. The development and operation of these projects would continue to reduce, fragment, and degrade natural forest, open field, and wetland habitats in the Southern Piedmont Plains. Operational projects with tall structures, such as the cooling towers at HCGS, would cause avian and bat mortalities. However, the projects listed are spread throughout the region, and avian and bat mortalities as a result of collision with tall structures would not cause a noticeable effect to avian or bat populations.

Future residential development and further urbanization of the area would result in the continued increase in fragmentation and loss of habitat. NJLWD projects that the population of Salem County will increase by about 5 percent between 2010 and 2030 (NJLWD 2014-TN3332). Although NJLWD predicts relatively low population growth, the development of a new nuclear power plant coupled with additional projects outlined in Table 9-18 could substantially increase the currently projected level of urbanization for the area. Urbanization in the vicinity of Site 7-2 would reduce area in natural vegetation and open space and decrease connectivity between wetlands, forests, and other wildlife habitat. The loss of habitats as a result of urbanization would result in added pressures to the remaining habitat available for wildlife populations. However, it is not expected that these activities would substantially affect the

overall availability of wildlife habitat or travel corridors near Site 7-2 or the general extent of forested areas in the site vicinity.

Other reasonably foreseeable projects planned in the area of Site 7-2 that could add to the cumulative impacts include a site-redevelopment project as the result of a BRAC for Camp Pedricktown, an airport infrastructure upgrade, and the USACE channel deepening project. The Camp Pedricktown redevelopment area and Millville Municipal Airport improvements are currently developed/disturbed and, therefore, would not further impact any terrestrial and wetland resources. The USACE channel deepening project involves dredging and deepening portions of the main channel of the Delaware River (USACE 2011-TN2262). Terrestrial and wetland resources could be affected by the disposal of dredging materials, which could potentially require new disposal facilities. However, the USACE NEPA documentation for the channel deepening project concludes that there are sufficient dredge disposal areas in the region and that there would be no significant impacts from the project (USACE 1997-TN2281; USACE 2009-TN2663; USACE 2011-TN2262).

The fourth project with the potential to affect terrestrial and wetland resources is the proposed transmission line corridor being developed to address voltage and stability constraints within the PJM region. In its ER (PSEG 2015-TN4280), PSEG conducted a study of a hypothetical 5-mi-wide macro-corridor known as the WMC ("West Macro-Corridor") and transmission line ROWs that extend 55 mi from the PSEG property to Peach Bottom Substation in Pennsylvania. The transmission line ROW within the corridor is expected to be 200 ft wide. The development of the transmission line corridor would cause disturbances to more than 1,500 ac of land. Habitats that could be affected include barren land, deciduous forests, evergreen forests, mixed forest, agricultural land, woody wetlands, and emergent wetlands (PSEG 2015-TN4280). The exact amounts of the resources are not known, and it is expected that the project would cause fragmentation and degradation of terrestrial and wetland resources. However, the corridor would be expected to follow existing ROWs to the extent practicable. A new transmission line ROW would cause wildlife mortalities as a result of operations and maintenance. However, mortalities would not be expected to have a noticeable impact on wildlife populations, and sufficient terrestrial and wetland habitats exist elsewhere in the Southern Piedmont Plains. PSEG identified more than 27,000 ac of wetland and 36,000 ac of forestland resources in the 5-mi-wide corridor that could be traversed by the potential new transmission line ROW. It is unknown exactly how much of these wetlands and forestlands would be affected by the ROW, and mitigation may be required by applicable permitting entities. The review team has determined that as a result of potential losses of wetland resources, the impact of a new transmission line ROW to terrestrial and wetland resources would be noticeable.

The report on climate change impacts in the United States provided by GCRP (2014-TN3472) summarizes the projected impacts of future climate changes in the United States. The report divides the United States into nine regions. Site 7-2 is located in the Northeast region. The GCRP climate models for this region project temperatures to rise 2.5ºF to 4ºF in the winter and 1.5ºF to 3.5ºF in the summer over the next several decades. Winters are projected to be much shorter with fewer cold days and more precipitation. Cities that currently experience few days above 100ºF each summer would average 20 or more days. Hot summer conditions would come 3 weeks earlier and last 3 additional weeks into the fall. Sea level is projected to rise more than the global average, with more frequent severe flooding and heavy downpours.

These projected changes could potentially alter wildlife habitat and the composition of wildlife populations. Large-scale shifts in the ranges of wildlife species and the timing of seasons and animal migration that are already occurring are very likely to continue.

The potential cumulative impacts to terrestrial and wetland resources from building and operating a new nuclear power plant on Site 7-2, in combination with the other activities described above, would noticeably alter terrestrial and wetland resources. These activities would result in the loss or modification of terrestrial and wetland habitats that could potentially affect important species that live in or migrate through the area. For these reasons, the review team has concluded that impacts to terrestrial and wetland resources from building and operating a new nuclear power plant at Site 7-2 in conjunction with other past, present, and reasonably foreseeable future actions would be noticeable. Building and operating a new nuclear power plant at Site 7-2 would contribute to the noticeable impacts.

Summary

Potential impacts to terrestrial and wetland resources were evaluated based on information provided by PSEG, the conceptual layout of a new nuclear power plant at Site 7-2, and an independent review by the review team. Permanent impacts to terrestrial and wetland habitat and wildlife would result in effects to these resources. Additionally, impacts to these resources from building a new nuclear power plant at Site 7-2 would be noticeable. Any terrestrial and wetland resources temporarily disturbed by building a new plant are expected to return to predisturbed conditions. Operational impacts to terrestrial and wetland resources would be similar to those of the PSEG Site. Therefore, the conclusion of the review team is that cumulative impacts on terrestrial and wetland habitat and wildlife, including threatened and endangered species, would be noticeable in the surrounding landscape and therefore MODERATE. Building and operating a new nuclear power plant at Site 7-2 would be a significant contributor to the cumulative impact.

9.3.4.4 Aquatic Resources

The following analysis evaluates impacts from building activities and operations on aquatic ecology resources at Site 7-2. The analysis also considers cumulative impacts from other past, present, and reasonably foreseeable future actions including the other Federal and non-Federal projects listed in Table 9-18 that could affect aquatic resources. In developing this EIS, the review team relied on reconnaissance-level information to perform the alternative site evaluation in accordance with ESRP 9.3 (NRC 2000-TN614). Reconnaissance-level information is data that are readily available from regulatory and resources agencies (e.g., NMFS, FWS, and NJDEP) and other public sources such as scientific literature, books, and Internet websites. It can also include information obtained through site visits (NRC 2012-TN2498; NRC 2012-TN2499; NRC 2012-TN2855) and documents provided by the applicant.

Affected Environment

The affected aquatic environment consists of the Delaware River Estuary in the vicinity of Delaware RM 48.4, and numerous salt marsh creek systems and streams on and near Site 7-2 (S&L 2010-TN2671). The water withdrawal rate from the Delaware River Estuary for Site 7-2

would be the same as for a new nuclear power plant at the PSEG Site (78,196 gpm) because Site 7-2 is located in the same DRBC water-quality zone. Water availability issues at Site 7-2 would also be the same as for the PSEG Site in that an additional 6.9 percent of the Merrill Creek reservoir allocation would be needed during drought conditions, as described in Section 5.2.2. There are no known exceptional aquatic resources at Site 7-2 (PSEG 2015-TN4280).

Commercial/Recreational Species

Site 7-2 has the same species as those listed for the PSEG Site (Section 2.4.2.3). Commercial fisheries in the Delaware River Estuary and in offshore Atlantic waters for the Delaware River Estuary include American Eel, American Shad, Atlantic Croaker, Atlantic Menhaden, Black Drum, Black Sea Bass, Bluefish, Butterfish, Channel Catfish, Conger Eel, Northern Kingfish, Northern Searobin, Scup, Silver Hake, Spot, Striped Bass, Summer Flounder, Weakfish, White Perch, Windowpane Flounder, Winter Flounder, blue crab, eastern oyster, horseshoe crab, knobbed whelk, channeled whelk, and the northern quahog clam. All of these species are also considered recreationally important, with the exception of American Shad, Atlantic Menhaden, Butterfish, Conger Eel, Silver Hake, Windowpane Flounder, eastern oyster, horseshoe crab, knobbed whelk, channeled whelk, and northern quahog clam, and are described in detail in Section 2.4.2.3. Note that since 2008 there has been a moratorium in place on the harvest of horseshoe crabs in New Jersey (ASMFC 2014-TN3511).

Non-Native and Nuisance Species

Site 7-2 has the same potential for nuisance species as those listed for the PSEG Site (Section 2.4.2.3). These include the Asian shore crab, Chinese mitten crab, Northern Snakehead, and Flathead Catfish.

Essential Fish Habitats

The Site 7-2 water intake and discharge areas on the Delaware River Estuary are designated as EFH for many species by the Mid-Atlantic Regional Fishery Management Council, and the NMFS considers the estuarine portion of the Delaware River and tidal waters near the PSEG Site to be EFH for 15 species (PNNL 2013-TN2687; NMFS 2013-TN2804), as described in Section 2.4.2.3. Due to proximity, Site 7-2 EFH would be expected to be similar to that for the PSEG Site.

Federally and State-Listed Species

There are no critical habitats designated by NMFS or FWS in the vicinity of Site 7-2. Listed species found near the proposed water intake and discharge structures, near the possible barge docking facility and inlet channel, and along the proposed transmission line corridor are listed in Table 9-20 (NMFS 2013-TN2804).

The Kemp's ridley sea turtle is listed as Federally and State endangered. The Federally threatened Northwest Atlantic DPS of the loggerhead sea turtle is listed as State endangered for both New Jersey and Delaware. The Atlantic green sea turtle is listed as endangered at both the Federal and State of Delaware levels and listed as threatened in the State of New Jersey. All sea turtles have certain life-history similarities in that females swim ashore to sandy beaches

and deposit eggs in nesting pits that are covered to allow incubation. Juveniles hatch, struggle out of the sandy nest, and make their way to their respective ocean habitats. Although there are no known records of sea turtles nesting along Delaware Bay beaches, sea turtles have been observed to forage in Delaware Bay waters.

Table 9-20. Federally and State-Listed Aquatic Species in the Delaware River Estuary Near Site 7-2

Species Name	Common Name	Federal Status[(a)]	State Status[(b,c)]
Caretta caretta	Loggerhead sea turtle[(d)]	Threatened	Endangered
Chelonia mydas	Atlantic green sea turtle[(e)]	Endangered	Endangered[(b)] Threatened[(c)]
Lepidochelys kempii	Kemp's ridley sea turtle	Endangered	Endangered
Acipenser brevirostrum	Shortnose Sturgeon	Endangered	Endangered
Acipenser oxyrinchus oxyrinchus	Atlantic Sturgeon[(f)]		Endangered

Sources:
(a) NMFS 2013-TN2614.
(b) DNREC 2013-TN3067.
(c) NJDEP 2012-TN2186; NJDEP 2013-TN2722.
(d) Northwest Atlantic distinct population segment (DPS).
(e) Proposed DPS for North Atlantic (T) (80 FR 15271-TN4272).
(f) Gulf of Maine DPS (T), New York Bight DPS (E), Chesapeake Bay DPS (E), Carolina DPS (E), and South Atlantic DPS (E) (77 FR 5880-TN2081; 77 FR 5914-TN4365).

Adult Shortnose Sturgeon use freshwater for spawning and estuarine and marine habitats for feeding. Juveniles migrate downriver to estuarine waters and may go back and forth between freshwater and estuarine habitats for several years before maturing to adults. Adults sometimes migrate to marine habitats for feeding but live the majority of their life cycle in estuarine habitats (Rohde et al. 1994-TN2208; NOAA 2012-TN2173). Migration to spawning habitat occurs in late winter and spring, and adults return to estuarine waters in May and June (Gilbert 1989-TN2149). Spawning occurs in freshwaters characterized by low-to-moderate velocities and over substrates that include clay, sand, gravel, and woody debris. Sturgeon feed on benthic invertebrates such as snails, insect larvae, crustaceans, and worms (Gilbert 1989-TN2149). Shortnose Sturgeon occur in the Delaware River system (NOAA 2012-TN2173). A Shortnose Sturgeon was collected in a bottom trawl from the Delaware River Estuary just downriver of the PSEG Site in 2004 (PSEG 2005-TN2566). Two Shortnose Sturgeon were collected in 2008 and one in 2010 from bottom trawl sampling between Delaware RKM 100 and RKM 120 (RM 62.1 and RM 74.6), which is upriver of the proposed areas for in-water installation and potential dredging activities for Site 7-2 (PSEG 2009-TN2513; PSEG 2011-TN2571).

Atlantic Sturgeon share many life-history characteristics with the Shortnose Sturgeon in that adults migrate to freshwater to spawn and feed on benthic invertebrates such as worms, crustaceans, and aquatic insects (Gilbert 1989-TN2149). Unlike Shortnose Sturgeon, adult Atlantic Sturgeon prefer more marine habitats and make extensive migrations away from natal estuaries beginning as subadults (Gilbert 1989-TN2149). Historically, the Delaware River supported the largest population of Atlantic Sturgeon along the Atlantic coast (Secor and Waldman 1999-TN2207). Tagging studies in 2005 and 2006 indicated that Atlantic Sturgeon followed migration patterns similar to Shortnose Sturgeon with spawning potentially occurring

mid-to-late June in the upper tidal Delaware reaches between Philadelphia, Pennsylvania, and Trenton, New Jersey (Simpson and Fox 2007-TN2194). Gill net surveys by the Delaware Division of Fish and Wildlife collected more than 1,700 juveniles near Artificial Island and the Cherry Island Flats (upriver of Site 7-2) between 1991 and 1998 (ASSRT 2007-TN2082). A single Atlantic Sturgeon was collected in 2004 and 2009 in bottom trawl sampling in Delaware River Estuary waters between RKM 100 and RKM 120 (RM 62.1 and RM 74.6), which is upriver of the proposed areas for in-water installation and potential dredging activities for Site 7-2 (PSEG 2005-TN2566; PSEG 2010-TN2570).

Three New Jersey threatened freshwater mussel species, tidewater mucket, triangle floater, and eastern pondmussel (previously described in Sections 9.3.2.4 and 9.3.3.4), are listed as occurring in Salem County, New Jersey (NatureServe 2012-TN2182; NatureServe 2012-TN2183; NatureServe 2012-TN2184; respectively); however, there are no State-listed occurrences of freshwater mussel species within a 1-mi radius of either the Site 7-2 intake (NJDEP 2013-TN2722) or the Site 7-2 location (NJDEP 2013-TN3577).

Field studies would be required to definitively determine whether any rare or protected species are present in streams in the project area. Federally endangered Shortnose and Atlantic Sturgeon are known to occur near the proposed areas for in-water installation and potential dredging activities at Site 7-2.

Building Impacts

Building the plant structures, roads, and transmission lines and switchyard would disturb streams on the site and along offsite corridors. In addition to buildings and other structures, buried water intake and discharge pipes would run 12.9 mi from the Delaware River Estuary to the site. The total length of streams that would be affected by building activities on Site 7-2, including the access roads, rail spur, and water pipelines, is 9,710 ft (PSEG 2015-TN4280). This represents 0.7 percent of the total length of streams within 6 mi of the site. In addition, an estimated 2,130 ft of streams could be affected by activities related to the new transmission corridor and switchyard installation (representing less than 0.5 percent of the total stream lengths in the area) (S&L 2010-TN2671). However, potential impacts to streams from transmission corridor installation could be avoided or minimized by final corridor placement and use of BMPs to reduce erosion and sedimentation effects from building activities (PSEG 2015-TN4280).

The installation of the water intake structure, and possibly a barge facility with a turning basin, would result in disturbance of benthic habitat in the Delaware River Estuary. Dredging would disturb about 6 ac of bottom habitat (about 145,000 yd^3 dredged) for the intake structure and possibly 67 ac (possibly 1,197,000 yd^3 dredged) for the barge facility (S&L 2010-TN2671). A barge inlet channel may also be needed. Dredging the barge inlet channel would disturb an additional 43 ac of benthic habitat and would remove an additional 490,000 yd^3 of dredged material (S&L 2010-TN2671). Installation and site-preparation activities could temporarily affect water quality but would require Federal and State permitting and use of BMPs to minimize and mitigate the temporary and localized effects. Effects on aquatic organisms are expected to be minimal and temporary because adjacent habitat is accessible and mobile aquatic organisms such as fish and most macroinvertebrates would be able to avoid or move away from the

affected area during intake installation activities, but effects could be greater if the installation of a barge facility with a turning basin and inlet channel are required. However, the impact on aquatic ecology of the Delaware River Estuary and streams on the site and in pipeline corridors would be minimal.

Operational Impacts

During operation of a new nuclear power plant at Site 7-2, there would be no direct discharges and few impacts to small streams on the site. Operation of the cooling and service water systems would require water to be withdrawn from and discharged back to the Delaware River Estuary as described for the PSEG Site. Aquatic impacts associated with impingement and entrainment of aquatic biota in the Delaware River Estuary and discharge of cooling water to the Delaware River Estuary could occur. Because the specifications associated with the water intake structure include a closed-cycle cooling system designed to meet the EPA Phase I regulations for new facilities (66 FR 65256-TN243), the maximum through-screen velocity at the water intake structure would be less than 0.5 fps. Thus, if a new nuclear power plant is built at Site 7-2, the anticipated impacts to aquatic communities from impingement and entrainment in the Delaware River Estuary are not expected to be different from those described in the analysis presented in Section 5.3.2 for the PSEG Site and are expected to be minimal. Operational impacts associated with water quality and discharge cannot be determined without additional detailed analysis, but are also expected to be similar to the effects described for the PSEG Site. Maintenance activities on the site and in offsite corridors would follow BMPs required by Federal and State permits to minimize impacts on aquatic resources. Consequently, impacts on aquatic ecology due to project operations at Site 7-2 are expected to be minor.

Cumulative Impacts

Past alteration and degradation of the Delaware River Estuary, as described in Sections 2.4.2.1 and 7.3.2, have had long-term noticeable and sometimes destabilizing consequences on the aquatic resources within the Delaware River Basin and continue to be the subject of numerous restoration activities in targeted portions of the area. For assessment of cumulative impacts for Site 7-2, the ROI includes a 6-mi radius of water resources around the site, and a 6-mi radius around the point of the water intake and discharge structures on the Delaware River Estuary.

The non-nuclear plant projects listed in Table 9-18 may result in alterations to surface-water drainage pathways and water bodies. It is not expected that these projects would have noticeable effects on water quality within the vicinity of Site 7-2 because they would need Federal, State, and local permits that require implementation of BMPs. The past, current, and future operation of SGS and HCGS will result in continued losses of aquatic species through impingement and entrainment at the water intake systems and alteration of thermal profiles in the immediate Delaware River Estuary area located near these facilities. Ongoing restoration efforts through the PSEG EEP will continue to provide mitigation for losses by increasing available habitat for early life stages of aquatic organisms and restoring previously fragmented habitats. A grid stability transmission line may be necessary for operation of a new nuclear power plant at Site 7-2, and would be similar to that described for the PSEG Site (Section 7.3.2).

Anthropogenic activities such as residential or industrial development near the vicinity of a new nuclear power plant could present additional constraints on aquatic resources. It is not expected that these projects would have noticeable effects on water quality within the vicinity of Site 7-2 because they would need Federal, State, and local permits that require implementation of BMPs. The review team is also aware of the potential for climate change affecting aquatic resources, but the potential impacts of climate change on aquatic organisms and habitat in the geographic area of interest are not precisely known. In addition to rising sea levels, climate change could lead to regional increases in the frequency and intensity of extreme precipitation events, increases in annual precipitation, and increases in average temperature (GCRP 2014-TN3472). Such changes in climate could alter aquatic community composition on or near Site 7-2 through changes in species diversity, abundance, and distribution. Elevated water temperatures, droughts, and severe weather phenomena could adversely affect or severely reduce aquatic habitat, but specific predictions of aquatic habitat changes in this region due to climate change are inconclusive at this time. The level of impact resulting from these events would depend on the intensity of the perturbation and the resiliency of the aquatic communities.

Summary

Impacts on aquatic ecology resources are estimated based on the information provided by PSEG, NMFS, the State of New Jersey, and the review team's independent review. Properly siting the associated transmission line and switchyard; avoiding habitat for protected species; minimizing interactions with water bodies and watercourses along the corridors; and use of BMPs during water intake and discharge structure installation, possible installation of a barge facility with a turning basin and inlet channel, transmission line corridor preparation, and tower placement would minimize building and operation impacts. The review team concludes that the cumulative impacts on most aquatic resources in the Delaware River Estuary, including Federally and State threatened and endangered species, of building and operating a new nuclear power plant at Site 7-2, combined with other past, present, and future activities, would be MODERATE to LARGE. The new plant would not be a significant contributor to the cumulative impact.

9.3.4.5 Socioeconomics

As discussed in Section 9.3.4, Site 7-2 is located in Salem County, New Jersey. The economic impact area for Site 7-2 would be the same as for the PSEG Site. The site is a greenfield site located 12 mi east-northeast of the PSEG Site and approximately 6 mi north of the town of Shiloh (PSEG 2015-TN4280; PSEG 2010-TN257).

The review team's baseline discussion focuses on the 50-mi region surrounding Site 7-2. As discussed in Section 2.5, the review team expects that construction and operations workers for Site 7-2 would likely settle in the same areas as for the PSEG Site. Therefore, the review team focuses on Salem, Cumberland, and Gloucester Counties in New Jersey and New Castle County in Delaware for the majority of impacts. These four counties compose the economic impact area for Site 7-2.

Based on experience with construction of SGS and HCGS, PSEG believes about 84.5 percent of the workforce required to build a new nuclear power plant would come from within the 50-mi

region surrounding the proposed site. PSEG assumes the remaining 15.5 percent of workers would relocate to the region from outside and would choose to reside in the same four counties that house the majority of the operations workers. The review team, as discussed in Sections 4.4 and 5.4, found similar estimates. Thus, both adverse and beneficial socioeconomic impacts of building and operating a new plant would not be noticeable except in these four counties. As discussed in Section 2.5, the review team finds the assumptions to be reasonable.

Physical and Aesthetic Impacts

Physical impacts include impacts on workers and the general public, noise, air quality, buildings, roads, and aesthetics. The physical impacts on workers would be similar to those described for the PSEG Site. The primary differences would be due to the presence of the HCGS and SGS workforces near the PSEG Site.

Site 7-2 is within 0.5 mi of a school and housing developments. Site 7-2 would retrieve its cooling water from the Delaware River, requiring a 13-mi-long water pipeline that would go through WMAs that are used for hunting, trapping, and birding (PSEG 2010-TN257). PSEG would also build a 5.4-mi-long rail spur and 2.2 mi of new road (PSEG 2015-TN4280). Because the site is a greenfield site, PSEG would have to reroute an existing transmission line about 1.8 mi and build another 4.1-mi-long transmission line. Even with mitigation measures similar to those discussed in Section 4.4.1, during the building phase, these areas would receive adverse physical impacts from noise, vibration, and fugitive dust. Aesthetic impacts from building and operations at Site 7-2 would be similar to those discussed in Sections 4.4.1.6 and 5.4.1.6. The primary differences would be due to the presence of HCGS and SGS near the PSEG Site and the proximity of the Delaware River to the PSEG Site. Because Site 7-2 is a greenfield site and would create new infrastructure in previously undisturbed rural areas, and new infrastructure would affect previously undisturbed WMAs, the review team expects the aesthetic impacts from building and operations to be noticeable and locally destabilizing.

Demography

Section 2.5.1 discusses the baseline demographic information in the economic impact area and region. Site 7-2 is located in the same county as the PSEG Site and has the same economic impact area as the PSEG Site. The review team predicts the same workforce requirements and in-migrating worker housing scenario as discussed in Sections 4.4.2 and 5.4.2. The review team found that building- and operations-related impacts on demography would be minimal in the economic impact area and the region.

Economic and Tax Impacts

Section 2.5.2.1 discusses the baseline economy and Section 2.5.2.2 discusses the tax structure in the economic impact area and region. Site 7-2 is located in the same county as the PSEG Site and has the same economic impact area as the PSEG Site. For the purposes of the analysis of impacts to the local economy and tax revenues from the building and operations of a new nuclear power plant at Site 7-2, the review team predicts economic and tax impacts similar to those discussed in Sections 4.4.3 and 5.4.3. The review team found that building- and

operations-related impacts on the local economy and local tax revenues would range from minimal and beneficial in the region and economic impact area to a major, beneficial impact to Salem County.

Infrastructure and Community Service Impacts

This section provides the estimated impacts on infrastructure and community services, including transportation, recreation, housing, public services, and education.

Traffic

Section 2.5.2.3 discusses the local roadways and transportation characteristics in the economic impact area and region. Sections 4.4.4.1 and 5.4.4.1 discuss the traffic impacts around the PSEG Site. Road access to the Site 7-2 area is provided primarily by New Jersey Route 540, which is a wide two-lane highway. The current vehicle count on the road is 5,406 vehicles. Road access to the site itself is provided by County Road 635, a narrow two-lane road (PSEG 2015-TN4280). The site is about 19 mi from Interstate 295 and the New Jersey Turnpike via Route 540. The nearest rail spur is about 5 mi east of the site, and barge access would be provided by the Delaware River, about 10 mi southwest of the site. The site would require about 4 mi of roadway improvements (PSEG 2010-TN257). Due to the size of the workforce for building and the similarity of the roads and their LOS values compared to the PSEG Site, the review team expects a noticeable, but not destabilizing, impact from traffic. Because the workforce for operations is smaller (even during outages), the review team expects traffic impacts to be minimal.

Recreation

Section 2.5.2.4 discusses the recreational activities in the economic impact area and region. As discussed in Sections 4.4.4.2 and 5.4.4.2, the review team does not expect any stresses to be placed upon the capacity of the recreational resources in the PSEG Site's economic impact area and region from new in-migrating workers and their families. This would also be true for Site 7-2's recreational impacts. Also, like the PSEG Site, recreational resources near Site 7-2 would receive a noticeable aesthetic impact from building and operational activities and a noticeable impact from traffic during peak building activities.

However, because the pipeline corridor would cross three WMAs where there is trapping, hunting, and fishing, the review team expects noticeable and potentially destabilizing impacts on recreational activities in these areas from the new infrastructure (PSEG 2010-TN257; PSEG 2015-TN4280).

Housing

Section 2.5.2.5 discusses the baseline housing market in the economic impact area and region. Site 7-2 is located in the same county as the PSEG Site and has the same economic impact area as the PSEG Site. For the purposes of the analysis of impacts to the local housing market from the building and operations of a new nuclear power plant at Site 7-2, the review team predicts housing impacts similar to those discussed in Sections 4.4.4.3 and 5.4.4.3. The

primary difference would be that many of the 46 houses within the conceptual site boundaries would have to be removed to build and operate a new nuclear plant (PSEG 2015-TN4280). However, any taking related to a new power plant would have to be performed with an equitable compensation, which would render minimal any potential impact from that taking. The review team found that building- and operations-related impacts on the local housing market would be minimal in the economic impact area and the region.

Public Services

Section 2.5.2.6 discusses the baseline public services information in the economic impact area. This includes water and wastewater, police, fire, medical services, and social services. Site 7-2 is located in the same county as the PSEG Site and has the same economic impact area as the PSEG Site. For the purposes of the analysis of impacts to the local public services infrastructure from the building and operations of a new nuclear power plant at Site 7-2, the review team predicts the impacts to be similar to those discussed in Sections 4.4.4.4 and 5.4.4.4. The review team found that building- and operations-related impacts on the local public services infrastructure would be minimal in the economic impact area and the region.

Education

Section 2.5.2.6 discusses baseline education information in the economic impact area. Site 7-2 is located in the same county as the PSEG Site and has the same economic impact area as the PSEG Site. For the purposes of the analysis of impacts to the local education services from the building and operations of a new nuclear power plant at Site 7-2, the review team predicts impacts similar to those discussed in Sections 4.4.4.5 and 5.4.4.5. The review team found that building- and operations-related impacts on the local education services would be minimal in the economic impact area and the region.

Summary of Infrastructure and Community Service Impacts

The review team has concluded from the information provided by PSEG, review of existing reconnaissance-level documentation, and its own independent evaluation that the impact of building and operations activities on regional infrastructure and community services—including housing, public services, and education—would be minor. Physical and aesthetic impacts from building and operations would be noticeable and potentially destabilizing. The estimated peak workforce would have a noticeable, but not destabilizing, impact on traffic near Site 7-2. Increased traffic would have a noticeable, but not destabilizing, impact on recreational facilities; however, physical-aesthetic impacts would have a noticeable and potentially destabilizing impact on recreational facilities and activities near Site 7-2.

Cumulative Impacts

As discussed above, the economic impact area for Site 7-2 is Salem, Cumberland, and Gloucester Counties in New Jersey, and New Castle County in Delaware. The review team discusses information pertaining to these areas in Sections 2.5 and 7.4.1. Table 9-18 lists the past, present, and reasonably foreseeable future activities associated with Site 7-2. Building and operating a new nuclear power plant at Site 7-2 could result in cumulative impacts on the

demographics, economy, and community infrastructure of the economic impact area counties in conjunction with those reasonably foreseeable future actions.

Within the economic impact area, the project with the greatest potential to affect cumulative socioeconomic impacts would be the continued operation of the three nuclear units at HCGS and SGS. The other projects involve continuation of development in the economic impact area and are included in county comprehensive plans and in other public agency planning processes. According to Section 2.5.1.3, about 1,300 people are employed at HCGS and SGS, and the majority of the workforce lives in the four counties in the economic impact area. Each reactor has outages that employ a further 1,034 to 1,361 workers for about 1 month on a staggered 18- to 24-month schedule (about an outage every 6 months at the site). Operations at HCGS and SGS also contribute to economic activity and tax revenue to the local communities. These characteristics are discussed further in Section 2.5 and in the HCGS and SGS License Renewal EIS (NRC 2011-TN3131).

An outage at the HCGS/SGS site could occur during peak building at Site 7-2. The review team considers this potential occurrence in Section 7.4. The majority of traffic impacts discussed in Section 7.4 would occur where the HCGS/SGS workforce, HCGS/SGS outage workforce, and the PSEG Site building workforce merge in and around Salem City (PSEG 2013-TN2525). Because Site 7-2 is southeast of Salem City, the review team expects cumulative impacts similar to those discussed in Section 7.4 because the three traffic streams may merge in and around Salem City.

The operating licenses for SGS Units 1 and 2 and HCGS expire in 2036, 2040, and 2046, respectively. Salem County would see a loss in property tax revenue, PSEG purchases of supplies and materials, and employment. However, this loss would be partially offset by the continued operations at Site 7-2 compared to the baseline discussed in Section 2.5.

Summary of Socioeconomic Impacts

The review team expects the cumulative effects of most of the physical impacts to be SMALL with the exception of a LARGE impact to aesthetics. The LARGE aesthetic impact is because Site 7-2 is a greenfield site and would create new infrastructure in previously undisturbed rural areas, and new infrastructure would affect previously undisturbed WMAs. The cumulative impacts on demography would be SMALL. The cumulative impacts on taxes and the economy would be SMALL and beneficial throughout the region, except for a MODERATE and beneficial income tax impact to the State of New Jersey and a LARGE and beneficial economic and tax impact to Salem County. The cumulative impacts on infrastructure and community services would be SMALL throughout the region, with the exception of a MODERATE impact from traffic to Salem County during building activities and a LARGE impact to recreation-based aesthetics. Based on the above considerations, the review team concludes that cumulative socioeconomic impacts from building and operations at Site 7-2 (with the exception of the physical and recreational aesthetic impacts and the beneficial impacts to taxes and the economy) would not noticeably contribute to the existing cumulative socioeconomic effects discussed earlier in this section.

9.3.4.6 Environmental Justice

The economic impact area for Site 7-2 includes Salem, Gloucester, and Cumberland Counties in New Jersey and New Castle County in Delaware. Because of the proximity of Site 7-2 to the PSEG Site (about 12 mi), the review team determined that the analysis of populations for the PSEG Site was a close approximation of an independent assessment of Site 7-2, according to the methodology discussed in Section 2.6.1. Therefore, the review team used the distribution of minority and low-income populations around the PSEG Site to determine minority and low-income population distributions around Site 7-2. This distribution is discussed in detail in Section 2.6. The closest minority groups to Site 7-2 are located about 7 mi to the north, in Salem. The closest low-income populations of interest to Site 7-2 are located about 6 mi to the west, in Upper Deerfield Township in Cumberland County (PSEG 2012-TN2450). The review team found no indication of subsistence activities in the economic impact area. As discussed in Sections 2.5 and 2.6, the majority of migrant populations are outage workers at HCGS and SGS. The closest high-density communities are in Salem and Penns Grove, north of Carneys Point (Salem County 2010-TN2486).

As discussed in Section 9.3.4.5, the review team expects that building and operating a new nuclear power plant at Site 7-2 would have some adverse physical and aesthetic impacts to the local population. However, even though the review team expects adverse physical impacts during building and operations, distance, intervening foliage, and topography would significantly diminish such impacts on minority or low-income populations. Therefore, the review team does not expect the adverse physical and aesthetic impacts to be disproportionately high and adverse toward minority and low-income populations. For the rest of the economic impact area and region, the review team expects environmental justice impacts similar to those at the PSEG Site. Therefore, the review team determined there would be no environmental justice impacts.

Cumulative Impacts

Based on the analysis above and the discussion of cumulative impacts in Section 9.3.4.5, the review team determined that there would not be any further disproportionately high and adverse impacts on environmental justice populations above and beyond those discussed in this section. The review team did not identify any pathways for environmental justice impacts from the continued operations at HCGS and SGS.

9.3.4.7 Historic and Cultural Resources

The following impact analysis includes impacts from building and operating a new nuclear power plant at Site 7-2 in Salem County, New Jersey. The analysis also considers other past, present, and reasonably foreseeable future actions that impact historic and cultural resources, including the Federal and non-Federal projects listed in Table 9-18. For the analysis of historic and cultural impacts at Site 7-2, the geographic area of interest is considered to be the APE that would be defined for this proposed undertaking. This includes the physical APE, defined as the area directly affected by the site-development and operation activities at the site, the transmission lines, and the visual APE. The visual APE is defined as the additional 4.9-mi radius around the physical APE. The 4.9-mi radius was chosen by the New Jersey SHPO as

the appropriate distance for consideration of visual resources near the PSEG Site and was therefore applied to the alternative sites (AKRF 2012-TN2876).

Reconnaissance-level activities in this cultural resource review have a particular meaning. For example, these activities include preliminary field investigations to confirm the presence or absence of cultural resources and historical properties. In developing this EIS, the review team relies upon reconnaissance-level information to perform its alternative site evaluation. Reconnaissance-level information consists of data that are readily available from agencies and other public sources. It can also include information obtained through visits to the alternative site area. The following information was used to identify the cultural resources and historical properties at Site 7-2:

- the PSEG ER (PSEG 2015-TN4280),
- *Field Verification of Key Resources at PSEG Alternative Sites* (AKRF 2011-TN2869), and
- New Jersey SHPO archaeological site files.

Affected Environment

Site 7-2 is a greenfield located in Salem County in southwestern New Jersey. Site 7-2 is 12 mi east of the Delaware River. Site 7-2 contains agricultural fields as well as wood lots and wetland areas. Historically, portions of the Site 7-2 have been used for agricultural purposes. Site 7-2 encompasses a total of 996 ac. The location would require 2.2 mi of new roads, a 5.4-mi railroad spur, and a 12.9-mi-long makeup water pipeline. An existing 500-kV transmission line crosses the location, but 1.8 mi of this existing line would need to be rerouted. A 4.1-mi connector transmission line would be needed to connect to the existing lines running to the HCGS/SGS site. A new line may also be needed to ensure grid stability. The new line would run about 107 mi. The current major industry in Salem County is agriculture. Twenty-three properties listed on the NRHP are located in Salem County, New Jersey (NPS 2013-TN2400). The closest listed property to Site 7-2 is the Nathaniel Chambliss House (within 1,000 ft of Site 7-2).

No known archaeological sites have been recorded within Site 7-2. Two historic period archaeological sites are recorded within the 1-mi APE around Site 7-2: Sites 28-SA-184 and 28-SA-185. Four archaeological sites are close to the conceptual pipeline corridor. Three of the sites date to the historic period and the fourth to the prehistoric era.

Three previously identified architectural resources are within 4.9 mi of Site 7-2 and its ancillary components. Resources include residences and a church. Two architectural resources are within 1 mi of Site 7-2 and the conceptual corridors: the Deerfield Presbyterian Church and the Phillip Fries House. A review of architectural resources in the immediate vicinity of Site 7-2 identified six additional architectural resources within 1,000 ft of Site 7-2 that could potentially be eligible for NRHP listing (AKRF 2011-TN2869). These resources are all residences. Two of the residences are within the Site 7-2 footprint. An additional 26 resources that have potential for eligibility for NRHP listing were noted between 1 and 4.9 mi from Site 7-2.

Building Impacts

No known historic or cultural resources exist within Site 7-2. However, additional cultural resource inventories would likely be needed for any portion of Site 7-2 that has not been previously surveyed. Other lands that are acquired to support the new plant (e.g., for roads and pipeline corridors) would also likely require a survey to identify potential cultural resources and historical properties and mitigation measures to offset the potential adverse effects of ground-disturbing activities. The types of historic property and cultural resource impacts resulting from construction and operation of a new nuclear power plant would consist of alterations to archaeological sites from ground-disturbing activities and visual alteration of the setting for a historic structure. In some cases vibrations from construction equipment could affect historic structures.

There is one existing transmission corridor connecting directly to Site 7-2 and a second existing line; however, a 4.1-mi connector would be needed (PSEG 2015-TN4280). One new transmission line corridor would also be needed for Site 7-2. There are no NRHP-listed or recorded historic or prehistoric sites in the area where the transmission line would be routed. In the event that Site 7-2 was chosen for the proposed project, the review team assumes that the transmission service provider for this region would conduct cultural resource surveys for all areas needed for the transmission lines. If NRHP-eligible resources are identified, then efforts to avoid, minimize, or mitigate impacts would be developed in consultation with the New Jersey SHPO and any interested parties as required under NHPA Section 106 (54 USC 300101 et seq. -TN4157). In addition, visual impacts from transmission lines could result in significant alterations to the visual landscape within the geographic area of interest. Building impacts are expected to be noticeable because listed or eligible resources are within the viewshed of Site 7-2 and the introduction of a power plant and cooling tower is new to the viewshed. It is likely that archaeological resources would not be found at Site 7-2.

Operational Impacts

Operational impacts from a new nuclear power plant located at Site 7-2, with the exception of visual impacts from the plant and cooling tower, would be expected to be minimal. Most impacts to cultural resources would occur during preconstruction and construction. Visual impacts to historic structures would occur within the viewshed of a new plant during operation. It is anticipated that visual effects on historic and cultural resources from operation would be noticeable.

Cumulative Impacts

The visual impacts to cultural and historic resources from a new plant and cooling towers would be noticeable. Cumulative impacts would also result from non-NRC-licensed activities associated with construction of the transmission lines and pipelines. These impacts would depend on the locations of the various activities and the nature, number, and significance of the historic and cultural resources present. Existing information suggests that the region surrounding Site 7-2 contains intact cultural resources and historical properties. It is possible that currently unknown cultural resources could be found in close proximity to areas needed for the transmission lines and pipelines. Due to the visual effect to the historic resources from the

plant and the cooling tower and the effects of the non-NRC-licensed activities, the effects on the cultural and historic resources are expected to be noticeable. Because of the uncertainty associated with the lack of previous cultural surveys, cumulative impacts could be greater depending on whether significant resources were encountered and whether they could be avoided.

Summary

Cultural resources are nonrenewable; therefore, the impact from the destruction of cultural resources is cumulative. Based on the reconnaissance-level information the review team concludes that the cumulative impacts on cultural resources and historical properties from building and operating a new nuclear power plant at Site 7-2 would be MODERATE. The incremental contribution from building and operating a new plant at Site 7-2 would be a significant contributor to the cumulative impact. This impact-level determination reflects the fact that significant cultural resources and historical properties are found within the viewshed of a new nuclear power plant and associated facilities at Site 7-2. However, if Site 7-2 were to be developed, additional cultural resource surveys might reveal additional historic and cultural resources, which could result in greater cumulative impacts.

9.3.4.8 Air Quality

Criteria Pollutants

The air-quality impacts of building and operating a new nuclear power plant and offsite facilities at Site 7-2 would be similar to those expected at the PSEG Site and Site 7-1 because all three sites are located in Salem County. Salem County is in the PA-NJ-MD-DE nonattainment area for 8-hour ozone NAAQSs (40 CFR Part 81-TN255) and administratively in the Metropolitan Philadelphia Interstate AQCR (40 CFR 81.15 [TN255]). With the exception of the 8-hour ozone NAAQSs, air quality in Salem County is in attainment with or better than national standards for criteria pollutants. An applicability analysis would need to be performed if a nuclear power plant was built at Site 7-2 per 40 CFR Part 93, Subpart B (TN2495), to determine whether a general conformity determination was needed.

As discussed in Section 4.7, emissions of criteria pollutants from building a nuclear power plant are expected to be temporary and limited in magnitude. Emissions from these activities would be primarily the fugitive dust from ground-disturbing activities and engine exhaust from heavy equipment and vehicles. These impacts would be similar to the impacts associated with any large construction project. During building activities, a New Jersey State Air Quality Permit would be required that would prescribe emissions limits and mitigation measures to be implemented. The applicant also plans to implement a fugitive dust control program (PSEG 2015-TN4280).

Section 5.7 discusses air-quality impacts during operations. Emissions during operations would primarily be from operation of the cooling towers, auxiliary boilers, diesel generators and/or gas turbines, and commuter traffic. Stationary sources such as the diesel generators and/or gas turbines (operating infrequently) and auxiliary boilers (operating mostly during the winter months) would be operated according to State and Federal regulatory requirements.

A Title V operating permit administered through the State of New Jersey would ensure compliance with NAAQSs and other applicable regulatory requirements and prescribe mitigation measures to ensure compliance. There are 13 major sources of air emissions in Salem County with existing Title V operating permits (EPA 2013-TN2504). These existing sources include the energy and industrial projects listed in Table 9-18. The existing energy and industrial projects and the planned development and transportation projects would contribute to air-quality impacts in Salem County. However, the impacts on air quality in the county from emissions from Site 7-2 would be temporary and not noticeable when combined with other past, present, and reasonably foreseeable future projects. The cumulative air-quality impacts of building and operating a nuclear power plant at Site 7-2 would be minor.

Greenhouse Gases

The cumulative impacts of GHG emissions related to nuclear power are discussed in Section 7.6. The impacts of the emissions are not sensitive to the location of the source. Consequently, the discussion in Section 7.6 would be applicable to a nuclear power plant located at Site 7-2. The review team concludes that the national and worldwide cumulative impacts of GHG emissions are noticeable but not destabilizing. The review team further concludes that the cumulative impacts would be noticeable but not destabilizing, with or without the GHG emissions of the project at Site 7-2.

Summary

The review team concludes that the cumulative impacts from other past, present, and reasonably foreseeable future actions on air-quality resources in the geographic areas of interest would be SMALL for criteria pollutants and MODERATE for GHG emissions. The incremental contribution of impacts on air-quality resources from building and operating a new nuclear power plant at Site 7-2 would be SMALL for both criteria pollutants and GHG emissions.

9.3.4.9 Nonradiological Health

The following impact analysis considers nonradiological health impacts on the public and workers from building activities and operations associated with a new nuclear power plant at Site 7-2, which is located in Alloway Township, Salem County, New Jersey (about 12 mi east-northeast of the PSEG Site). The analysis also considers other past, present, and reasonably foreseeable future actions that could affect nonradiological health within the geographic area of interest, including other Federal and non-Federal projects and those projects listed in Table 9-18. The building-related activities that have the potential to affect the health of members of the public and workers include exposure to dust and vehicle exhaust, occupational injuries, noise, and the transport of construction materials and personnel to and from the site. The operation-related activities that have the potential to affect the health of members of the public and workers include exposure to etiological agents, noise, and EMFs and transport of workers to and from the site.

Most of the nonradiological impacts of building and operation (e.g., noise, etiological agents, and occupational injuries) would be localized and would not have significant impact at offsite locations. However, activities such as vehicle emissions from transport of personnel to and

from the site would encompass a larger area. Therefore, for nonradiological health impacts associated with vehicle and other air emissions sources, the geographic area of interest for cumulative impacts analysis includes projects within a 50-mi radius of Site 7-2. For cumulative impacts associated with transmission lines, the geographical area of interest is the transmission line corridor. These geographical areas are expected to encompass areas where cumulative impacts to public and worker health could occur in combination with any past, present, or reasonably foreseeable future actions.

Building Impacts

Nonradiological health impacts on the construction workers from building a new nuclear power plant at Site 7-2 would be similar to those from building a new plant at the PSEG Site, as evaluated in Section 4.8. They include occupational injuries, noise, odor, vehicle exhaust, and dust. Applicable Federal, State, and local regulations on air quality and noise would be complied with during the plant construction phase. Site 7-2 does not have any characteristics that would be expected to lead to fewer or more construction accidents than would be expected for the PSEG Site. Transportation of personnel and construction materials at Site 7-2 would result in minimal nonradiological health impacts. Site 7-2 is in a greenfield area, and construction impacts would likely be minimal on the surrounding areas, which are classified as low-population areas.

Operational Impacts

Nonradiological health impacts on members of the public and on the occupational health of workers from operation of a new nuclear power plant at Site 7-2 would be similar to those evaluated in Section 5.8 for a new plant at the PSEG Site. Occupational health impacts on workers (e.g., falls, electric shock, or exposure to other hazards) at Site 7-2 would likely be the same as those evaluated for workers at a new plant at the PSEG Site. Discharges to the Delaware River would be controlled by NPDES permits issued by NJDEP. The growth of etiological agents would not be significantly encouraged at Site 7-2 because of the temperature attenuation in the length of the pipe required for a discharge system. Noise and EMF exposure would be monitored and controlled in accordance with applicable OSHA regulations. Effects of EMFs on human health would be controlled and minimized by conformance with NESC criteria. Nonradiological impacts of traffic during operations would be less than the impacts during building. Mitigation measures used during building to improve traffic flow would also minimize impacts during operation of a new plant.

Cumulative Impacts

Past and present actions within the geographic area of interest that could contribute to cumulative nonradiological health impacts include the energy projects in Table 9-18 and vehicle emissions and existing urbanization. Reasonably foreseeable future projects in the geographical area of interest that could contribute to cumulative nonradiological health impacts include expansion of natural-gas pipelines, improvements and new construction for roadways and interstates, future transmission line development, and future urbanization. The review team is also aware of the potential climate changes that could affect human health, and a recent compilation of the state of knowledge in this area (GCRP 2014-TN3472) has been considered in

the preparation of this EIS. Projected changes in climate for the region include an increase in average temperature; increased likelihood of drought in summer; more heavy downpours; and an increase in precipitation, especially in the winter and spring, which could alter the presence of microorganisms and parasites. In view of the water source characteristics, the review team did not identify anything that would alter its conclusion regarding the presence of etiological agents or change in the incidence of waterborne diseases.

Summary

Based on the information provided by PSEG and the review team's independent evaluation, the review team expects that the impacts on nonradiological health from building and operating a new nuclear power plant at Site 7-2 would be similar to the impacts evaluated for the PSEG Site. Although there are past, present, and future activities in the geographical area of interest that could affect nonradiological health in ways similar to the building and operation of a new plant at Site 7-2, the impacts from such activities would be localized and managed through adherence to existing regulatory requirements. Similarly, impacts on public health of a new nuclear power plant operating at Site 7-2 would be expected to be minimal. The review team concludes, therefore, that the cumulative impacts on nonradiological health of building and operating a new nuclear power plant at Site 7-2 would be SMALL.

9.3.4.10 Radiological Impacts of Normal Operations

The following impact analysis includes radiological impacts on the public and workers from building activities and operations for a new nuclear power plant at Site 7-2, which is located in Alloway Township, Salem County, New Jersey (about 12 mi east-northeast of the PSEG Site). The analysis also considers other past, present, and reasonably foreseeable future actions that could affect radiological health, including other Federal and non-Federal projects and the projects listed in Table 9-18. As described in Section 9.3.4, Site 7-2 is a greenfield site; there are currently no nuclear facilities on the site. The geographic area of interest is the area within a 50-mi radius of Site 7-2. Other nuclear reactor sites that potentially affect the radiological health within this geographic area of interest are HCGS, SGS Units 1 and 2, Limerick Generating Station Units 1 and 2, and Peach Bottom Atomic Power Station Units 2 and 3. The Shieldalloy radioactive materials decommissioning site in Newfield, New Jersey, is also within 50 mi of Site 7-2. In addition, medical, industrial, and research facilities that use radioactive materials are likely to be within 50 mi of Site 7-2.

The radiological impacts of building and operating a new nuclear power plant at Site 7-2 include doses from direct radiation and liquid and gaseous radioactive effluents. These pathways would result in doses to people and biota other than humans off the site that would be well below regulatory limits. The impacts are expected to be similar to those at the proposed PSEG Site.

The radiological impacts of HCGS, SGS Units 1 and 2, Limerick Generating Station, and Peach Bottom Atomic Power Station include doses from direct radiation and liquid and gaseous radioactive effluents. These pathways result in doses to people and biota other than humans off the site that are well below regulatory limits as demonstrated by the ongoing radiological environmental monitoring program conducted around HCGS, SGS Units 1 and 2, Limerick Generating Station, and Peach Bottom Atomic Power Station. The NRC staff concludes that the

dose from direct radiation and effluents from medical, industrial, and research facilities that use radioactive material would be an insignificant contribution to the cumulative impact around Site 7-2. This conclusion is based on data from the radiological environmental monitoring programs conducted around currently operating nuclear power plants. Based on the information provided by PSEG and the NRC staff's independent analysis, the NRC staff concludes that the cumulative radiological impacts from building and operating a new nuclear power plant and other existing and planned projects and actions in the geographic area of interest around Site 7-2 would be SMALL.

9.3.4.11 Postulated Accidents

The following impact analysis includes radiological impacts from postulated accidents from the operation of a new nuclear power plant at Site 7-2 in Salem County, New Jersey. The analysis also considers other past, present, and reasonably foreseeable future actions that could affect radiological health from postulated accidents, including other Federal and non-Federal projects and those projects listed in Table 9-18, within the geographic area of interest. As described in Section 9.3.4, Site 7-2 is a greenfield site, and there are currently no nuclear facilities on the site. The geographic area of interest considers all existing and proposed nuclear power plants that have the potential to increase the probability-weighted consequences (i.e., risks) from a severe accident at any location within 50 mi of this site. Existing facilities potentially affecting radiological accident risk within this geographic area of interest are HCGS Unit 1, SGS Units 1 and 2, Oyster Creek Nuclear Generating Station, Limerick Generating Station Units 1 and 2, Peach Bottom Atomic Power Station Units 2 and 3, Three Mile Island Nuclear Station Unit 1, and Calvert Cliffs Nuclear Power Plant Units 1 and 2.

As described in Section 5.11, the NRC staff concludes that the environmental consequences of DBAs at the PSEG Site would be minimal for a US-APWR, two AP1000s, a U.S. EPR, or an ABWR. DBAs are addressed specifically to demonstrate that any of these four reactor designs is sufficiently robust to meet NRC safety criteria. The reactor designs are independent of site conditions and meteorological conditions at Site 7-2 and the PSEG Site are similar; therefore, the NRC staff concludes that the environmental consequences of DBAs at Site 7-2 would be SMALL.

Because the meteorology, population distribution, and land use for Site 7-2 are expected to be similar to those of the PSEG Site, risks from a severe accident for a new nuclear power plant located at Site 7-2 are expected to be similar to those analyzed for the PSEG Site. These risks for the PSEG Site are presented in Tables 5-30 and 5-31 and are well below the mean and median values for current-generation reactors. In addition, as discussed in Section 5.11.2.1, estimates of average individual early fatality and latent cancer fatality risks are well below Commission safety goals (51 FR 30028-TN594). For existing plants within the geographic area of interest (i.e., whose 50-mi radius overlaps with the 50-mi radius around the PSEG Site), namely HCGS Unit 1, SGS Units 1 and 2, Oyster Creek Nuclear Generating Station, Limerick Generating Station Units 1 and 2, Peach Bottom Atomic Power Station Units 2 and 3, Three Mile Island Nuclear Station Unit 1, and Calvert Cliffs Nuclear Power Plant Units 1 and 2, the Commission has determined the probability-weighted consequences of severe accidents are small (10 CFR Part 51, Appendix B, Table B-1 [TN250]). Because of NRC safety review criteria, it is expected that risks for any new reactors at any other locations within the geographic

area of interest for Site 7-2 would be well below the risks for current-generation reactors and would meet Commission safety goals. The severe accident risk due to any particular nuclear power plant becomes smaller as the distance from that plant increases. However, the combined risk at any location within 50 mi of Site 7-2 would be bounded by the sum of risks for all these operating nuclear power plants and would still be low.

The postulated accident risk due to any particular nuclear power plant becomes smaller as the distance from that plant increases. However, the combined risk at any location within 50 mi of Site 7-2 site would be bounded by the sum of risks for all these operating and proposed nuclear power plants. Even though several plants would potentially be included in the combination, this combined risk would still be low. On this basis, the NRC staff concludes that the cumulative risks of postulated accidents at any location within 50 mi of Site 7-2 would be SMALL.

9.3.5 Site 7-3

This section covers the review team evaluation of the potential environmental impacts of siting a new nuclear power plant at the site designated as Site 7-3 in Cumberland County, New Jersey, located about 10 mi southeast of the proposed PSEG Site (see Figure 9-1). Site 7-3 is a greenfield site that is not owned by PSEG; however, PSEG currently possesses a DCR for a portion of this site. The site is located about 1 mi from the Delaware River, which would be the source of cooling water for a new nuclear plant at this site. The total area of the site is 886 ac.

As indicated by PSEG, the use of Site 7-3 would require the following infrastructure upgrades and improvements (PSEG 2015-TN4280).

- Portions of the public roads that currently provide access to the site would need to be relocated around plant facilities and/or improved to increase their load-carrying capacity. An estimated total of 4.2 mi of road building would be required, and the ROW width would be 150 ft.
- Because Site 7-3 is located near the Delaware River, barge transport could be used to deliver materials and equipment to the site, and no rail spur would be needed. However, a new road would be required between the barge unloading location and the site. The length of this new road is estimated to be about 1 mi within a 150-ft-wide ROW.
- A new water supply pipeline would need to be installed to withdraw water from the Delaware River. A new discharge pipeline would also need to be installed to convey blowdown and wastewater to the Delaware River. PSEG assumed that the two new pipelines would be installed parallel to each other and within the same 100-ft-wide ROW. The estimated length of the route is 0.7 mi.
- Three new 500-kV transmission lines would need to be installed to connect to the existing transmission line system. PSEG assumed that these three new lines would be installed parallel to one another, each within a 200-ft ROW. The length of these three new lines would be 6.8 mi.
- A new switchyard would be required at the connection of the above new transmission lines and the existing transmission line system. PSEG assumed that this new switchyard would be located on 25 ac.

The following sections include a cumulative impact assessment conducted for each major resource area. The assessment considered the specific resources and components that could be affected by the incremental effects of a new nuclear plant at Site 7-3, including the impacts of NRC-authorized construction and operations and impacts of preconstruction activities. Also included in the assessment are past, present, and reasonably foreseeable future Federal, non-Federal, and private actions in the same geographical area that could have meaningful cumulative impacts when considered together with a new nuclear plant if such plant were to be built at Site 7-3. Other actions and projects considered in this cumulative analysis are described in Table 9-21.

Table 9-21. Projects and Other Actions Considered in the Cumulative Impacts Analysis for Site 7-3

Project Name	Summary of Project	Location	Status
Nuclear Projects			
Hope Creek Generating Station, Unit 1	The station consists of a single operating boiling water reactor (BWR) rated at 3,840 MW(t), adjacent to the Salem units	10 mi northwest of Site 7-3	Operational, licensed through April 11, 2046 (NRC 2012-TN2626)
Salem Generating Station, Units 1 and 2	The station consists of two operating pressurized water reactors (PWRs) rated at 3,459 MW(t) each, adjacent to the Hope Creek unit	10 mi northwest of Site 7-3	Operational, licensed through August 13, 2036, and April 18, 2040 (NRC 2012-TN2626)
Oyster Creek Nuclear Generating Station	The station consists of a single operating BWR rated at 1,930 MW(t)	70 mi northeast of Site 7-3	Operational, licensed through April 9, 2029 (NRC 2012-TN2626). However, Exelon plans to shut the plant down in 2019 (Exelon 2013-TN2521)
Limerick Generating Station, Units 1 and 2	The station consists of two operating BWRs rated at 3,515 MW(t) each	60 mi north of Site 7-3	Operational, licensed through October 26, 2024, and June 22, 2029 (NRC 2012-TN2626)
Peach Bottom Atomic Power Station, Units 2 and 3	The station consists of two operating BWRs rated at 3,514 MW(t) each and one permanently shutdown unit (Unit 1)	54 mi northwest of Site 7-3	Operational, licensed through August 8, 2033, and July 2, 2034 (NRC 2012-TN2626)
Three Mile Island Nuclear Station, Unit 1	The station consists of a single operating PWR rated at 2,568 MW(t) and one permanently shutdown unit (Unit 2).	90 mi northwest of Site 7-3	Operational, licensed through April 19, 2034 (NRC 2012-TN2626)
Calvert Cliffs Nuclear Power Plant Units 1 and 2	The station consists of two operating PWRs rated at 2,737 MW(t) each.	87 mi south-southwest of Site 7-3	Operational, licensed through July 31, 2034, and August 13, 2036 (NRC 2012-TN2626)
Energy Projects			
Cumberland County Landfill Gas-to-Energy Plant	Methane gas input, provides 6.4 MW baseload power	25 mi east of Site 7-3	Operational (EPA 2013-TN2515)

Table 9-21. (continued)

Project Name	Summary of Project	Location	Status
Vineland Municipal Electric Utility	Utility owns two natural-gas units, Howard M. Down substation and West Substation, combined 86 MW	27 mi northeast of Site 7-3	Operational (EPA 2013-TN2515)
Sherman Ave. Energy Center	92-MW natural-gas peaking facility	27 mi east of Site 7-3	Operational (EPA 2013-TN2515)
Carll's Corner Energy Center	84-MW two-unit natural-gas peaking facility	13 mi northeast of Site 7-3	Operational (EPA 2013-TN2515)
Cumberland Generating Station	99-MW natural-gas-fired power plant	12 mi east of Site 7-3	Operational (EPA 2013-TN2515)
Grid stability transmission line for Artificial Island	Line needed to support the grid in the area around the island. No specific route is known. Review team assumes a line west to the Peach Bottom substation	10 mi northwest of Site 7-3	Proposals requested by PJM Interconnection, LLC (PSEG 2013-TN2669)
New Developments/Redevelopment			
Millville Municipal Airport Improvements	Infrastructure upgrades	17.1 mi east of Site 7-3	Funding acquired (Menendez 2013-TN2666)
Parks			
Mad Horse Creek Wildlife Management Area	Restoration of about 200 ac	6.8 mi northwest of Site 7-3	In progress (NJDEP 2013-TN2534)
Supawna Meadows National Wildlife Refuge	About 3,000-ac refuge with some walking and boating trails	15 mi northwest of Site 7-3	Operational (FWS 2013-TN2530)
Fort Mott State Park	124-ac park built around a historical site	17 mi northwest of Site 7-3	Operational (NJDEP 2013-TN2532)
Parvin State Park	2,092-ac park with trails, camping, boating, fishing, and hunting	16 mi northeast of Site 7-3	Operational (NJDEP 2013-TN2531)
Glades Wildlife Refuge	7,700-ac refuge with trails and access for kayaks and canoes	14 mi southeast of Site 7-3	Operational (NLT 2013-TN2667)
Millville Wildlife Management Area	16,259-ac wildlife management area (also known as the Edward G Bevan WMA)	16 mi east-southeast of Site 7-3	Operational (NJDEP 2013-TN2541)
Menantico Ponds Wildlife Management Area	395-ac wildlife management area	20 mi east of Site 7-3	Operational (NJDEP 2013-TN2541)
Egg Island Wildlife Management Area	8,992-ac wildlife management area	16 mi northeast of Site 7-3	Operational (NJDEP 2013-TN2541)
Bombay Hook National Wildlife Refuge	15,978-ac wildlife refuge across the Delaware River	10 mi southwest of Site 7-3	Operational (FWS 2013-TN2539)
Other Parks, Forests, and Reserves	Numerous State and National parks, forests, reserves, and other recreational areas are located within a 50-mi region	Throughout 50-mi region	Parks are currently being managed by National, State, and/or local agencies
Other Actions/Projects			
USACE Delaware River Main Channel	Deepening of river channel; Reach D: Delaware RM 55 to 41;	3.8 mi west of Site 7-3	In progress (USACE 2013-TN2665)

Table 9-21. (continued)

Project Name	Summary of Project	Location	Status
Deepening Project	Reach E: Delaware RM 41 to 5		
Salem County Solid Waste Landfill	Regional landfill for solid waste	14 mi north of Site 7-3	Operational (SCIA 2013-TN2664)
Air Emissions Sources	Nearby air emissions sources include small-scale commercial facilities (emissions below reporting limits), on-road mobile sources (cars and trucks), non-road mobile sources (airplanes, boats, tractors, etc.), and industrial stationary point emissions sources (glass manufacturers)	Within Cumberland County	Ongoing
Surface-water withdrawals and discharges	Surface-water withdrawals for public water supply and other potable use and wastewater treatment plant discharges	Within 10 RM of the intake and discharge for Site 7-3	Significant surface-water withdrawals and discharges have been taking place for decades. Withdrawal rates are expected to continue at current rates or increase slightly in the future
Groundwater withdrawals	Groundwater withdrawals throughout the region supply the majority of freshwater needs. Major pumping centers in Salem, Gloucester, and Camden Counties in New Jersey and New Castle County in Delaware affect groundwater heads and groundwater flow paths throughout the region	Throughout region	Significant groundwater withdrawals have been taking place since the 1950s. Withdrawal rates are expected to continue at current rates or increase slightly in the future
Various Hospitals and Industries That Use Radioactive Materials	Medical and other isotopes	Within 50 mi	Operational in nearby cities and towns
Future Urbanization	Construction of housing units and associated commercial buildings; roads, bridges, and rail; construction of water and/or wastewater treatment and distribution facilities and associated pipelines, as described in local land-use planning documents	Throughout region	Construction would occur in the future, as described in State and local land-use planning documents

9.3.5.1 Land Use

Affected Environment

As discussed in Section 9.3.5, Site 7-3 covers 886 ac in Greenwich Township, Cumberland County, New Jersey (Figure 9-1). Existing land use at Site 7-3 is predominantly agricultural, with large areas planted in cultivated crops. Soils classified as prime farmland occur across much of the site.

Most of Site 7-3 is zoned Rural Residential, and there are nine single-family houses located within the site boundaries. Also, although the site is located more than 6 mi from the nearest incorporated town, there are small concentrations of houses within 2 mi of the site. There are no significant industrial land uses on or in close proximity to Site 7-3 (PSEG 2015-TN4280).

According to 2012 State of New Jersey Department of Agriculture GIS mapping conducted by PSEG, there are no County Preserved Farmlands within the Site 7-3 boundaries. However, Site 7-3 contains an 871-ac tract of land (the "Bayside Tract") that is owned by PSEG but protected under a DCR as part of the PSEG EEP (Figure 9-10) (PSEG 2012-TN2282). The Bayside Tract covers more than 98 percent of the total 886 ac within the Site 7-3 boundaries. The purpose of the DCR on the Bayside Tract is to preserve the property in a predominantly natural state with a site-specific management plan approved by the State (PSEG 2012-TN2282).

The offsite corridors for the access roads and water pipelines to Site 7-3, as well as the short connector transmission line from Site 7-3 to the grid, would be largely confined to the immediate site vicinity, and land uses within these corridors are similar to the site itself, with most of the land in agricultural use and residences scattered throughout the area. There are no significant industrial land uses within the offsite corridors (PSEG 2015-TN4280).

Building Impacts

According to PSEG, building a new nuclear power plant at Site 7-3 would directly disturb (temporarily and permanently) a total of 395 ac on the site. The remaining land within Site 7-3 (491 ac) would not be directly disturbed, but access to this land would be controlled and it would be unavailable for uses not related to a nuclear power plant. In addition, developing the access road and water pipeline corridors for Site 7-3 would disturb 84 ac off the site. Therefore, a total of 970 ac, not including transmission line corridors, would be disturbed or made unavailable for uses not related to a new plant at Site 7-3. Land uses affected by building a new nuclear power plant at Site 7-3 and support facilities include about 575 ac of planted/cultivated land, 3 ac of developed land, 115 ac of barren land, 122 ac of forest land, 7 ac of estuarine and marine deepwater area, 97 ac of estuarine and marine wetland, 7 ac of freshwater emergent wetland, 61 ac of freshwater forested/shrub wetland, and 1 ac of other wetlands (PSEG 2015-TN4280).

It is likely that a new nuclear power plant at Site 7-3 would connect with the potential transmission line corridor that could be developed to address voltage and stability constraints within the PJM region (see Section 7.0). However, PSEG would need to develop a connector transmission line from Site 7-3 to this new grid stability line. This 6.8-mi connector transmission line corridor would disturb about 209 ac of planted/cultivated land, less than 1 ac of developed land, 19 ac of barren land, 225 ac of forest land, 2 ac of estuarine and marine deepwater areas, 24 ac of estuarine and marine wetland, less than 1 ac of freshwater emergent wetland, 96 ac of freshwater forested/shrub wetland, and less than 1 ac of other wetlands (PSEG 2015-TN4280).

Site 7-3 is predominantly zoned Rural Residential, and the definitions for this zoning classification indicate that "power generation is not an allowable use" (PSEG 2010-TN257). Therefore, the current zoning designation would have to be changed or a variance granted before the site could be developed for a nuclear power plant.

Figure 9-10. Deed of Conservation Restriction Parcels at Site 7-3 (Source: PSEG 2012-TN2282)

PSEG has stated that most of the nine houses within the Site 7-3 boundaries would have to be removed before the site could be developed for a nuclear power plant. PSEG anticipates that the offsite corridors could be developed without removing existing houses, but has stated that some houses would be located in close proximity to the various ROW alignments (PSEG 2015-TN4280).

The 871-ac Bayside Tract owned by PSEG and preserved under a DCR was not purchased using funds from the State of New Jersey Green Acres Program, so removing the DCR would be guided by the New Jersey Conservation Restriction and Historic Preservation Restriction Act (NJSA 13:8B-1 et seq. –TN4308), which provides a specific process for clearing DCR restrictions from privately held lands (see Section 4.1.2) (PSEG 2012-TN2282).

Site 7-3 has an existing site elevation between 0 and 20 ft MSL. PSEG estimates that the total fill quantity for Site 7-3 would be 6.1 million yd^3, with 1.3 million yd^3 of Category 1 fill and 4.8 million yd^3 of Category 2 fill. PSEG has stated that the fill material for Site 7-3 could come from the same sources as the fill material for the PSEG Site (i.e., existing permitted borrow sites in New Jersey, Delaware, and Maryland). However, PSEG would conduct testing to determine whether the material excavated from Site 7-3 could be reused as fill at the site (PSEG 2012-TN2282).

Overall, the land-use impacts of building a new nuclear power plant at Site 7-3 would be sufficient to alter noticeably, but not destabilize, important attributes of existing land uses at the site and in the vicinity. Building a new nuclear power plant would directly disturb 395 ac of land and eliminate access to and use of another 491 ac of land that currently supports productive agricultural and rural residential uses. Building the new access road and water pipeline corridors for Site 7-3 would disturb 84 ac of similar land uses off the site. Further, developing the new connector transmission corridor from Site 7-3 to the new grid stability lines would disturb an additional 510 ac of similar offsite land uses. Land uses in the vicinity of Site 7-3 include about 19,393 ac of planted/cultivated land, 640 ac of developed land, 1,192 ac of barren land, 9,704 ac of forest land, 37,691 ac of estuarine and marine deepwater area, 19,684 ac of estuarine and marine wetland, 811 ac of freshwater emergent wetland, 4,744 ac of freshwater forested/shrub wetland, and 529 ac of other wetland. Building a new nuclear power plant at Site 7-3 would permanently or temporarily disturb about 11 percent of the available barren land in the vicinity. Additionally, building a new plant on Site 7-3 would require that most of the nine houses within the site boundaries be removed, that any residents be relocated, and that 871 ac of land owned by PSEG but preserved as open space under a DCR be developed (PSEG 2015-TN4280).

Based on the information provided by PSEG and the review team's independent review, the review team concludes that the combined land-use impacts of preconstruction and construction activities on Site 7-3 would be noticeable. The review team reaches this conclusion because the conversion of existing barren land to heavy industrial and transmission corridor use and the relocation of nine residences would alter noticeably, but not destabilize, important attributes of existing land uses at the site and in the vicinity.

Operational Impacts

The land-use impacts of operating a new nuclear power plant at Site 7-3 would be smaller than the impacts of building, but they would still permanently eliminate almost all access to and use of 970 ac of land that supports productive agricultural and rural residential uses. Most of the impacts would occur during the building of a new nuclear power plant, and operations are not expected to cause additional impacts. Additionally, there are sufficient agricultural and residential land-use resources in the vicinity. Therefore, based on the information provided by PSEG and the review team's independent review, the review team concludes that the land-use impacts of operating a new nuclear power plant at Site 7-3 would be minimal.

Cumulative Impacts

The geographic area of interest for consideration of cumulative land-use impacts at Site 7-3 includes Cumberland County, New Jersey (in which Site 7-3 is located) and the other counties in New Jersey, New York, and Pennsylvania within the 50-mi region around Site 7-3. The direct and indirect impacts to land use of building and operating a new nuclear power plant at Site 7-3 would be confined to Cumberland County, but the cumulative impacts to land use when combined with other actions (discussed below) could extend to other counties in New Jersey, New York, and Pennsylvania.

Table 9-21 lists projects that, in combination with building and operating a new nuclear power plant at Site 7-3, could contribute to cumulative impacts in the region. One of the projects closest to Site 7-3 is the USACE Delaware River Main Channel Deepening Project. In this project, the USACE is conducting dredging operations to deepen a section of the Delaware River, including the portion of the river near Site 7-3 (USACE 2011-TN2262). The primary land-use impact of this deepening project would be the USACE use of some of the existing CDFs along the Delaware River for the disposal of dredge materials. The total dredging operation would generate an estimated 16 million yd^3 of spoil material. The USACE NEPA documentation for the channel deepening project (USACE 1997-TN2281; USACE 2009-TN2663; USACE 2011-TN2262) concludes that there would be no significant land-use impacts from the project.

Another project that would be in relatively close proximity to Site 7-3 is the continued operation of SGS and HCGS. In 2011, the NRC issued new operating licenses for SGS Unit 1 (expires 2036), SGS Unit 2 (expires 2040), and HCGS (expires 2046). A cumulative land-use impact would result from the combined commitment of land for a new plant at Site 7-3 (886 ac) with the land already dedicated to SGS and HCGS (734 ac). Although this would represent a relatively large land-use impact in Salem and Cumberland Counties, the cumulative impact to land use in the 50-mi region would be relatively small. None of the other nuclear projects listed in Table 9-21 are located within the 50-mi region.

A third project that could occur in close proximity to Site 7-3 is the potential transmission line corridor that could be developed to address voltage and stability constraints within the PJM region. In its ER (PSEG 2015-TN4280), PSEG identifies a new 5-mi-wide transmission macro-corridor known as the WMC ("West Macro-Corridor"). The WMC is 55 mi long and generally follows existing transmission line corridors from the PSEG property to the Peach Bottom

Substation in Pennsylvania (PSEG 2015-TN4280). PSEG considers the WMC to be "the most effective route for addressing the regional voltage and stability constraints that PJM is trying to resolve" (PSEG 2013-TN2669).

However, in its ER (PSEG 2015-TN4280), PSEG cites a GIS analysis that assumes a 5-mi-wide hypothetical macro-corridor and a transmission line ROW width of 200 ft within the corridor. This PSEG analysis did not identify a specific 200-ft-wide ROW within the hypothetical corridor but calculated the amount of each land-use type that could be affected in a 200-ft-wide ROW based on each land-use type as a percentage of total land use within the corridor (PSEG 2015-TN4280). However, PJM has not selected a specific route for the potential new transmission line. The review team has determined, based on the analysis performed by PSEG and the land uses that could be affected, that a new transmission line could have a noticeable impact on land uses in the region.

Most of the other projects listed in Table 9-21 are not expected to create noticeable cumulative impacts to land use in the 50-mi region when combined with a new nuclear power plant at Site 7-3. The other energy projects listed in Table 9-21 (the closest being Cumberland Generating Station and Carll's Corner Energy Center) are all too far from Site 7-3 and from each other to create noticeable cumulative land-use impacts in the region. The new development/ redevelopment project listed (Millville Municipal Airport Improvements) is too far from Site 7-3 to create noticeable cumulative land-use impacts in the region. The parks and recreation activities listed (the closest being Mad Horse Creek WMA and Bombay Hook NWR) are not expected to contribute to adverse land-use impacts, especially on the regional scale.

The GCRP report *Global Climate Change Impacts in the United States* (GCRP 2014-TN3472), summarizes the projected impacts of future climate changes in the United States. The report divides the United States into nine regions, and Site 7-3 is located in the Northeast region. The report indicates that climate change could increase precipitation, sea level, and storm surges in the Northeast region, thus changing land use through the inundation of low-lying areas that are not buffered by high cliffs. However, cliffs could experience increased rates of erosion as a result of frequent storm surges, flooding events, and sea-level rise. Forest growth could increase as a result of more CO_2 in the atmosphere. Existing parks, reserves, and managed areas would help preserve wetlands and forested areas to the extent that they are not affected by the same factors. In addition, climate change could reduce crop yields and livestock productivity, which might change portions of agricultural land uses in the region (GCRP 2014-TN3472). Thus direct changes resulting from climate change could cause a shift in land use in the 50-mi region that would contribute to the cumulative impacts of building and operating a new nuclear power plant at Site 7-3.

Overall, when combined with other past, present, and reasonably foreseeable future actions, the cumulative land-use impacts of building and operating a new nuclear power plant at Site 7-3 (along with the new connector transmission line corridors) would be sufficient to alter noticeably, but not destabilize, important attributes of existing land uses in the geographic area of interest. Therefore, based on the information provided by PSEG and the review team's independent review, the review team concludes that the cumulative land-use impacts would be MODERATE. The incremental contribution of building and operating a new nuclear power plant at Site 7-3 would be a significant contributor to the cumulative impact.

9.3.5.2 Water Use and Quality

The following analysis includes impacts from building activities and operations at Site 7-3. The analysis also considers cumulative impacts from other past, present, and reasonably foreseeable future actions, including the other Federal and non-Federal projects listed in Table 9-21, that could affect water use and quality.

The potentially affected surface-water environment consists of the Delaware River Basin, which would be affected by water withdrawn from and wastewater discharged to the river. Site 7-3 is an 886-ac greenfield site in Cumberland County, New Jersey, located less than 1 mi east of the Delaware River at RM 41.6, about 10 mi downriver from the PSEG Site. Site 7-3 is flat, with elevations ranging from 0 to 20 ft MSL. PSEG has stated in its ER that the Delaware River would be the primary source of water (PSEG 2015-TN4280). The Delaware River reach adjacent to Site 7-3 lies in DRBC water-quality Zone 5, which is the same zone within which the PSEG Site is located.

Flow data for the Delaware River at USGS Gaging Station 01463500 at RM 131.0, near Trenton, New Jersey, are described in Section 2.3. This gaging station is located about 90 mi upstream of the Site 7-3 conceptual water intake location at RM 41.6. The mean annual river flow at the Trenton gage is 12,004 cfs. Mean annual flow during the historic low-water period of 1961–1967 was 7,888 cfs, with the minimum monthly flow of 1,548 cfs recorded in July 1965.

As mentioned in Section 2.3, the Coastal Plain deposits dip and thicken to the southeast toward the coast. Site 7-3 is located southeast of the PSEG Site and, as a result, the hydrogeologic environment is somewhat different. Because it is a greenfield site, there is no hydraulic fill and the surficial unit is alluvium from the Delaware River. Studies from NJGS (Sugarman 2001-TN3218) and USGS (Martin 1998-TN2259; dePaul et al. 2009-TN2948) indicate that in western Cumberland County the uppermost aquifer is the unconfined Kirkwood-Cohansey aquifer system.

In its ER the applicant indicated that “plant groundwater requirements could be supplied by one or two wells drilled to the Kirkwood-Cohansey” aquifer system (PSEG 2015-TN4280). This aquifer system ranges from 20 to 350 ft thick (USGS 2013-TN3228). However, because Site 7-3 is located near the Delaware River within the outcrop area of the Kirkwood-Cohansey aquifer system, the thickness is probably at the lower end of this range (Martin 1998-TN2259), and salinity within the unit may be near levels measured within the Delaware River (dePaul et al. 2009-TN2948). As a result, it is not likely that the aquifer is widely used in the area immediately surrounding Site 7-3, and pumping may induce flow of saline water from the river.

USGS studies also indicate that the Vincentown aquifer is very thin or not present at Site 7-3, and that the Kirkwood-Cohansey aquifer system is separated from the underlying Wenonah-Mount Laurel aquifer by a thickened confining sequence, which may help to limit flow between the units. Salinity levels within the Wenonah-Mount Laurel aquifer are at or near the drinking water standard (250 mg/L) but are less than levels within the Delaware River. Salinity values within the upper and middle PRM aquifers are above the drinking water standard. Salinity within the lower PRM is reported to exceed 10,000 mg/L for chloride (dePaul et al. 2009-TN2948). As

a result, it is likely that groundwater needed for construction and operation at Site 7-3 would be obtained from the Wenonah-Mount Laurel aquifer.

Building Impacts

Impacts to surface waters from building activities at Site 7-3 would be similar to those at the PSEG Site and may occur from site-preparation and plant building activities. Potential impacts to surface water, including wetlands and floodplains, could result from physical alteration of surface-water bodies because of installation of intake and discharge structures, alteration of land surface and surface-water drainage pathways, increased runoff from the site area that could include additional sediment load and building-related pollutants, and building transmission lines. Additional disturbance to the shoreline and river bottom may occur from building a new barge docking facility, if needed. Offsite building activities to support a new nuclear power plant would include building access roads and other facilities including a new makeup water pipeline, a new blowdown pipeline, and three new transmission lines from Site 7-3 to the existing 500-kV transmission system.

PSEG has proposed in Section 9.3.2 of its ER (PSEG 2015-TN4280) to withdraw either surface water or groundwater for building activities. The review team assumes that water use for building activities at Site 7-3 would be similar to that for the PSEG Site. As estimated by PSEG in ER Section 4.2 (PSEG 2015-TN4280), water use to support concrete plant operations, dust suppression, and potable water would be 119 gpm. Because water quality in the Delaware River is brackish near Site 7-3, potable and sanitary use of the river water is not expected.

Dewatering of the plant area and the nuclear island foundation would also likely be required to limit inflow from the river alluvium and the Kirkwood-Cohansey aquifer system during construction at Site 7-3. Because these units are unconfined and productive, it is assumed that dewatering flow rates would be reduced through the use of vertical low-permeability barriers, which would also limit the horizontal effects of dewatering. It is assumed that the extracted groundwater would be managed and disposed of in compliance with the permit requirements.

Impacts from groundwater use and dewatering during construction activities would be limited due to the temporary time frame of construction. In addition, construction-related pumping would be bounded by the impacts from pumping to support plant operations. Therefore, the review team concludes that the groundwater-use impacts of building a new nuclear power plant at Site 7-3 would be minor.

During building, water-quality-related impacts would be similar to those expected for any other large project. Alterations to the Delaware River would occur during installation of the makeup water intake structure and the wastewater discharge structure. During installation of these structures, some additional turbidity in the river is expected because of disturbance of bottom sediments. However, these sediments would be localized to the area needed to install the structures, and engineering measures would be in place as part of BMPs to minimize movement of the disturbed sediment beyond the immediate work area. These impacts would also be temporary and would not occur after the structures were installed. Because these activities would occur in waters of the United States, appropriate permits from the USACE and NJDEP would be required. PSEG would be required to implement BMPs to control erosion and

sedimentation and discharge of building-related pollutants to the Delaware River or to nearby water bodies. Because the effects from building-related activities would be minimized using BMPs, would be temporary and localized, and would be controlled under various permits, the review team concludes that the impact from building-related activities on the water quality of the Delaware River and nearby surface-water bodies would be minor.

During building, groundwater quality may be affected by leaching of spilled effluents into the subsurface. The review team assumes that the BMPs PSEG has proposed for the PSEG Site would also be in place at Site 7-3 during building activities and that any spills would be quickly detected and remediated. In addition, groundwater-quality impacts would be limited to the duration of these activities, and therefore would be temporary. Because any spills related to building activities would be quickly remediated under BMPs, the activities would be temporary, and pumping rates would be greater during operations than during building, the review team concludes that the groundwater-quality impacts from building at Site 7-3 would be minimal.

Operational Impacts

During operation of a new nuclear power plant at Site 7-3, surface water would be withdrawn from the Delaware River to provide makeup water to the new plant CWS. Because water quality in the Delaware River near Site 7-3 is brackish, similar to that at the PSEG Site, it is assumed that the withdrawal rate and the consumptive use rate at Site 7-3 would be the same as that at the PSEG Site: 78,196 gpm (174.2 cfs) and 26,420 gpm (58.9 cfs), respectively. As described in Section 5.2, applying an equivalent impact factor of 0.18 to account for the salinity of the withdrawn river water makes the water consumption equivalent to a freshwater consumption of 4,756 gpm (10.6 cfs). This equivalent freshwater consumptive use is 0.1 percent of the mean annual flow at Trenton, New Jersey, during the historic low-water period of 1961–1967 (7,888 cfs) and 0.7 percent of the minimum monthly flow of 1,548 cfs recorded in July 1965. Assuming similar tidal flows at Site 7-3 and at the PSEG Site, the total consumptive losses associated with a new nuclear power plant at Site 7-3 would be less than 0.01 percent of the tidal flows. Because of the similarity of Site 7-3 to the proposed PSEG Site, the review team determined that water-use impacts would be similar to those at the PSEG Site. The review team also determined that PSEG would need to acquire an additional 465 ac-ft or 6.9 percent of its currently allocated storage in the Merrill Creek reservoir to meet instream flow targets during a DRBC-declared drought. Merrill Creek reservoir has a storage capacity of 46,000 ac-ft, far exceeding that needed to meet the 465 ac-ft exceedance. In addition, the DRBC allows for temporary or permanent acquisition of releases from other owners of Merrill Creek reservoir storage (DRBC 2004-TN2278). For these reasons, the review team determined that surface-water use for operations would be met without a noticeable impact to the instream flow targets in the Delaware River. Therefore, the review team concludes that the surface-water-use impact of operating a new nuclear power plant at Site 7-3 would be minor.

Because Site 7-3 is located near the PSEG Site, the Delaware River water quality, flow characteristics, and river cross section are expected to be similar to those at the PSEG Site. Therefore, the review team concludes that the incremental water-quality impacts from operation of a new nuclear power plant at Site 7-3 would be similar to those determined for the proposed PSEG Site in Section 5.2.3 and that the surface-water-quality impacts from operation of a new nuclear power plant at Site 7-3 would be minor.

Groundwater withdrawal, as was indicated in ER Section 9.3.2 (PSEG 2015-TN4280), would be necessary to provide freshwater for plant uses, as the Delaware River water is brackish in the Site 7-3 area. For the sake of consistency in comparison, it was assumed that the amount of groundwater withdrawal needed for general site purposes, including the potable and sanitary water system, demineralized water distribution system, fire protection system, and other miscellaneous systems at Site 7-3 would be the same as that required at the proposed PSEG Site. As discussed in ER Section 3.3 (PSEG 2015-TN4280), an average of 210 gpm and a maximum of 953 gpm would be required to provide freshwater for plant uses. This water could likely be supplied from pumping of groundwater from the Wenonah-Mount Laurel aquifer. According to the USGS (dePaul et al. 2009-TN2948) there is a cluster of production wells located 6–7 mi to the north of Site 7-3 that withdrew more than 1 million gal per year (as of 2003) and depressed groundwater levels about 2 ft within a mile of the wells. If the groundwater needs of the plant were supplied by wells within the Wenonah-Mount Laurel aquifer, pumping rates would be greater than those discussed above and drawdowns could be greater and extend farther. However, because impacts of pumping are localized, it is not likely that these pumping impacts would extend to a wellhead protection area indicated by ER Figure 2.3-20 to be located 7 mi north of the site (PSEG 2015-TN4280). Groundwater withdrawal would also be regulated by both DRBC and NJDEP. As a result, impacts to water use due to pumping of groundwater during operation would be minor.

During the operation of a new nuclear power plant at Site 7-3, impacts on groundwater quality could result from accidental spills. Because BMPs would be used to quickly remediate spills and no intentional discharge to groundwater would occur, the review team concludes that the groundwater-quality impacts from operations would be minimal. Groundwater withdrawal for operation of a new plant at Site 7-3 would likely be from the Wenonah-Mount Laurel aquifer. Because salinity is currently at levels near the drinking water standard in the area of Site 7-3, additional pumping may increase salinity somewhat within the aquifer. However, results from the USGS (Pope and Gordon 1999-TN3006) showed that changes in aquifer salinity have been more responsive to historic sea levels than to the regional groundwater withdrawals in the 20th century. In addition, groundwater is not likely used heavily in the area of Site 7-3. Therefore, the review team concludes that groundwater-quality impacts from the operation of a new plant at Site 7-3 would be minor.

Cumulative Impacts

In addition to water-use and water-quality impacts from building and operations activities, this cumulative analysis considers past, present, and reasonably foreseeable future actions that could affect the same water resources. The actions and projects in the vicinity of Site 7-3 considered in this cumulative analysis are listed in Table 9-21.

The review team is aware of the potential climate changes that could affect the water resources available for cooling and the impacts of reactor operations on water resources for other users. Because Site 7-3 is located near the proposed PSEG Site, the potential changes in climate would be similar (GCRP 2014-TN3472). Therefore the review team concludes that the impact of climate change on water resources would be similar to that at the proposed site.

Cumulative Water-Use Impacts

Based on a review of the history of water-use and water-resources planning in the Delaware River Basin, the review team determined that past and present use of the surface waters in the basin has been noticeable, necessitating consideration, development, and implementation of careful planning.

Of the projects listed in Table 9-21, consumptive water use by SGS and HCGS were considered by the review team in evaluating cumulative surface-water impacts. Because the water-quality impacts and potential consumptive use of a new nuclear power plant at Site 7-3 would be similar to those at the PSEG Site, PSEG would need to acquire an additional 6.9 percent allocation in the Merrill Creek reservoir. As stated in Section 5.2.2, the review team determined that obtaining this additional allocation was feasible and would ensure that the plant could operate without noticeable impact to other water users, even under declared drought conditions, and without the need to release additional flows to meet instream flow targets in the Delaware River.

Mainly because of extensive past and present use of surface waters from the Delaware River, the review team concludes that the cumulative impact to surface-water use from past and present actions and building and operating a new nuclear power plant at Site 7-3 would be MODERATE and that a new plant's incremental contribution to this impact would not be significant.

Of the projects listed in Table 9-21, regional groundwater withdrawal was considered by the review team in evaluating cumulative groundwater impacts. Other projects do not use groundwater or are too far from Site 7-3 to interact with groundwater use at the site. On a regional scale, pumping of the Wenonah-Mount Laurel aquifer has drawn down water levels more than 460 ft around high-use areas such as Camden, but these effects do not extend to the Site 7-3 area (dePaul et al. 2009-TN2948). As discussed previously, drawdowns within the Wenonah-Mount Laurel aquifer are expected to be localized around the wells. As a result, the groundwater-use impact from building and operating a new nuclear power plant at Site 7-3 would be minor. Therefore, the review team concludes that the cumulative impact on groundwater use would be MODERATE and that a new plant's incremental contribution to this impact would not be a significant contributor to the cumulative impact.

Cumulative Water-Quality Impacts

As stated in Section 7.2.2.1, DRBC has implemented careful planning and regulation of water quality in the Delaware River Basin. Although there have been improvements in water quality in the Delaware River Basin because of careful planning and management policies put in place by DRBC (e.g., improved levels of dissolved oxygen), the presence of toxic compounds leads to advisories for fish consumption (DRBC 2008-TN2277). In its review of the PSEG license renewal application for SGS and HCGS, the NRC staff concluded that water quality will likely continue to be adversely affected by human activities in the Delaware River Basin (NRC 2011-TN3131). The review team concludes that past and present actions in the Delaware River Basin have resulted in noticeable impact to water quality.

The projects listed in Table 9-21 could result in alterations to land surface, surface-water drainage pathways, and water bodies. These projects would need Federal, State, and local permits that would require implementation of BMPs. Therefore, the impacts to surface-water quality from these projects are not expected to be noticeable. The discharge for a plant at Site 7-3 would be located at Delaware RM 41.6, about 9.4 mi from the SGS discharge and outside the SGS thermal plume HDA. The area affected by the thermal plume from a plant at Site 7-3 would be small, would be localized near the discharge outlet, and would not interact with the thermal plumes from SGS. Therefore, the review team determined the cumulative impact of the combined discharges from SGS and a plant at Site 7-3 would not be noticeable.

Because of extensive past and present use of surface waters from the Delaware River, the review team concludes that the cumulative impact to surface-water quality in the Delaware River Basin from past and present actions and building and operating a new nuclear power plant at Site 7-3 would be MODERATE. However, the review team further concludes that a new plant's incremental contribution to this impact would not be a significant contributor to the cumulative impact.

As discussed in Section 7.2, groundwater withdrawals within the geographic area of interest have noticeably altered the groundwater quality in localized areas where pumping occurs near recharge areas. This is a concern at the proposed PSEG Site where pumping from the Wenonah-Mount Laurel aquifer may induce flow of saline water from the overlying Vincentown aquifer. The proposed site is located near the river and within the outcrop area of the Kirkwood-Cohansey aquifer, however the Wenonah-Mount Laurel is separated from the surficial aquifer by a thickened confining sequence (dePaul et al. 2009-TN2948). Though salinity levels may increase slightly, pumping from the Wenonah-Mount Laurel aquifer is not likely to contribute to cumulative impacts on groundwater quality near Site 7-3. Based on the proposed or possible projects listed in Table 9-21, additional impacts to groundwater quality are expected to be minimal. As discussed previously, BMPs would be implemented and dewatering and pumping within the Site 7-3 area is unlikely to induce flow from an area of higher salinity into the Wenonah-Mount Laurel aquifer. Therefore, the review team concludes that the cumulative groundwater-quality impacts of past, present, and reasonably foreseeable future projects, as well as climate change, would be MODERATE, and a new plant's incremental contribution would not be a significant contributor to the cumulative impact.

9.3.5.3 Terrestrial and Wetland Resources

The following analysis includes potential impacts to terrestrial and wetland resources resulting from building activities and operations associated with a new nuclear power plant on Site 7-3. The analysis also considers other past, present, and reasonably foreseeable future actions that may impact terrestrial and wetland resources, including the other Federal and non-Federal projects listed in Table 9-21.

Site Description

Site 7-3 is located in Cumberland County, New Jersey. It is a flat greenfield site located less than 1 mi east of the Delaware River, which would act as the primary water source. The

elevations on this site range from 0 to 20 ft above MSL. The site has a total area of 886 ac (PSEG 2015-TN4280).

Site 7-3 is located in the Shoreline Zone of the Delaware Bay Landscape Region (New Jersey Wildlife Action Plan). Critical habitats in this zone include beaches, dunes, tidal wetlands, and freshwater wetlands. The area also contains rich farmlands inland from the Delaware Bay shoreline and small amounts of upland and wetland forest. Several thousand acres of marsh habitat have been restored since 1996. The Shoreline Zone provides critical habitat for migratory birds and wildlife along the coastal plains (NJDEP 2008-TN3117).

The general ecological conditions on Site 7-3 are typical of the farmlands found in the Shoreline Zone. Most of the land is used for agriculture. The forested areas consist mainly of scattered woodlots and strips of trees along streams. The tidal and freshwater wetlands in the area are found primarily in isolated low areas, and some of the wetlands are farmed. There are some managed grasslands in the area. The offsite corridors for access roads and water pipelines are largely confined to the immediate site vicinity, and the natural habitats within these corridors are similar to Site 7-3 itself (PSEG 2015-TN4280).

Site 7-3 and vicinity does contain more areas of managed and natural habitat than the other alternative sites under consideration. This includes a conservation easement that contains a relatively extensive network of buffers and hedgerows with taller trees and low shrubs. Fields in the area are also maintained in warm and cold season grasses for wildlife habitat.

Federally and State-Listed Species

No site-specific surveys for threatened and endangered species were conducted at Site 7-3. Information on protected and rare species that may occur in the area of Site 7-3 was obtained from NJDEP and the FWS ECOS. There are two Federally listed threatened plant species and one Federally listed threatened avian species known or having the potential to occur in the 6-mi vicinity of Site 7-3: the Federally listed sensitive joint-vetch (*Aeschynomene virginica*), swamp pink (*Helonias bullata*), and the Federally listed threatened rufa red knot (*Calidris canutus rufa*). NJDEP considers all Federally listed species as endangered. Additionally, 8 State-listed endangered species, 5 State-listed threatened species, and 43 species listed by NJDEP as species of special concern or regional priority wildlife species may occur in the area of Site 7-3 (FWS 2014-TN3333; NJDEP 2008-TN3117).

The NJDEP information shows that a total of 13 listed animal species have been recorded within about 1 mi of Site 7-3. Table 9-22 lists the species that have been recorded within the area of Site 7-3 (PSEG 2015-TN4280). Documentation of the actual presence of any of these species on the site and along offsite corridors would require that detailed field surveys be conducted. There were no Natural Heritage Sites noted in the 6-mi vicinity of Site 7-3 (PSEG 2015-TN4280).

Table 9-22. State and Federal Threatened, Endangered, and Rare Species Recorded in the Site 7-3 Area

Common Name	Scientific Name/Description	State or Regional Status/Rank	Federal Status
Insects			
Bronze Copper	*Lycaena hyllus*	E	
Fish			
Shortnose Sturgeon	*Acipenser brevirostrum*	E	E
Birds			
Bald Eagle	*Haliaeetus leucocephalus*	E[(a)]/T[(b)]	
Black Rail	*Laterallus jamaicensis*	E[(a)]	
Great Blue Heron	*Ardea herodias*	SC[(a)]	
Northern Harrier	*Circus cyaneus*	E[(a)]/SC[(b)]	
Osprey	*Pandion haliaetus*	T	
Red-Shouldered Hawk	*Buteo lineatus*	E[(a)]/SC[(b)]	
Wood Thrush	*Hylocichla mustelina*	SC[(a)]	
Amphibians			
Fowler's Toad	*Anaxyrus fowleri*	SC	
Reptiles			
Eastern Box Turtle	*Terrapene carolina carolina*	SC	
Eastern King Snake	*Lampropeltis getuala getula*	SC	
Northern Diamondback Terrapin	*Malaclemys terrapin terrapin*	SC	

(a) Breeding
(b) Nonbreeding
Abbreviations
E = Endangered species
T = Threatened species
SC = Special concern

Source: PSEG 2015-TN4280.

Wildlife Sanctuaries, Refuges, and Preserves

There are four WMAs and one state park within a 6-mi radius of Site 7-3 (Figure 9-11) that could be affected by building and operating a new nuclear power plant at Site 7-3 (PSEG 2012-TN2389). A brief description of these areas is given below.

Gumtree Corner Wildlife Management Area

Gumtree Corner is a 1,104-ac WMA located in Stow Creek Township, Cumberland County. The WMA is located just east of Stow Creek and contains mainly tidal marsh and open field habitat, with some areas of deciduous forest. The site provides foraging and nesting habitat for bald eagle (*Haliaeetus leucocephalus*), osprey (*Pandion haliaetus*), and great blue heron (*Ardea herodias*) (PSEG 2012-TN2389).

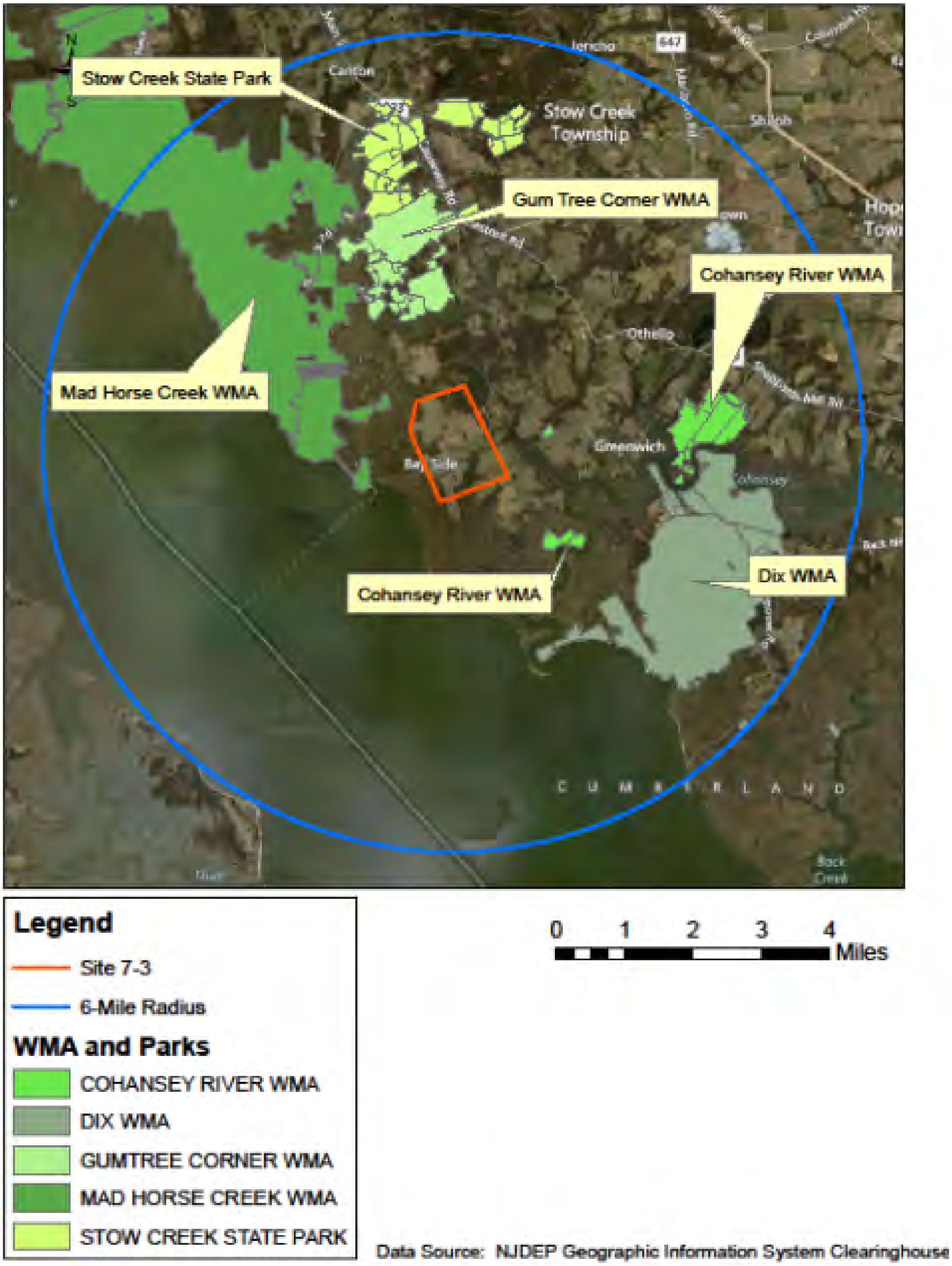


Figure 9-11. Wildlife Sanctuaries, Refuges, and Preserves within the 6-mi Vicinity of Site 7-3 (Source: Modified from PSEG 2012-TN2389)

Mad Horse Creek Wildlife Management Area

Mad Horse Creek is a 9,498-ac WMA located in Lower Alloways Creek Township, Salem County. The WMA is an area made up mainly of tidal marsh on the Delaware Bay. The site provides foraging and nesting habitat for migratory bird species such as the bald eagle, osprey, and great blue heron. Parking and a boat ramp are provided at the end of Stowneck Road (PSEG 2012-TN2389).

Dix Wildlife Management Area

Dix is a 4,225-ac WMA located in Fairfield Township, Cumberland County, east of the Cohansey River where it meets the Delaware Bay to the south. The area is mainly made up of tidal marsh, with small areas of open field and deciduous forest. The WMA contains habitat for black rail (*Laterallus jamaicensis*), northern harrier (*Circus cyaneus*), and bald eagle. The WMA is also frequented by river otters (*Lontra canadensis*) and most of the passerine avian species found in New Jersey (NJWLT 2014-TN3205).

Cohansey River Wildlife Management Area

Cohansey River WMA is 993 ac in size and is located in Hopewell Township, Cumberland County. This WMA is made up of several noncontiguous parcels along the Cohansey River. The area consists of mainly tidal wetlands. The WMA contains habitat for great blue heron, and foraging habitat for bald eagle. It also acts as a buffer for nesting bald eagles (PSEG 2012-TN2389).

Stow Creek State Park

Stow Creek State Park is 767 ac in size, located about 5 mi from Delaware Bay. Stow Creek State Park habitat includes tidal marshes with dense growth of tall grasses. The marsh habitat supports a variety of wildlife such as muskrat (*Ondatra zibethicus*), marsh wrens (*Cistothorus palustris*), rails (*Laterallus sp.*), red-winged blackbirds (*Agelaius phoeniceus*), swallows, purple martins (*Progne subis*), northern harriers, red-tailed hawks (*Buteo jamaicensis*), osprey, eagles, waterfowl and wading birds, white-tailed deer (*Odocoileus virginianus*), and fox (*Vulpes sp.*). A viewing platform at the site overlooks the extensive salt marsh (NJWLT 2014-TN3206).

Building Impacts

Building a new nuclear power plant at Site 7-3 would directly impact (permanently and temporarily) 395 ac of land. A total of 491 ac of land within the site boundaries would not be directly disturbed. However, certain building activities would result in indirect disturbance (noise, dust, etc.) to much of the area within the site boundaries. This could result in additional wildlife impacts in terms of affecting movements and causing further displacement from the site. The development of the access road and water pipeline corridors would result in the disturbance of an additional 84 ac of potential habitat. In total, 970 ac of potential habitat would be directly or indirectly impacted as a result of building at Site 7-3. The total acreage of forest, wetlands, and grassland habitat on the site was estimated based on GIS mapping data. Terrestrial and wetland habitats that would be affected by building a new nuclear power plant and support

facilities at Site 7-3 include about 575 ac of planted/cultivated land, 3 ac of developed land, 115 ac of barren land, 122 ac of forest land, 7 ac of estuarine and marine deepwater area, 97 ac of estuarine and marine wetland, 7 ac of freshwater emergent wetland, 61 ac of freshwater forested/shrub wetland, and 1 ac of other wetlands (PSEG 2015-TN4280).

A new nuclear power plant at Site 7-3 would likely connect with the potential transmission line corridor that could be developed to address voltage and stability constraints within the PJM region (see Section 7.0). However, PSEG would need to develop three connector transmission lines from Site 7-3 to this new 500-kV grid stability line. The lines would be routed through a 200-ft corridor for 6.8 mi and would disturb about 209 ac of planted/cultivated land, less than 1 ac of developed land, 19 ac of barren land, 225 ac of forest land, 2 ac of estuarine and marine deepwater areas, 24 ac of estuarine and marine wetland, less than 1 ac of freshwater emergent wetland, 96 ac of freshwater forested/shrub wetland, and less than 1 ac of other wetlands (PSEG 2015-TN4280).

The amount of terrestrial and wetland habitat disturbed by building a new nuclear power plant on Site 7-3 would be minimal for the majority of habitats available in the 6-mi vicinity. There are about 19,393 ac of planted/cultivated lands, 9,704 ac of forest, 37,691 ac of estuarine and marine deepwater, 19,684 ac of estuarine and marine wetland, 811 ac of freshwater emergent wetland, 4,744 ac of freshwater forest/shrub wetland, and 529 ac of other wetland habitat available in the 6-mi vicinity. However, 134 ac, or 11 percent, of the 1,192.1 ac of barren habitat available in the 6-mi vicinity would be disturbed (PSEG 2015-TN4280). As a result, building a nuclear power plant, support structures, and transmission line at Site 7-3 would have a noticeable impact to barren habitats. However, barren habitats lack vegetative cover or the vegetation is sparse, are not ideal foraging habitat, and lack necessary structure to support many wildlife species.

There is the potential for impacts to open country bird species and those that frequent smaller woodlots. Fragmentation and loss of forested areas could also potentially impact more area-sensitive species such as red-shouldered hawk and wood thrush. Inadvertent impacts to slower moving species (e.g., eastern box turtle [*Terrapene carolina carolina*]) are also a possibility. The larger amount of natural habitat in this area coupled with its proximity to the coast would increase concerns regarding potential impacts to listed species such as bald eagle, osprey, and northern harrier. Such impacts would be expected to be minor based on the fact that there are extensive areas of similar habitats in the 6-mi vicinity. However, Federally listed species could be affected by building a new nuclear power plant on Site 7-3. The Federally listed species sensitive joint-vetch and swamp pink could be affected by the loss of about 295 ac of wetland habitat, and the Federally threatened rufa red knot could be affected by disturbance along the Delaware Bay shoreline. Therefore, the impacts to these species from building a new nuclear power plant could be noticeable, but not destabilizing.

Building a new nuclear power plant at Site 7-3 could force displaced wildlife species into Mad Horse Creek WMA, Dix WMA, Cohansey River WMA, or Stow Creek State Park. Displaced wildlife species could place added pressure on terrestrial and wetland resources as a result of increased competition for limited resources. However, these sites would not be expected to be directly impacted by building activities at Site 7-3.

It is expected that a project of this size would result in impacts to terrestrial and wetland resources, including habitat loss, disturbance, and fragmentation. Building a nuclear power plant would result in the loss of available habitat on the site. Noise, lights, and dust during building activities could displace species in adjacent areas, reducing viable habitat. Less mobile species would be impacted the most by building a nuclear power plant at Site 7-3, and some mortality would be expected. More mobile wildlife species would be capable of moving to habitat in adjacent areas. These displaced species may experience impacts as a result of increased competition for more limited resources. Adjacent WMAs, preserves, and refuges could be affected by increased demand for limited resources as a result of species displacement. The habitat available at Site 7-3 is common to Cumberland County, and sufficient terrestrial and wetland resources exist in the Shoreline Zone of the Delaware Bay ecoregion. However, the review team has determined that impacts to terrestrial and wetland resources from building a new nuclear power plant at Site 7-3 would be noticeable as a result of the loss of wetland and the potential loss of shoreline habitat that is important to Federally listed species.

Operational Impacts

Potential impacts to terrestrial and wetland resources that may result from operation of a new nuclear power plant at Site 7-3 include those associated with cooling towers, transmission system structures, maintenance of transmission line ROWs, and the presence of project facilities that permanently eliminate habitat (PSEG 2015-TN4280). Operational impacts would be similar to those described in Section 5.3.1, although there may be minor differences as a result of topography, climate, and elevation. The review team has determined that the operational impacts to terrestrial and wetland resources at Site 7-3 would be minimal.

Cumulative Impacts

Several past, present, and reasonably foreseeable future projects could affect terrestrial and wetland resources in ways similar to building and operating a new nuclear power plant at Site 7-3. Table 9-21 lists these projects, and descriptions of their contributions to cumulative impacts to terrestrial and wetland resources are provided below.

The Delaware Bay Landscape Region supports expansive salt marshes, upland forests and forested wetlands, and sandy beaches. There are large amounts of agricultural lands as well, but the region has the lowest density of urban areas in the State (NJDEP 2008-TN3117). The WMAs and parks listed in Table 9-21 are not expected to contribute to adverse impacts to terrestrial and wetland resources.

Most of the projects listed in Table 9-21 are operational and have resulted in the conversion of natural areas to industrial and commercial development. These past actions have resulted in loss and/or fragmentation of natural habitat and displacement of wildlife. These projects include operational nuclear power plants located at HCGS and SGS. Additionally, the five operating fossil-fuel plants and the Salem County Solid Waste Landfill listed in Table 9-21 would continue to contribute to cumulative impacts to terrestrial and wetland resources. The development and operation of these projects would continue to reduce, fragment, and degrade natural forest, open field, and wetland habitats in the Shoreline Zone. Operational projects with tall structures

such as the cooling towers at HCGS would cause avian mortalities. However, the projects listed are spread throughout the region, and avian mortalities as a result of collision with tall structures would not cause a noticeable effect to avian populations.

Future residential development and further urbanization of the area would result in the continued increase in fragmentation and loss of habitat. NJLWD projects that the population of Cumberland County will increase by about 10 percent between 2010 and 2030 (NJLWD 2014-TN3332). Future urbanization in the area of Site 7-3 could result in further losses of agricultural lands, wetlands, and forested areas. Urbanization in the vicinity of Site 7-3 would reduce areas in natural vegetation and open space, and decrease connectivity between wetlands, forests, and other wildlife habitat. Although NJLWD predicts relatively low population growth, the development of a new nuclear power plant coupled with additional projects outlined in Table 9-21 could substantially increase the currently projected level of urbanization for the area.

Other reasonably foreseeable projects planned in the area of Site 7-3 that could add to the cumulative impacts include an airport infrastructure upgrade and the USACE channel deepening project. The Millville Municipal Airport improvements would occur on developed/disturbed land and, therefore, would not further impact any terrestrial and wetland resources. The USACE channel deepening project involves dredging and deepening portions of the main channel of the Delaware River (USACE 2011-TN2262). Terrestrial and wetland resources could be affected by the disposal of dredging materials, which could potentially require new disposal facilities. However, the USACE NEPA documentation for the channel deepening project concludes that there are sufficient dredge disposal areas in the region and there would be no significant impacts from the project (USACE 1997-TN2281; USACE 2009-TN2663; USACE 2011-TN2262).

The third project with the potential to affect terrestrial and wetland resources is the proposed transmission line corridor being developed to address voltage and stability constraints within the PJM region. In its ER (PSEG 2015-TN4280), PSEG conducted a study of a hypothetical 5-mi-wide macro-corridor known as the WMC (“West Macro-Corridor”) and transmission line ROWs that extend 55 mi from the PSEG property to Peach Bottom Substation in Pennsylvania. The transmission line ROW within the corridor is expected to be 200 ft wide. The development of the transmission line corridor would cause disturbances to more than 1,500 ac of land. Habitats that could be affected include barren land, deciduous forests, evergreen forests, mixed forest, agricultural land, woody wetlands, and emergent wetlands (PSEG 2015-TN4280). The exact amounts of the resources are not known, and it is expected that the project would cause fragmentation and degradation of terrestrial and wetland resources. However, the corridor would be expected to follow existing ROWs to the extent practicable. A new transmission line ROW would cause wildlife mortalities as a result of operations and maintenance. However, mortalities would not be expected to have a noticeable impact on wildlife populations, and sufficient terrestrial and wetland habitats exist elsewhere in the Shoreline Zone of the Delaware Bay Landscape Region. PSEG identified more than 64,000 ac of wetland resources in the 5-mi-wide corridor that could be traversed by the potential new transmission line ROW (PSEG 2015-TN4280). It is unknown exactly how much of these wetlands would be affected by the ROW, and mitigation may be required by applicable permitting entities. The review team has determined that, as a result of potential losses of wetland resources, the impact of the new transmission line ROW to terrestrial and wetland resources would be noticeable.

The GCRP report on climate change impacts in the United States (GCRP 2014-TN3472) summarizes the projected impacts of future climate changes in the United States. The report divides the United States into nine regions. Site 7-3 is located in the Northeast region. The GCRP climate models for this region project temperatures to rise over the next several decades by 4.5°F to 10°F if emissions continue or 3°F to 6°F if emissions are reduced substantially. Frequency, intensity, and duration of heat waves are projected to increase under both of the warming scenarios but with larger increases under the continuing emissions scenario. Winters are projected to be much shorter with fewer cold days and more precipitation. With higher temperatures, and earlier winter and spring snow melt, seasonal drought risk is projected to increase in summer and fall (GCRP 2014-TN3472). Increased frequency of summer heat stress can also impact crop yields and livestock productivity in the Northeast region. New Jersey is projected to experience 60 additional days above 90°F by mid-century under the continuing emissions scenario. Sea level is projected to rise more than the global average due to land subsidence, with more frequent severe flooding and heavy downpours. These projected changes could potentially alter wildlife habitat and the composition of wildlife populations. Large-scale shifts in the ranges of wildlife species and the timing of seasons and animal migration that are already occurring are very likely to continue.

The potential cumulative impacts to terrestrial resources from building and operating a new nuclear power plant on Site 7-3, in combination with the other activities described above, would noticeably alter terrestrial and wetland resources. These activities would result in the loss or modification of terrestrial habitats which could potentially affect important species that live in or migrate through the area. For these reasons, the review team has concluded that impacts to terrestrial and wetland resources from building and operating a new nuclear power plant at Site 7-3, in conjunction with other past, present, and reasonably foreseeable future actions, would be noticeable. Building and operating a new nuclear power plant would contribute to the noticeable impacts.

Summary

Potential impacts to terrestrial resources were evaluated based on information provided by PSEG, the conceptual layout of a new nuclear power plant at Site 7-3, and an independent review by the review team. Permanent impacts to terrestrial and wetland habitat and wildlife would result in effects on these resources. Additionally, impacts to these resources from building a new nuclear plant at Site 7-3 would be noticeable. Any terrestrial and wetland resources temporarily disturbed by building a new nuclear power plant are expected to return to pre-building conditions. Operational impacts to terrestrial and wetland resources would be similar to those at the PSEG Site. Therefore, the conclusion of the review team is that cumulative impacts on terrestrial and wetland plants and wildlife, including threatened and endangered species, and wildlife habitat would be noticeable in the surrounding landscape and therefore MODERATE. Building and operating a new nuclear power plant at Site 7-3 would be a significant contributor to the cumulative impact.

9.3.5.4 Aquatic Resources

The following impact analysis includes impacts on aquatic ecology resources from building activities and operations at Site 7-3. The analysis also considers cumulative impacts from other

past, present, and reasonably foreseeable future actions that could affect aquatic resources, including the other Federal and non-Federal projects listed in Table 9-21. In developing this EIS, the review team relied on reconnaissance-level information to perform the alternative site evaluation in accordance with ESRP 9.3 (NRC 2000-TN614). Reconnaissance-level information is data that are readily available from regulatory and resources agencies (e.g., NJDEP, NMFS, and FWS) and other public sources such as scientific literature, books, and Internet websites. It can also include information obtained through site visits (NRC 2012-TN2498; NRC 2012-TN2499; NRC 2012-TN2855) and documents provided by the applicant.

Affected Environment

The affected aquatic environment consists of the Delaware River Estuary in the vicinity of Delaware RM 41.6 and numerous salt marsh creek systems and streams on and near Site 7-3 (S&L 2010-TN2671). The water withdrawal rate from the Delaware River Estuary for Site 7-3 would be the same as for a new nuclear power plant at the PSEG Site (78,196 gpm) because Site 7-3 is located in the same DRBC water-quality zone. Water availability issues would also be the same as for the PSEG Site in that an additional 6.9 percent of the Merrill Creek reservoir allocation would be needed during drought conditions as described in Section 5.2.2. There are no known exceptional aquatic resources at Site 7-3 (PSEG 2015-TN4280).

Commercial/Recreational Species

Site 7-3 has the same species as those listed for the PSEG Site (Section 2.4.2.3). Commercial fisheries in the Delaware River Estuary and in offshore Atlantic waters for the Delaware River Estuary include American Eel, American Shad, Atlantic Croaker, Atlantic Menhaden, Black Drum, Black Sea Bass, Bluefish, Butterfish, Channel Catfish, Conger Eel, Northern Kingfish, Northern Searobin, Scup, Silver Hake, Spot, Striped Bass, Summer Flounder, Weakfish, White Perch, Windowpane Flounder, Winter Flounder, blue crab, eastern oyster, horseshoe crab, knobbed whelk, channeled whelk, and the northern quahog clam. All of these species are also considered recreationally important, with the exception of American Shad, Atlantic Menhaden, Butterfish, Conger Eel, Silver Hake, Windowpane Flounder, eastern oyster, horseshoe crab, knobbed whelk, channeled whelk, and northern quahog clam, and are described in detail in Section 2.4.2.3. Note that since 2008 there has been a moratorium in place on the harvest of horseshoe crabs in New Jersey (ASMFC 2014-TN3511).

<u>Non-Native and Nuisance Species</u>

Site 7-3 has the same potential for nuisance species as those listed for the PSEG Site (Section 2.4.2.3). These include the Asian shore crab, Chinese mitten crab, Northern Snakehead, and Flathead Catfish.

<u>Essential Fish Habitats</u>

The Site 7-3 water intake and discharge areas on the Delaware River Estuary are designated as EFH for many species by the Mid-Atlantic Regional Fishery Management Council, and the NMFS considers the estuarine portion of the Delaware River and tidal waters near the PSEG Site to be EFH for 15 species (PNNL 2013-TN2687; NMFS 2013-TN2804), as described in

Section 2.4.2.3. Due to proximity of Site 7-3 to the PSEG Site, EFH would be expected to be similar for Site 7-3.

Federally and State-Listed Species

There are no critical habitats designated by NMFS or FWS in the vicinity of Site 7-3 (NMFS 2013-TN2614; FWS 2013-TN2147). Listed species found near the proposed water intake and discharge structures, near the possible barge docking facility and inlet channel, and along the proposed transmission line corridor are listed in Table 9-23.

Table 9-23. Federally and State-Listed Aquatic Species in the Delaware River Estuary Near Site 7-3

Species Name	Common Name	Federal Status[a]	State Status[b,c]
Caretta caretta	Loggerhead sea turtle[d]	Threatened	Endangered
Chelonia mydas	Atlantic green sea turtle[e]	Endangered	Endangered[b] Threatened[c]
Lepidochelys kempii	Kemp's ridley sea turtle	Endangered	Endangered
Acipenser brevirostrum	Shortnose Sturgeon	Endangered	Endangered
Acipenser oxyrinchus oxyrinchus	Atlantic Sturgeon[f]		Endangered

Sources:
(a) NMFS 2013-TN2614.
(b) DNREC 2013-TN3067.
(c) NJDEP 2012-TN2186; NJDEP 2013-TN3578.
(d) Northwest Atlantic distinct population segment (DPS).
(e) Proposed DPS for North Atlantic (T) (80 FR 15271-TN4272).
(f) Gulf of Maine DPS (T), New York Bight DPS (E), Chesapeake Bay DPS (E), Carolina DPS (E), and South Atlantic DPS (E) (77 FR 5880-TN2081; 77 FR 5914-TN4365).

The Kemp's ridley sea turtle is listed as Federally and State endangered. The Federally threatened Northwest Atlantic DPS of the loggerhead sea turtle is listed as State endangered for both New Jersey and Delaware. The Atlantic green sea turtle is listed as endangered at both the Federal and State of Delaware levels and is listed as threatened in the State of New Jersey. All sea turtles have certain life-history similarities in that females swim ashore to sandy beaches and deposit eggs in nesting pits that are covered to allow incubation. Juveniles hatch, struggle out of the sandy nest, and make their way to their respective ocean habitats. Although there are no known records of sea turtles nesting along Delaware Bay beaches, sea turtles have been observed to forage in Delaware Bay waters.

Adult Shortnose Sturgeon use freshwater for spawning and estuarine and marine habitats for feeding. Juveniles migrate downriver to estuarine waters and may go back and forth between freshwater and estuarine habitats for several years before maturing to adults. Adults sometimes migrate to marine habitats for feeding but live the majority of their life cycle in estuarine habitats (Rohde et al. 1994-TN2208; NOAA 2012-TN2173). Migration to spawning habitat occurs in late winter and spring, and adults return to estuarine waters in May and June (Gilbert 1989-TN2149). Spawning occurs in freshwaters characterized by low-to-moderate velocities and over substrates that include clay, sand, gravel, and woody debris. Sturgeon feed on benthic invertebrates such as snails, insect larvae, crustaceans, and worms (Gilbert 1989-TN2149).

Shortnose Sturgeon occur in the Delaware River system (NOAA 2012-TN2173). A Shortnose Sturgeon was collected in a bottom trawl from the Delaware River Estuary downriver of the PSEG Site in 2004 (PSEG 2005-TN2566). Two Shortnose Sturgeon were collected in 2008 and one in 2010 from bottom trawl sampling between Delaware RKM 100 and RKM 120 (RM 62.1 and RM 74.6), which is upriver of the proposed areas for in-water installation and potential dredging activities for Site 7-3 (PSEG 2009-TN2513; PSEG 2011-TN2571).

Atlantic Sturgeon share many life-history characteristics with the Shortnose Sturgeon in that adults migrate to freshwater to spawn and feed on benthic invertebrates such as worms, crustaceans, and aquatic insects (Gilbert 1989-TN2149). Unlike Shortnose Sturgeon, adult Atlantic Sturgeon prefer more marine habitats and make extensive migrations away from natal estuaries beginning as subadults (Gilbert 1989-TN2149). Historically, the Delaware River supported the largest population of Atlantic Sturgeon along the Atlantic coast (Secor and Waldman 1999-TN2207). Tagging studies in 2005 and 2006 indicated that Atlantic Sturgeon followed migration patterns similar to Shortnose Sturgeon with spawning potentially occurring mid-to-late June in the upper tidal Delaware reaches between Philadelphia, Pennsylvania, and Trenton, New Jersey (Simpson and Fox 2007-TN2194). Gill net surveys by the Delaware Division of Fish and Wildlife collected more than 1,700 juveniles near Artificial Island and the Cherry Island Flats (upriver of Site 7-3) between 1991 and 1998 (ASSRT 2007-TN2082). A single Atlantic Sturgeon was collected in 2004 and 2009 in bottom trawl sampling in Delaware River Estuary waters between RKM 100 and RKM 120 (RM 62.1 and RM 74.6), which is upriver of the proposed areas for in-water installation and potential dredging activities for Site 7-3 (PSEG 2005-TN2566; PSEG 2010-TN2570).

Two New Jersey threatened freshwater mussel species, the tidewater mucket and the eastern pondmussel (previously described in Sections 9.3.2.4 and 9.3.3.4), are listed as occurring in Cumberland County, New Jersey (NatureServe 2012-TN2182; NatureServe 2012-TN2184; respectively); however, there are no State-listed occurrences of freshwater mussel species within a 1-mi radius of Site 7-3 site and intake locations (NJDEP 2013-TN3578).

Field studies would be required to definitively determine whether any rare or protected species are present in streams in the project area. Federally endangered Shortnose and Atlantic Sturgeon are known to occur near the proposed areas for in-water installation and potential dredging activities for Site 7-3.

Building Impacts

Building the plant structures, roads, and transmission line and switchyard would disturb streams on the site and along offsite corridors. In addition to buildings and other structures, buried water intake and discharge pipes would run 0.7 mi from the Delaware River Estuary to the site. The total length of streams that would be affected by site-development activities on Site 7-3, including access roads, rail spurs, and water pipelines, is 3,747 ft (PSEG 2015-TN4280). This represents 0.1 percent of the total length of streams within 6 mi of the site. In addition, an estimated 9,508 ft of streams could be affected by building activities associated with the new transmission corridor and the switchyard, representing less than 0.5 percent of the total stream lengths in the area (S&L 2010-TN2671). However, potential impacts to streams from transmission corridor installation could be avoided or minimized by final corridor placement and

use of BMPs to reduce erosion and sedimentation effects from building activities (PSEG 2015-TN4280).

The installation of the water intake structure, and possibly a barge facility with a turning basin, would result in disturbance of benthic habitat in the Delaware River Estuary. Dredging would disturb about 11 ac of bottom habitat (about 185,000 yd^3 dredged) for the intake structure and possibly 67 ac (possibly 1,089,000 yd^3 dredged) for the barge facility (S&L 2010-TN2671). A barge inlet channel may also be needed. Dredging the barge inlet channel would disturb an additional 82 ac of benthic habitat and would remove an additional 990,000 yd^3 of dredged material (S&L 2010-TN2671). Installation and site-preparation activities could temporarily affect water quality but would require Federal and State permitting and use of BMPs to minimize and mitigate the temporary and localized effects. Effects on aquatic organisms are expected to be minimal and temporary as adjacent habitat is accessible, and mobile aquatic organisms such as fish and most macroinvertebrates would be able to avoid or move away from the affected area during intake installation activities, but effects could be greater if the installation of a barge facility with a turning basin and inlet channel are required. However, the impact on aquatic ecology of the Delaware River Estuary and streams on the site and in pipeline corridors would be minimal.

Operational Impacts

During operation of a new nuclear power plant at Site 7-3, there would be no direct discharges and few impacts to small streams on the site. Operation of the cooling and service water systems would require water to be withdrawn from and discharged back to the Delaware River Estuary as described for the PSEG Site. Aquatic impacts associated with impingement and entrainment of aquatic biota in the Delaware River Estuary and discharge of cooling water to the Delaware River Estuary could occur. Because the specifications associated with the water intake structure include a closed-cycle cooling system designed to meet EPA Phase I regulations for new facilities (66 FR 65256-TN243), the maximum through-screen velocity at the water intake structure would be less than 0.5 fps. Thus, if a new nuclear power plant is built at Site 7-3, the anticipated impacts to aquatic communities from impingement and entrainment in the Delaware River Estuary are not expected to be different from those in the PSEG Site analysis presented in Section 5.3.2 and are expected to be minimal. Operational impacts associated with water quality and discharge cannot be determined without additional detailed analysis but are expected to be similar to effects described for the PSEG Site. Maintenance activities on the site and in offsite corridors would follow BMPs required by Federal and State permits to minimize impacts on aquatic resources. Consequently, impacts on aquatic ecology due to project operations at Site 7-3 are expected to be minor.

Cumulative Impacts

Past alteration and degradation of the Delaware River Estuary, as described in Sections 2.4.2.1 and 7.3.2, have had long-term noticeable and sometimes destabilizing consequences on the aquatic resources within the Delaware River Basin and continue to be the subject of numerous restoration activities in targeted portions of the area. For assessment of cumulative impacts for Site 7-3, the ROI includes a 6-mi radius of water resources around the site and a 6-mi radius around the point of the water intake and discharge structures on the Delaware River Estuary.

The non-nuclear plant projects listed in Table 9-21 may result in alterations to surface-water drainage pathways and water bodies. It is not expected that these projects would have noticeable effects on water quality within the vicinity of Site 7-3 because they would need Federal, State, and local permits that require implementation of BMPs. The past, current, and future operation of SGS and HCGS will result in continued losses of aquatic species through impingement and entrainment at the water intake systems and alteration of thermal profiles in the immediate Delaware River Estuary area located near these facilities. Ongoing restoration efforts through the PSEG EEP will continue to provide mitigation for losses by increasing available habitat for early life stages of aquatic organisms and restoring previously fragmented habitats. A grid stability transmission line may be necessary for operation of a new nuclear power plant at Site 7-3 and would be similar to that described for the PSEG Site (Section 7.3.2).

Anthropogenic activities such as residential or industrial development near the vicinity of Site 7-3 could present additional constraints on aquatic resources. It is not expected that these projects would have noticeable effects on water quality within the vicinity because they would need Federal, State, and local permits that require implementation of BMPs. The review team is also aware of the potential for climate change affecting aquatic resources; however, the potential impacts of climate change on aquatic organisms and habitat in the geographic area of interest are not precisely known. In addition to rising sea levels, climate change could lead to regional increases in the frequency and intensity of extreme precipitation events, increases in annual precipitation, and increases in average temperature (GCRP 2014-TN3472). Such changes in climate could alter aquatic community composition on or near Site 7-3 through changes in species diversity, abundance, and distribution. Elevated water temperatures, droughts, and severe weather phenomena could adversely affect or severely reduce aquatic habitat, but specific predictions of aquatic habitat changes in this region due to climate change are inconclusive at this time. The level of impact resulting from these events would depend on the intensity of the perturbation and the resiliency of the aquatic communities.

Summary

Impacts on aquatic ecology resources are estimated based on the information provided by PSEG, NMFS, the State of New Jersey, and the review team's independent review. Properly siting the associated transmission line and switchyard; avoiding habitat for protected species; minimizing interactions with water bodies and watercourses along the corridors; and use of BMPs during water intake and discharge structure installation, possible installation of a barge facility with a turning basin and inlet channel, transmission line corridor preparation, and tower placement would minimize building and operation impacts. The review team concludes that the cumulative impacts on most aquatic resources in the Delaware River Estuary, including Federally and State threatened and endangered species, from building and operating a new nuclear power plant at Site 7-3, combined with other past, present, and future activities, would be MODERATE to LARGE, but a new plant's incremental impact would not be a significant contributor to the cumulative impact.

9.3.5.5 Socioeconomics

As discussed in Section 9.3.5, Site 7-3 is located in Cumberland County, New Jersey. Due to its proximity to the PSEG Site, the economic impact area for Site 7-3 would be the same as for

the PSEG Site. The site is a greenfield site located 10 mi southeast of the PSEG Site and about 2 mi west of the community of Greenwich (PSEG 2015-TN4280; PSEG 2010-TN257).

The review team's baseline discussion focuses on the 50-mi region surrounding Site 7-3. As discussed in Section 2.5, the review team expects that construction and operations workers for Site 7-3 would likely settle in the same areas as for the PSEG Site. Therefore, the review team focuses on Salem, Cumberland, and Gloucester Counties in New Jersey and New Castle County in Delaware for the majority of impacts. These four counties compose the economic impact area for Site 7-3.

Based on experience with construction of SGS and HCGS, PSEG believes about 84.5 percent of the workforce required to build a new nuclear power plant would come from within the 50-mi region surrounding the proposed site. PSEG assumes the remaining 15.5 percent of workers would relocate to the region from outside and would choose to reside in the same four counties that house the majority of the operations workers. The review team, as discussed in Sections 4.4 and 5.4, found similar estimates. Thus, both adverse and beneficial socioeconomic impacts of building and operating a new plant would not be noticeable except in these four counties. As discussed in Section 2.5, the review team finds the assumptions to be reasonable.

Physical and Aesthetic Impacts

Physical impacts include impacts on workers and the general public, noise, air quality, buildings, roads, and aesthetics. The physical impacts on workers would be similar to those described for the PSEG Site. The primary differences would be due to the presence of the HCGS and SGS workforces near the PSEG Site.

Site 7-3 is within 1 mi of a wildlife preserve. Site 7-3 would retrieve its cooling water from the Delaware River, requiring less than a 1-mi-long water pipeline that would go through WMAs that are used for hunting, trapping, and birding (PSEG 2010-TN257). PSEG would also build a 4.2-mi-long road (PSEG 2015-TN4280). Because the site is a greenfield site, PSEG estimates three new 500-kV transmission lines, constructed parallel to each other, would need to be constructed over 6.8 mi. This transmission lines would be adjacent to the Stow Creek WMA (PSEG 2015-TN4280). Even with mitigation measures similar to those discussed in Section 4.4.1, during the building phase these areas would receive adverse physical impacts from noise, vibration, and fugitive dust. Aesthetic impacts from building and operations at Site 7-3 would be similar to those discussed in Sections 4.4.1.6 and 5.4.1.6. The primary differences would be due to the presence of HCGS and SGS near the PSEG Site and the proximity of the Delaware River to the PSEG Site. Because Site 7-3 is a greenfield site, it would create new infrastructure in previously undisturbed rural areas and WMAs. Consequently, the review team expects the aesthetic impacts from building and operations to be noticeable and locally destabilizing.

Demography

Section 2.5.1 discusses the baseline demographic information in the economic impact area and region. Site 7-3 is located in Cumberland County; however, it is about 8 mi southeast of Lower Alloways Creek Township (the closest township to the PSEG Site). Due to its proximity to

Salem County, the review team predicts the same workforce requirements and in-migrating worker housing scenario as discussed in Sections 4.4.2 and 5.4.2. The review team found that building- and operations-related impacts on demography would be minimal in the economic impact area and the region.

Economic and Tax Impacts

Section 2.5.2.1 discusses the baseline economy and Section 2.5.2.2 discusses the tax structure in the economic impact area and region. Site 7-3 is located in Cumberland County, about 10 mi from the PSEG Site, and has the same economic impact area as the PSEG Site. For the purposes of the analysis of impacts to the local economy and tax revenues from the building and operations of a new nuclear power plant at Site 7-3, the review team predicts economic and tax impacts similar to those discussed in Sections 4.4.3 and 5.4.3. The exception would be in relation to property taxes, because PSEG would pay property taxes to Cumberland County. The review team found that building- and operations-related impacts on the local economy and local tax revenues would be minimal and beneficial in the economic impact area and the region.

Employees who own their residences would pay property taxes to the counties and/or municipalities in which their homes were located. In New Jersey, property tax rates vary from one county to another and also within townships in the same county. Property tax rates in Cumberland County, New Jersey, range between $1.733 and $5.503 per hundred dollars of assessed value. The rate in Greenwich Township, where Site 7-3 is located, is $3.592 per hundred.

Property taxes paid by construction workers who already live in the economic impact area are a part of the baseline and not relevant to this analysis. In-migrating workers would most likely move into existing houses rather than build a new home, so the in-migrating workforce would result in a transfer of property taxes instead of an increase in local property tax revenues. Based on the above assessments, the review team determined there would be no property tax impact from construction workers.

Cumberland County does not assess a property tax against construction projects in progress. PSEG would not pay property taxes to Cumberland County until a new power plant is completed at Site 7-3 and commercial operations commence.

From the above assessments, the review team determined there would be no construction-phase property tax impacts in the economic impact area, and that the overall impact of new tax revenues at the state and local levels would be minimal and positive.

As was the case in the PSEG Site analysis, the review team assumed that 198 in-migrating operations workers would have to either purchase or build new homes in the economic impact area. For existing homes, the property tax effect would be zero; for new homes, the review team expects a limited number of in-migrating workers would prefer to build. Given the magnitude of the property tax base in each of the counties in the economic impact area, the contribution of new real property to each area would result in a minor but beneficial impact.

All of the real property and improvements related to Site 7-3 would be located in Greenwich Township, Cumberland County, New Jersey. The review team determined that Greenwich Township imposes a $3.592 per hundred dollars of assessed value property tax on all improvements. For an AP1000 design, the expected property tax revenue to Greenwich Township would be about $356 million per year (unadjusted for depreciation). For the ABWR design, the property tax revenue would be about $210 million per year. Cumberland County's 2013 budget shows expected total revenues of $125 million (Cumberland County 2013-TN2585). Therefore, a new nuclear power plant would add between about 285 percent (AP1000) and 93 percent (ABWR) to the current Cumberland County budget. Consequently, the review team determined that Cumberland County would experience a major and beneficial impact from the anticipated new property tax revenues, and the economic impact area would experience a minimal and beneficial impact.

Infrastructure and Community Service Impacts

This section provides the estimated impacts on infrastructure and community services, including transportation, recreation, housing, public services, and education.

<u>Traffic</u>

Section 2.5.2.3 discusses the local roadways and transportation characteristics in the economic impact area and region. Sections 4.4.4.1 and 5.4.4.1 discuss the traffic impacts around the PSEG Site. Road access to the Site 7-3 area is provided primarily by County Roads 623 and 639, both of which are narrow two-lane roads. Road access to the site itself is provided by either County Road 631 or County Road 646. Access to the site is provided by Country Road 642, where the daily traffic count is 230 vehicles in both directions (PSEG 2015-TN4280). The site is about 27 mi from Interstate 295 and the New Jersey Turnpike via New Jersey Route 49 and County Road 551. The nearest rail spur is about 9 mi northeast of the site, and barge access would be provided by the Delaware River, about 1 mi from the site. The site would require about 3 mi of roadway improvements (PSEG 2010-TN257). Because the roads leading to Site 7-3 are narrow two-lane roads with low traffic volumes, peak building traffic would be noticeable and potentially destabilizing to local traffic. Due to the size of the operations workforce, with an outage, compared to the building workforce, the review team expects a minimal traffic impact during operations.

<u>Recreation</u>

Section 2.5.2.4 discusses the recreational activities in the economic impact area and region. As discussed in Sections 4.4.4.2 and 5.4.4.2, the review team does not expect any stresses to be placed upon the capacity of the recreational resources in the PSEG Site's economic impact area and region from new in-migrating workers and their families. This would also be true for Site 7-3's recreational impacts. Also, like the PSEG Site, recreational resources near Site 7-3 would receive a noticeable aesthetic impact from building and operational activities and a noticeable impact from traffic during peak building activities. The Stow Creek WMA would receive aesthetic impacts from building and operations due to its location near the site and transmission line corridor.

However, because a new nuclear power plant would be sited in an area with known hunting and trapping, the review team expects a further destabilizing impact on recreational activities in these areas from the new infrastructure (PSEG 2010-TN257; PSEG 2015-TN4280).

Housing

Section 2.5.2.5 discusses the baseline housing market in the economic impact area and region. Site 7-3 is located about 10 mi from the PSEG Site and has the same economic impact area as the PSEG Site. For the purposes of the analysis of impacts to the local housing market from the building and operation of a new nuclear power plant at Site 7-3, the review team predicts housing impacts similar to those discussed in Sections 4.4.4.3 and 5.4.4.3. The primary difference would be that many of the nine houses within the conceptual site boundaries would have to be removed to build and operate a new plant (PSEG 2015-TN4280). However, any taking related to a new nuclear power plant would have to be performed with an equitable compensation, which would render minimal any potential impact from that taking. The review team found that building- and operations-related impacts on the local housing market would be minimal in the economic impact area and the region.

Public Services

Section 2.5.2.6 discusses the baseline public services information in the economic impact area. This includes water and wastewater, police, fire, medical services, and social services. Site 7-3 is located in Cumberland County, about 10 mi from the PSEG Site, and has the same economic impact area as the PSEG Site. For the purposes of the analysis of impacts to the local public services infrastructure from the building and operation of a new nuclear power plant at Site 7-3, the review team predicts impacts similar to those discussed in Sections 4.4.4.4 and 5.4.4.4. The primary differences between the PSEG Site and Site 7-3 would be because local police/fire/EMS response to the site during construction and operation would have to come from Cumberland County services. The review team found that building- and operations-related impacts on the local public services infrastructure would be minimal in the economic impact area and the region.

Education

Section 2.5.2.6 discusses baseline education information in the economic impact area. Site 7-3 is located about 10 mi from the PSEG Site and has the same economic impact area as the PSEG Site. For the purposes of the analysis of impacts to the local education services from the building and operation of a new nuclear power plant at Site 7-3, the review team predicts impacts similar to those discussed in Sections 4.4.4.5 and 5.4.4.5. The review team found that building- and operations-related impacts on the local education services would be minimal in the economic impact area and the region.

Summary of Infrastructure and Community Service Impacts

The review team concluded from the information provided by PSEG, review of existing reconnaissance-level documentation, and its own independent evaluation that the impact of building and operations activities on regional infrastructure and community services—including

housing, public services, and education—would be minor. Physical-aesthetic impacts from building and operations would be noticeable and potentially destabilizing. The estimated peak workforce would have a noticeable, and potentially destabilizing, impact on traffic near Site 7-3. Increased traffic would have a noticeable, but not destabilizing, impact on recreational facilities, but recreation-based aesthetic impacts would have a noticeable and potentially destabilizing impact on recreational facilities and activities near Site 7-3. The cumulative impacts to economic and tax impacts would be SMALL and beneficial throughout the region and economic impact area, with the exception of a MODERATE and beneficial income tax effect to the State of New Jersey and a LARGE and beneficial impact to Cumberland County's economy and tax base.

Cumulative Impacts

As discussed above, the economic impact area for Site 7-3 is Salem, Cumberland, and Gloucester Counties in New Jersey, and New Castle County in Delaware. The review team discusses information pertaining to these areas in Sections 2.5 and 7.4.1. Table 9-21 lists the past, present, and reasonably foreseeable future activities associated with Site 7-3. Building and operating a new nuclear power plant at Site 7-3 could result in cumulative impacts on the demographics, economy, and community infrastructure of the economic impact area counties in conjunction with those reasonably foreseeable future actions.

Within the economic impact area, the project with the greatest potential to affect cumulative socioeconomic impacts would be the continued operation of the three nuclear units at HCGS and SGS. The other projects involve continuation of development in the economic impact area and are included in county comprehensive plans and in other public agency planning processes. According to Section 2.5.1.3, about 1,300 people are employed at HCGS and SGS and the majority of the workforce lives in the four counties in the economic impact area. Each reactor has outages that employ a further 1,034 to 1,361 workers for about 1 month on a staggered 18- to 24-month schedule (about one outage every 6 months at the site). Operations at HCGS and SGS also contribute to economic activity and tax revenue to the local communities. These characteristics are discussed further in Section 2.5 and in the HCGS and SGS License Renewal EIS (NRC 2011-TN3131).

An outage at HCGS/SGS could occur during peak building at Site 7-3. The review team considers this potential occurrence in Section 7.4. The majority of traffic impacts discussed in Section 7.4 would occur where the HCGS/SGS workforce, the HCGS/SGS outage workforce, and the PSEG Site building workforce merge in and around Salem City (PSEG 2013-TN2525). Because Site 7-3 is south of Salem City and farther from major interstates, the review team determined the potential for cumulative traffic impacts beyond those discussed in Section 9.3.5.5 is minimal.

The operating licenses for SGS Units 1 and 2 and HCGS expire in 2036, 2040, and 2046 respectively. Salem County would see a loss in tax revenue, PSEG purchases of supplies and materials, and employment. However, this loss would be partially offset by the continued operations at Site 7-3 compared to the baseline discussed in Section 2.5. The property tax revenue would not be offset, however, because Site 7-3 is in Cumberland County.

Summary of Socioeconomic Impacts

The review team expects the cumulative effects of most of the physical impacts to be SMALL with the exception of a LARGE impact to aesthetics because Site 7-3 is a greenfield site and would create new infrastructure in previously undisturbed rural areas and WMAs. The cumulative impacts on demography would be SMALL. The cumulative impacts on taxes and the economy would be SMALL and beneficial throughout the region, except for a MODERATE and beneficial income tax impact to the State of New Jersey and a LARGE and beneficial economic and tax impact to Cumberland County. The cumulative impacts on infrastructure and community services would be SMALL throughout the region, with the exception of a LARGE impact from traffic to Cumberland County during building activities and a MODERATE to LARGE impact to recreation-based aesthetics. Based on the above considerations, the review team concludes that cumulative socioeconomic impacts from building and operations at Site 7-3 (with the exception of the physical and recreational aesthetic impacts and the beneficial impacts to taxes and the economy) would not noticeably contribute to the existing cumulative socioeconomic effects discussed earlier in this section.

9.3.5.6 Environmental Justice

The economic impact area for Site 7-3 includes Salem, Gloucester, and Cumberland Counties in New Jersey and New Castle County in Delaware. Because of the proximity of Site 7-3 to the PSEG Site (about 10 mi), the review team determined the analysis of populations for the PSEG Site was a close approximation of an independent assessment of Site 7-3 (see Section 2.6.1). Therefore, the review team used the distribution of minority and low-income populations around the PSEG Site to determine minority and low-income population distributions around Site 7-3. This distribution is discussed in detail in Section 2.6. The closest minority and low-income groups to Site 7-3 are located about 7 mi away to the northeast in Bridgeton (PSEG 2012-TN2450). The review team found no indication of subsistence activities in the economic impact area. As discussed in Sections 2.5 and 2.6, the majority of migrant populations are outage workers at HCGS and SGS. The closest high-density communities are in Bridgeton (Cumberland County 2010-TN2496).

As discussed in Section 9.3.5.5, the review team expects that building and operating a new nuclear power plant at Site 7-3 would have some adverse physical and aesthetic impacts to the local population. However, even though the review team expects adverse physical impacts during building and operations, distance, intervening foliage, and topography would significantly diminish such impacts on minority or low-income populations. Therefore, the review team does not expect the adverse physical and aesthetic impacts to be disproportionately high and adverse for minority and low-income populations. For the rest of the economic impact area and region, the review team expects environmental justice impacts similar to those at the PSEG Site. Therefore the review team determined there would be no environmental justice impacts at Site 7-3.

Cumulative Impacts

Based on the analysis above and the discussion of cumulative impacts in Section 9.3.5.5, the review team determined that there would not be any further disproportionately high and adverse impacts on environmental justice populations above and beyond those discussed in this section.

The review team did not identify any pathways for environmental justice impacts from the continued operations at HCGS and SGS.

9.3.5.7 Historic and Cultural Resources

The following impact analysis includes impacts from building and operating a new nuclear power plant at Site 7-3 in Cumberland County, New Jersey. Site 7-3 is less than 1 mi east of the Delaware River. The analysis also considers other past, present, and reasonably foreseeable future actions that could impact cultural resources and historical properties, including the Federal and non-Federal projects listed in Table 9-21. For the analysis of historic and cultural impacts at Site 7-3, the geographic area of interest is considered to be the APE that would be defined for this proposed undertaking. This includes the physical APE, defined as the area directly affected by site-development and operation activities at the site and transmission lines, and the visual APE. The visual APE is defined as the additional 4.9-mi radius around the physical APE. The 4.9-mi radius was chosen by the New Jersey SHPO as the appropriate distance for consideration of visual resources near the PSEG Site and was therefore applied to the alternative sites (AKRF 2012-TN2876).

Reconnaissance-level activities in this cultural resource review have a particular meaning. For example, these activities include preliminary field investigations to confirm the presence or absence of cultural resources and historical properties. However, in developing this EIS, the review team relies upon reconnaissance-level information to perform alternative site evaluations. Reconnaissance-level information consists of data that are readily available from agencies and other public sources. It can also include information obtained through visits to the alternative site area. The following information was used to identify the cultural resources and historical properties at Site 7-3:

- the PSEG ER (PSEG 2015-TN4280),
- *Field Verification of Key Resources at PSEG Alternative Sites* (AKRF 2011-TN2869), and
- New Jersey SHPO archaeological site files.

Affected Environment

Site 7-3 is a greenfield located in Cumberland County in southern New Jersey. Historically, Site 7-3 has been used for agricultural purposes. Site 7-3 encompasses a total of 886 ac. The location would require 4.2 mi of new roads, a 0.7-mi-long makeup water pipeline, and three new 500-kV transmission lines covering a total distance of 6.8 mi. A fourth line, for grid stability, could also be needed and would run 107 mi. Due to the close proximity of Site 7-3 to the Delaware River, delivery of materials for the plant would be by barge. A new road would connect Site 7-3 to the barge facility. The current major industry in Cumberland County is agriculture. Twenty-six properties in Cumberland County, New Jersey, are listed in the NRHP (NPS 2013-TN2775). The four listed properties closest to Site 7-3 are the Bridgeton Historic District, the Greenwich Historic District, Bethel African Methodist Episcopal (A.M.E.) Church, and the Thomas Maskel House (within 1,000 ft of Site 7-3).

No archaeological sites have been previously recorded within the 1-mi APE around Site 7-3. Two archaeological sites were noted in close proximity to the conceptual transmission corridor.

Thirteen previously identified architectural resources are within 4.9 mi of Site 7-3 and its ancillary components. Resources include residences and historic districts. Nine architectural resources have been identified within 1 mi of Site 7-3 and the conceptual corridors: the Deerfield Pike Tollgate House, General Giles House, Old Broad Street Presbyterian Church and Cemetery, East Commerce Street Historic District, Jeremiah Buck House, Samuel Seeley House, Potter's Tavern, Bethel A.M.E. Church, and 9 Manheim Avenue. A review of architectural resources in the immediate vicinity of Site 7-3 identified 13 additional architectural resources that could potentially be eligible for listing in the NRHP within 1,000 ft of Site 7-3; however, none were within the footprint (AKRF 2011-TN2869). These resources included residences and farmhouses. Three additional buildings (two residences and a school) with potential for listing in the NRHP were identified within 1 mi of Site 7-3. Another 12 structures and architectural features that have the potential for listing on the NRHP were identified between 1 and 4.9 mi of Site 7-3.

Building Impacts

Additional cultural resources inventories would likely be needed for any portion of Site 7-3 that has not been previously surveyed. Other lands that might be acquired to support the plant (e.g., for roads and pipeline corridors) would also likely require a survey to identify potential cultural resources and historical properties and mitigation measures to offset the potential adverse effects of ground-disturbing activities. The types of historic and cultural resource impacts resulting from construction and operation of new nuclear units would consist of alterations to archaeological sites from ground-disturbing activities and visual alterations to the settings for historic structures. In some cases vibrations from construction equipment could also affect historic structures.

There are no existing transmission corridors connecting directly to Site 7-3 (PSEG 2015-TN4280). Three new transmission line corridors would be needed to connect Site 7-3 to existing lines. There are two previously recorded historic and cultural resource sites in the area where the transmission line would be routed. In the event that Site 7-3 is chosen for the proposed project, the review team assumes that the transmission service provider for this region would conduct cultural resource surveys for all areas needed for the transmission lines. In addition, visual impacts from the plant, the cooling towers, and the transmission lines would result in noticeable alterations to the visual landscape within the geographic area of interest. Building impacts are expected to be noticeable because significant (i.e., NRHP-listed) resources are in close proximity to Site 7-3.

Operational Impacts

Operational impacts from a new plant located at Site 7-3, with the exception of the visual impacts, would be expected to be minimal. Most impacts to historic and cultural resources would occur during preconstruction and construction. Noticeable visual impacts to historic structures could occur within the viewshed of the new plant during operation.

Cumulative Impacts

Noticeable cumulative impacts would occur to the historic properties within the viewshed from the preconstruction and construction activities associated with the plant. Cumulative impacts would also result from the non-NRC-licensed activities associated with construction of the transmission lines and pipelines. Therefore, cumulative impacts would be noticeable due to the impact to historic properties within the viewshed of Site 7-3, depending on what resources were encountered. If unidentified archaeological or historical resources are found on Site 7-3 or in areas needed for the transmission lines and pipelines, then the impacts could be greater.

Summary

Cultural resources are nonrenewable; therefore, the impact from destruction of cultural resources is cumulative. Based on the reconnaissance-level information, the review team concludes that the cumulative impacts on historic and cultural resources of building and operating a new nuclear power plant at Site 7-3 would be MODERATE. The incremental contribution from building and operating a new plant at Site 7-3 would be a significant contributor to the cumulative impact. This impact-level determination reflects the fact that cultural resources and historical properties are found within the viewshed and would be affected by the plant, cooling tower, and transmission lines.

9.3.5.8 Air Quality

Criteria Pollutants

The air-quality impacts of building and operating a new nuclear power plant and offsite facilities at Site 7-3 would be similar to the impacts expected for the PSEG Site. As with Salem County, in which the PSEG Site is located, the county in which Site 7-3 is located (Cumberland County) is classified as a nonattainment area for the 8-hour ozone NAAQSs and in attainment or better than national standards for all other criteria pollutants (40 CFR Part 81-TN255). Administratively, Cumberland County is in the New Jersey Intrastate AQCR (40 CFR 81.331 [TN255]), while neighboring Salem County is in the Metropolitan Philadelphia Interstate AQCR (40 CFR 81.15 [TN255]). As with the PSEG Site, an applicability analysis would need to be performed if a new nuclear power plant was built on Site 7-3 per 40 CFR Part 93, Subpart B (TN2495), to determine whether a general conformity determination was needed.

As discussed in Section 4.7, emissions of criteria pollutants from building a nuclear power plant are expected to be temporary and limited in magnitude. Emissions from these activities would be primarily the fugitive dust from ground-disturbing activities and engine exhaust from heavy equipment and vehicles. These impacts would be similar to the impacts associated with any large construction project. During building activities, a New Jersey State Air Quality Permit would be required that would prescribe emissions limits and mitigation measures to be implemented. The applicant also plans to implement a fugitive dust control program (PSEG 2015-TN4280).

Section 5.7 discusses air-quality impacts during operations. Emissions during operations would primarily be from operation of the cooling towers, auxiliary boilers, diesel generators and/or gas turbines, and commuter traffic. Stationary sources such as the diesel generators and/or gas

turbines (operating infrequently) and auxiliary boilers (operating mostly during the winter months) would be operated according to State and Federal regulatory requirements.

A Title V operating permit administered through the State of New Jersey would ensure compliance with NAAQSs and other applicable regulatory requirements and prescribe mitigation measures to ensure compliance. There are 17 major sources of air emissions in Cumberland County with existing Title V operating permits (EPA 2013-TN2515). These existing sources include the energy and industrial projects listed in Table 9-21. The existing energy and industrial projects (including various glass manufacturers) and the planned developments and road-widening transportation project would contribute to air-quality impacts in Cumberland County. However, the impacts on air quality in the county from emissions from Site 7-3 would be temporary and not noticeable when combined with other past, present, and reasonably foreseeable future projects. The cumulative air-quality impacts of building and operating a new nuclear power plant at Site 7-3 would be minor.

Greenhouse Gases

The cumulative impacts of GHG emissions related to nuclear power are discussed in Section 7.6. The impacts of the emissions are not sensitive to the location of the source. Consequently, the discussion in Section 7.6 would be applicable to a nuclear power plant located at Site 7-3. The review team concludes that the national and worldwide cumulative impacts of GHG emissions are noticeable but not destabilizing. The review team further concludes that the cumulative impacts would be noticeable but not destabilizing, with or without the GHG emissions of a nuclear power plant at Site 7-3.

Summary

The review team concludes that the cumulative impacts from other past, present, and reasonably foreseeable future actions on air-quality resources in the geographic areas of interest would be SMALL for criteria pollutants and MODERATE for GHG emissions. The incremental contribution of impacts on air-quality resources from building and operating a new nuclear power plant at Site 7-3 would be SMALL for both criteria pollutants and GHG emissions.

9.3.5.9 Nonradiological Health

The following impact analysis considers nonradiological health impacts from building activities and operations on the public and workers from a new nuclear power plant at Site 7-3, which is located in Greenwich Township, Cumberland County, New Jersey (about 10 mi southwest of the PSEG Site). The analysis also considers other past, present, and reasonably foreseeable future actions that could affect nonradiological health, including other Federal and non-Federal projects and those projects listed in Table 9-21 within the geographic area of interest. The building-related activities that have the potential to affect the health of members of the public and workers include exposure to dust and vehicle exhaust, occupational injuries, noise, and the transport of construction materials and personnel to and from the site. The operation-related activities that have the potential to affect the health of members of the public and workers include exposure to etiological agents, noise, and EMFs and transport of workers to and from the site.

Most of the nonradiological impacts of building and operation (e.g., noise, etiological agents, and occupational injuries) would be localized and would not have significant impact at offsite locations. However, activities such as vehicle emissions from transport of personnel to and from the site would encompass a larger area. Therefore, for nonradiological health impacts associated with vehicle and other air emissions sources, the geographic area of interest for cumulative impacts analysis includes projects within a 50-mi radius of Site 7-3. For cumulative impacts associated with transmission lines, the geographical area of interest is the transmission line corridor. These geographical areas are expected to encompass areas where cumulative impacts to public and worker health could occur in combination with any past, present, or reasonably foreseeable future actions.

Building Impacts

Nonradiological health impacts on the construction workers building a new nuclear power plant at Site 7-3 would be similar to those for construction workers building a new plant at the PSEG Site, as evaluated in Section 4.8. They include occupational injuries, noise, odor, vehicle exhaust, and dust. Applicable Federal, State, and local regulations on air quality and noise would be complied with during the plant construction phase. Site 7-3 does not have any characteristics that would be expected to lead to fewer or more construction accidents than would be expected for the PSEG Site. Transportation of personnel and construction materials at Site 7-3 would result in minimal nonradiological health impacts. Site 7-3 is in a greenfield area, and construction impacts would likely be minimal on the surrounding population areas, which are classified as low-population areas.

Operational Impacts

Nonradiological health impacts on members of the public and on the occupational health of workers from operation of a new nuclear power plant at Site 7-3 would be similar to those evaluated in Section 5.8 for a new plant at the PSEG Site. Occupational health impacts on workers (e.g., falls, electric shock, or exposure to other hazards) at Site 7-3 would likely be the same as those evaluated for workers at a new plant at the PSEG Site. Discharges to the Delaware River would be controlled by NPDES permits issued by NJDEP. The growth of etiological agents would not be significantly encouraged at Site 7-3 because of the temperature attenuation in the length of the pipe required for a discharge system. Noise and EMF exposure would be monitored and controlled in accordance with applicable OSHA regulations. Effects of EMFs on human health would be controlled and minimized by conformance with NESC criteria. Nonradiological impacts of traffic during operations would be less than the impacts during building. Mitigation measures used during building to improve traffic flow would also minimize impacts during operation.

Cumulative Impacts

Past and present actions within the geographic area of interest that could contribute to cumulative nonradiological health impacts include the energy projects in Table 9-21, as well as vehicle emissions and existing urbanization. Reasonably foreseeable future projects in the geographical area of interest that could contribute to cumulative nonradiological health impacts include expansion of natural-gas pipelines, improvements to and new construction for roadways

and interstates, future transmission line development, and future urbanization. The review team is also aware of the potential climate changes that could affect human health, and a recent compilation of the state of knowledge in this area (GCRP 2014-TN3472) was considered in the preparation of this EIS. Projected changes in climate for the region include an increase in average temperature, increased likelihood of drought in summer, more heavy downpours, and an increase in precipitation, especially in the winter and spring, which could alter the presence of microorganisms and parasites. In view of the water source characteristics, the review team did not identify anything that would alter its conclusions regarding the presence of etiological agents or change in the incidence of waterborne diseases.

Summary

Based on the information provided by PSEG and the review team's independent evaluation, the review team expects that the impacts on nonradiological health from building and operating a new nuclear power plant at Site 7-3 would be similar to the impacts evaluated for the PSEG Site. Although there are past, present, and future activities in the geographical area of interest that could affect nonradiological health in ways similar to the building and operation of a new nuclear power plant at Site 7-3, the impacts from such activities would be localized and managed through adherence to existing regulatory requirements. Similarly, impacts on public health from a new nuclear power plant operating at Site 7-3 would be expected to be minimal. The review team concludes, therefore, that the cumulative impacts on nonradiological health of building and operating a new nuclear power plant at Site 7-3 would be SMALL.

9.3.5.10 Radiological Impacts of Normal Operations

The following impact analysis includes radiological impacts on the public and workers from building activities and operations for a new nuclear power plant at Site 7-3, which is located in Greenwich Township, Cumberland County, New Jersey (about 10 mi southwest of the PSEG Site). The analysis also considers other past, present, and reasonably foreseeable future actions that could affect radiological health, including other Federal and non-Federal projects and the projects listed in Table 9-16. As described in Section 9.3.5, Site 7-3 is a greenfield site; there are currently no nuclear facilities on the site. The geographic area of interest is the area within a 50-mi radius of Site 7-3. Other nuclear reactor sites that potentially affect the radiological health within this geographic area of interest are HCGS, SGS Units 1 and 2, and Peach Bottom Atomic Power Station Units 2 and 3. The Shieldalloy radioactive materials decommissioning site in Newfield, New Jersey, is also within 50 mi of Site 7-3. In addition, medical, industrial, and research facilities that use radioactive materials are likely to be within 50 mi of Site 7-3.

The radiological impacts of building and operating a new nuclear power plant at Site 7-3 include doses from direct radiation and liquid and gaseous radioactive effluents. These pathways would result in doses to people and biota other than humans off the site that would be well below regulatory limits. The impacts are expected to be similar to those at the PSEG Site.

The radiological impacts of HCGS, SGS Units 1 and 2, and Peach Bottom Atomic Power Station include doses from direct radiation and liquid and gaseous radioactive effluents. These pathways result in doses to people and biota other than humans off the site that are well below

regulatory limits as demonstrated by the ongoing radiological environmental monitoring program conducted around HCGS, SGS Units 1 and 2, and Peach Bottom Atomic Power Station. The NRC staff concludes that the dose from direct radiation and effluents from medical, industrial, and research facilities that use radioactive material would be an insignificant contribution to the cumulative impact around Site 7-3. This conclusion is based on data from the radiological environmental monitoring programs conducted around currently operating nuclear power plants. Based on the information provided by PSEG and the NRC staff's independent analysis, the NRC staff concludes that the cumulative radiological impacts from building and operating a new nuclear power plant and other existing and planned projects and actions in the geographic area of interest around Site 7-3 would be SMALL.

9.3.5.11 Postulated Accidents

The following impact analysis includes radiological impacts from postulated accidents from the operation of a new nuclear power plant at Site 7-3 in Cumberland County, New Jersey. The analysis also considers other past, present, and reasonably foreseeable future actions that could affect radiological health from postulated accidents, including other Federal and non-Federal projects and those projects listed in Table 9-21 within the geographic area of interest. As described in Section 9.3.5, Site 7-3 is a greenfield site; currently there are no nuclear facilities on the site. The geographic area of interest considers all existing and proposed nuclear power plants that have the potential to increase the probability-weighted consequences (i.e., risks) from a severe accident at any location within 50 mi of the site. Existing facilities potentially affecting radiological accident risk within this geographic area of interest are HCGS Unit 1, SGS Units 1 and 2, Oyster Creek Nuclear Generating Station, Limerick Generating Station Units 1 and 2, Peach Bottom Atomic Power Station Units 2 and 3, Three Mile Island Nuclear Station Unit 1, and Calvert Cliffs Nuclear Power Plant Units 1 and 2.

As described in Section 5.11, the NRC staff concludes that the environmental consequences of DBAs at the PSEG Site would be minimal for a US-APWR, two AP1000s, a U.S. EPR, or an ABWR. DBAs are addressed specifically to demonstrate that any of these four reactor designs is sufficiently robust to meet the NRC safety criteria. The reactor designs are independent of site conditions, and the meteorological characteristics of Site 7-3 and the PSEG Site are similar; therefore, the NRC staff concludes that the environmental consequences of DBAs at Site 7-3 would be SMALL.

Because the meteorology, population distribution, and land use for Site 7-3 are expected to be similar to the PSEG Site, risks from a severe accident for a new reactor located at Site 7-3 are expected to be similar to those analyzed for the PSEG Site. These risks for the PSEG Site are presented in Tables 5-30 and 5-31 and are well below the mean and median values for current-generation reactors. In addition, as discussed in Section 5.11.2.1, estimates of average individual early fatality and latent cancer fatality risks are well below Commission safety goals (51 FR 30028-TN594). For existing plants within the geographic area of interest (i.e., whose 50-mi radius overlaps with the 50-mi radius around the PSEG Site), namely HCGS Unit 1, SGS Units 1 and 2, Oyster Creek Nuclear Generating Station, Limerick Generating Station Units 1 and 2, Peach Bottom Units 1 and 2, Three Mile Island Nuclear Station Unit 1, and Calvert Cliffs Nuclear Power Plant Units 1 and 2, the Commission has determined the probability-weighted consequences of severe accidents are small (10 CFR Part 51, Appendix B,

Table B-1 [TN250]). Because of the NRC safety review criteria, it is expected that risks for any new reactors at any other locations within the geographic area of interest for Site 7-3 would be well below risks for current-generation reactors and would meet Commission safety goals. The severe accident risk due to any particular nuclear power plant becomes smaller as the distance from that plant increases. However, the combined risk at any location within 50 mi of Site 7-3 would be bounded by the sum of risks for all these operating nuclear power plants and would still be low.

The postulated accident risk due to any particular nuclear power plant gets smaller as the distance from that plant increases. However, the combined risk at any location within 50 mi of Site 7-3 site would be bounded by the sum of risks for all of these operating and proposed nuclear power plants. Even though there would be potentially several plants included in the combination, this combined risk would still be low. On this basis, the NRC staff concludes that the cumulative risks of postulated accidents at any location within 50 mi of Site 7-3 would be SMALL.

9.3.6 Comparison of the Impacts of the Proposed Action and Alternative Sites

This section summarizes the review team characterization of the cumulative impacts related to locating a new nuclear power plant at the proposed PSEG Site and at each of the four alternative sites. The sites selected for detailed review as part of the alternative sites environmental analysis included the four sites designated as Site 4-1, Site 7-1, Site 7-2, and Site 7-3 in New Jersey (see Figure 9-1). Comparisons are made between the PSEG Site and the alternative sites to determine whether one of the alternative sites would be “environmentally preferable”[(1)] to the PSEG Site. The NRC determination as to whether an alternative site would be environmentally preferable to the PSEG Site is independent of the USACE determination of a LEDPA pursuant to CWA Section 404(b)(1) Guidelines at 40 CFR Part 230 (TN427). The USACE will conclude its analysis of both offsite and onsite alternatives in its permit decision documents.

The need to compare the PSEG Site with alternative sites arises from the requirement in NEPA Section 102(2)(c)(iii) (42 USC 4321 et seq. -TN661) that EISs include an analysis of alternatives to the proposed action. The NRC criteria to be used in assessing whether a proposed site is to be rejected in favor of an alternative site are based on whether the alternative site is “obviously superior” to the site proposed by the applicant (PSCO v. NRC 1978-TN2633). An alternative site is obviously superior to the proposed site if it is “clearly and substantially” superior to the proposed site (NRC 1978-TN2636). The standard of obviously superior “is designed to guarantee that a proposed site will not be rejected in favor of an alternate unless, on the basis of appropriate study, the Commission can be confident that such action is called for” (NECNP v. NRC 1978-TN2632).

The “obviously superior” test is appropriate for two reasons. First, the analysis performed by the NRC in evaluating alternative sites is necessarily imprecise. Key factors considered in the

(1) As defined in Section 9.3 of NUREG-1555, an “environmentally preferred” alternative site is a site for which the environmental impacts are sufficiently less than for the proposed site so that environmental preference for the alternative site can be established (NRC 2000-TN614).

alternative site analysis, such as population distribution and density, hydrology, air quality, aquatic and terrestrial ecological resources, aesthetics, land use, and socioeconomics, are difficult to quantify in common metrics. Given this difficulty, any evaluation of a particular site must have a wide range of uncertainty. Second, the PSEG Site has been analyzed in detail, with the expectation that most adverse environmental impacts associated with the site have been identified. The alternative sites have not undergone a comparable level of detailed study. For these reasons, a proposed site may not be rejected in favor of an alternative site when the alternative site is marginally better than the proposed site, only when it is obviously superior (NRC 1978-TN2636). NEPA (42 USC 4321 et seq. -TN661) does not require that a nuclear plant be constructed on the single best site for environmental purposes. Rather, “all that NEPA requires is that alternative sites be considered and that the effects on the environment of building the plant at the alternative sites be carefully studied and factored into the ultimate decision” (NECNP v. NRC 1978-TN2632).

The NRC staff review of alternative sites consists of a two-part sequential test (NRC 2000-TN614). The first part of the test determines whether any of the alternative sites are environmentally preferable to the applicant-proposed site. The NRC staff considers whether the applicant has (1) reasonably identified candidate sites, (2) evaluated the likely environmental impacts of building and operation at these sites, and (3) used a logical means of comparing sites that led to applicant selection of the proposed site. Based on the independent NRC review, the NRC staff determines whether any of the alternative sites are environmentally preferable to the applicant-proposed site. If the NRC staff determines that one or more alternative sites are environmentally preferable, then it would compare the estimated costs (i.e., environmental, economic, and time) of constructing the proposed plant at the applicant-proposed site and at the environmentally preferable site or sites (NRC 2000-TN614). The second part of the test determines whether an environmentally preferable alternative site is obviously superior to the applicant-proposed site. The NRC staff must determine that (1) one or more important aspects, either singly or in combination, of an environmentally preferable alternative site are obviously superior to the corresponding aspects of the applicant-proposed site and (2) the alternative site does not have offsetting deficiencies in other important areas. An NRC staff conclusion that an alternative site is obviously superior to the applicant-proposed site would normally lead to a recommendation that the application for the license be denied.

Section 9.3.6.1 reviews the cumulative environmental impacts of building and operating a new nuclear power plant at the PSEG Site. Cumulative impact levels for the PSEG Site (from Chapter 7) and the four alternative sites (from Sections 9.3.2, 9.3.3, 9.3.4, and 9.3.5) are given in Table 9-24. Sections 9.3.6.2 and 9.3.6.3 discuss the cumulative environmental impacts of a new nuclear power plant at the PSEG Site in relation to the alternative sites as they relate to “environmentally preferable” and “obviously superior” evaluations.

9.3.6.1 Comparison of Cumulative Impacts at the PSEG Site and Alternative Sites

The review team characterizations of the cumulative environmental impacts of building and operating a new nuclear power plant at the PSEG Site and at the four alternative sites are listed by resource area in Table 9-24.

Table 9-24. Comparison of Cumulative Impacts at the Proposed PSEG Site and Four Alternative Sites

Resource Area	PSEG Site[a]	Site 4-1	Site 7-1	Site 7-2	Site 7-3
Land Use	MODERATE	MODERATE	MODERATE	MODERATE	MODERATE
Water Resources					
Surface-Water Use	MODERATE	MODERATE	MODERATE	MODERATE	MODERATE
Groundwater Use	MODERATE	SMALL	MODERATE	MODERATE	MODERATE
Surface-Water Quality	MODERATE	MODERATE	MODERATE	MODERATE	MODERATE
Groundwater Quality	MODERATE	SMALL	MODERATE	MODERATE	MODERATE
Ecological Resources					
Terrestrial and Wetland Resources	MODERATE	MODERATE	MODERATE	MODERATE	MODERATE
Aquatic Resources	MODERATE to LARGE	MODERATE	MODERATE to LARGE	MODERATE to LARGE	MODERATE to LARGE
Socioeconomics					
Physical Impacts	SMALL to MODERATE	SMALL to LARGE	SMALL to LARGE	SMALL to LARGE	SMALL to LARGE
Demography	SMALL	SMALL	SMALL	SMALL	SMALL
Taxes and Economy	SMALL to LARGE (beneficial)	SMALL to LARGE (beneficial)	SMALL to LARGE (beneficial)	SMALL to LARGE (beneficial)	SMALL to LARGE (beneficial)
Infrastructure and Community Services	SMALL to MODERATE	SMALL to LARGE	SMALL to LARGE	SMALL to LARGE	SMALL to LARGE
Environmental Justice	None[b]	None[b]	Potential[b]	None[b]	None[b]
Historic and Cultural Resources	MODERATE	LARGE	MODERATE	MODERATE	MODERATE
Air Quality					
Criteria pollutants	SMALL	SMALL	SMALL	SMALL	SMALL
Greenhouse gas emissions	MODERATE	MODERATE	MODERATE	MODERATE	MODERATE
Nonradiological Health	SMALL	SMALL	SMALL	SMALL	SMALL
Radiological Health	SMALL	SMALL	SMALL	SMALL	SMALL
Nonradioactive Waste	SMALL	SMALL	SMALL	SMALL	SMALL
Postulated Accidents	SMALL	SMALL	SMALL	SMALL	SMALL

(a) From Table 7-4.
(b) The entry "None" for Environmental Justice does not mean there are no adverse impacts to minority or low-income populations from the proposed action. Rather, "None" means that, while there may be adverse impacts, those impacts do not affect minority or low-income populations in any disproportionate manner, relative to the general population. Similarly, the entry "Potential" means that the review team has determined the presence of pathways by which a minority or low-income population could be affected disproportionately.

The review team evaluated the environmental resource areas listed in Table 9-24 using the NRC three-level standard of impact significance: SMALL, MODERATE, or LARGE. These levels were developed using the CEQ guidelines and set forth in the footnotes to 10 CFR Part 51, Subpart A, Appendix B, Table B-1 (TN250).

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 review team performed reconnaissance-level reviews of each of the four alternative sites and reviewed information provided in the PSEG ER and RAI responses, information from other Federal and State agencies, and information gathered during visits to each alternative site. The review team found that PSEG implemented a reasonable process to select alternative sites and used a logical process to compare the impacts of the PSEG Site to those at the alternative sites. The following discussion summarizes the review team's independent assessment of the PSEG Site and alternative sites.

Full explanations for the cumulative impact characterizations are provided in Chapter 7 for the PSEG Site and in Sections 9.3.2, 9.3.3, 9.3.4, and 9.3.5 for the four alternative sites. The review team assignment of impact category levels is based on professional judgment, experience, and consideration of controls likely to be imposed under required Federal, State, or local permits that would not be acquired until an application for a construction permit or combined construction permit and operating license were under way. These considerations and assumptions were similarly applied at each of the alternative sites to provide comparisons of impact levels at the PSEG Site and each of the four alternative sites.

9.3.6.2 Environmentally Preferable Sites

Neither the PSEG Site nor any of the four alternative sites appear to have inherent characteristics that would completely preempt building a nuclear plant at that location. However, as shown in Table 9-24, the cumulative impacts of building and operating a new nuclear power plant at the proposed PSEG Site or at one of the alternative sites vary across the impact categories.

The cumulative impacts of building and operating a new nuclear power plant at the PSEG Site or at any one of the alternative sites are SMALL for several impact categories (e.g., demography, radiological health, and postulated accidents). The resource categories for which the impact level at an alternative site would be the same as for the proposed site do not contribute to the alternative site being judged to be environmentally preferable to the proposed site (e.g., taxes and economy, and air quality). Therefore, these resource categories are not discussed further in determining whether an alternate site is environmentally preferable to the proposed site. Where there is a range of impacts for a resource category, the upper value of that range is used for the comparison. In addition, for those cases in which the cumulative impacts for a resource category would be greater than SMALL, consideration is given to those cases in which the impacts of the project at the specific site would not make a significant contribution to the cumulative impact level.

Site 4-1

For most resources, the environmental impacts at Site 4-1 would be similar to the impacts at the PSEG Site. The cumulative impacts to groundwater use and quality at the PSEG Site are MODERATE, as compared to SMALL at Site 4-1. However, building and operating a new nuclear plant would not be a significant contributor to the MODERATE impacts at the PSEG Site, so there is no real difference between the sites in this regard. Similarly, the impacts to aquatic resources is shown as MODERATE to LARGE for the PSEG Site, as compared to MODERATE for Site 4-1, but at both sites building and operating a new nuclear plant is not a significant contributor to the impacts. For surface-water use, the table indicates that the cumulative impacts at both sites are MODERATE. However, at Site 4-1 building and operating a new nuclear plant is a significant contributor to the impacts, while at the PSEG Site it is not. Therefore, Site 4-1 is less favorable in regard to surface-water-use impacts. Finally, Table 9-24 also shows greater impacts at Site 4-1 for physical impacts, infrastructure and community services, and historic and cultural resources. For all three of these resource areas, the higher impacts are related to building and operating a new nuclear plant at the site. Based on this comparison of the sites, Site 4-1 is not environmentally preferable to the PSEG Site.

Site 7-1

For most resources, the environmental impacts at Site 7-1 would be similar to the impacts at the PSEG Site. However, Table 9-24 shows greater impacts at Site 7-1 for physical impacts, infrastructure and community services, and environmental justice. For all three of these resource areas, the higher impacts are related to building and operating a new nuclear plant at the site. In addition, building and operating a new nuclear plant at Site 7-1 would be a significant contributor to the MODERATE groundwater-use impacts, while at the PSEG Site, building and operating a new nuclear plant is not a significant contributor, which means that Site 7-1 is less favorable in this regard. Based on this comparison of the sites, Site 7-1 is not environmentally preferable to the PSEG Site.

Site 7-2

For most resources, the environmental impacts at Site 7-2 would be similar to the impacts at the PSEG Site. However, Table 9-24 shows greater impacts at Site 7-2 for physical impacts and for infrastructure and community services. For both of these two resource areas, the higher impacts are related to building and operating a new nuclear plant at the site. Based on this comparison of the sites, Site 7-2 is not environmentally preferable to the PSEG Site.

Site 7-3

For most resources, the environmental impacts at Site 7-3 would be similar to the impacts at the PSEG Site. However, Table 9-24 shows greater impacts at Site 7-3 for physical impacts and for infrastructure and community services. For both of these two resource areas, the higher impacts are related to building and operating a new nuclear plant at the site. Based on this comparison of the sites, Site 7-3 is not environmentally preferable to the PSEG Site.

In conclusion, although there are differences and distinctions between the cumulative environmental impacts of building and operating a new nuclear power plant at the proposed

PSEG Site or at one of the alternative sites, the review team concludes that these differences are not sufficient to determine that any of the alternative sites would be environmentally preferable to the proposed site for building and operating a new nuclear power plant. In such a case, the proposed site prevails because none of the alternative sites is clearly environmentally preferable.

9.3.6.3 Obviously Superior Sites

None of the alternative sites was determined to be environmentally preferable to the proposed PSEG Site. Therefore, the NRC staff concludes that none of the alternative sites would be obviously superior to the PSEG Site. The USACE will make its LEDPA decision in a permit decision document.

9.4 System Design Alternatives

The review team considered several alternative designs for the heat dissipation systems and CWS. The heat dissipation from the CWS during operation requires the most capacity, and for an extended time, to support the cooling needs of a commercial power reactor. The heat dissipation needs from other cooling systems such as the service water system (SWS) are smaller. For the suite of reactor designs being considered for the PSEG Site, the bounding CWS would need to dissipate 1.508×10^{10} Btu per hour, while the bounding SWS would need to dissipate a maximum of 4.72×10^{8} Btu per hour, about 32 times less than the CWS. Therefore, the review team only considered alternative heat dissipation systems and water treatment systems for the CWS. The review team considered alternative water sources for both CWS and SWS because the cooling water withdrawal of both systems has the potential to affect the environment.

The CWS for a new nuclear power plant at the PSEG Site as described by PSEG in the ER (PSEG 2015-TN4280) would be a closed-loop system composed of wet cooling towers, water pumps, and cooling tower basins. The water lost as evaporation and drift from CWS and SWS cooling towers and as blowdown from CWS and SWS cooling tower basins would be replenished by makeup water withdrawn from the Delaware River via a new intake structure. CWS and SWS are discussed in Section 3.2.

9.4.1 Heat Dissipation Systems

Waste heat, about two-thirds of a commercial nuclear reactor’s thermal generation, is rejected to the environment via latent heat exchange (e.g., by evaporating water) or sensible heat exchange (e.g., via warmer air or water). Sections 4.2 and 5.2 describe the impacts of the wet, closed-loop cooling towers proposed and described by PSEG in the ER (PSEG 2015-TN4280). The following sections describe alternative heat dissipation systems considered by the review team for the PSEG Site.

Because the final reactor design has not been chosen at this stage, several options exist for the closed-loop heat dissipation system for the PSEG Site, including wet MDCTs, NDCTs, and fan-assisted NDCTs. The review team has not compared these three designs to each other because PSEG has not yet selected a specific design. One of the designs would be chosen by

PSEG if, at some time in the future, it requests authorization from the NRC (e.g., a combined license) to construct and operate a new nuclear plant. The review team would compare the chosen design to the other two designs at that time. The makeup water for the closed-cycle heat dissipation system would be withdrawn from the Delaware River via the new intake system.

9.4.1.1 Plant Cooling System − Once-Through Operation

A once-through heat dissipation system withdraws water from a water source, circulates the water through the condenser where heat exchange warms the circulating water, and discharges virtually the same amount of water back to the water source. Typically, the withdrawal point (the intake system) and the discharge point (the discharge system) are separated by sufficient distance to prevent recirculation of the discharge warm water back to the intake and loss of efficiency. For the PSEG Site, the Delaware River would be the source of cooling water. There is no consumptive loss in a once-through heat dissipation system; however, the elevated temperature of the discharge would result in induced evaporative loss from the water source. Once-through systems typically require a large amount of circulating water and, therefore, have the potential for hydrologic alterations to the water source and may cause higher levels of impingement and entrainment of aquatic organisms. A once-through cooling system for a 2,200-MW(e) nuclear power plant at the PSEG Site would require a circulating water flow of 1.7 to 2.1 million gpm.

The review team has determined, based on a review of EPA 316(b) Phase I regulations (EPA 2001-TN2384), that a once-through cooling system for new nuclear reactors is not likely to be permitted in the future except in rare situations. The review team also has determined a once-through heat dissipation system for the PSEG Site would not be environmentally preferable to the proposed system because of the impacts (1) from building large intake and discharge structures, (2) from requiring large amounts of water to be withdrawn, and (3) to the aquatic ecosystem caused by potential impingement and entrainment.

9.4.1.2 Cooling Ponds and Spray Ponds

A heat dissipation system using cooling ponds circulates water in a human-made pond where waste heat is transferred to the atmosphere primarily via evaporation and, to a limited extent, through radiation and conduction. Spray ponds are cooling ponds that use sprays to augment evaporative cooling by providing greater contact area with air over the pond. Because of the spraying of cooling water into the air, the area required can be substantially smaller than a cooling pond that does not use sprays. Generally, cooling ponds and spray ponds are closed-cycle systems isolated from natural water bodies; they require makeup water from an external source and occasionally discharge water to a receiving water body to control concentration of dissolved solids. The makeup water source is not the heat sink for these designs.

While cooling ponds and spray ponds would avoid the building and operating expense of cooling towers, they would require substantial land area. Because of this land-use requirement, the review team determined a heat dissipation system using cooling ponds or spray ponds would not be environmentally preferable to a closed-loop heat dissipation system for the PSEG Site.

9.4.1.3 Dry Cooling Towers

A heat dissipation system using dry cooling towers directly rejects waste heat to the atmosphere without using water for evaporative cooling. Waste heat is transferred to the air using conduction and convection; therefore, the heat exchange depends on the temperature of the ambient air and thermal properties of the piping within the cooling tower. NDCTs or MDCTs can be used for dry cooling. The most common dry cooling tower cools the steam from turbine exhaust by piping it through large ducts to an air-cooled condenser located next to the turbine building. Air is blown over the cooling coils to cool the steam and condense it to water, which is returned for recirculation.

Dry cooling towers would reduce or eliminate water-related impacts of the heat dissipation system because no makeup water or blowdown discharge would be required. However, dry cooling systems typically require much larger cooling systems, result in some loss of steam turbine efficiency because the approach temperature is limited by the dry-bulb temperature rather than the lower wet-bulb temperature, and result in parasitic energy drain if a large array of fans is used for forced draft in dry MDCTs. Because the review team has determined in Sections 4.2 and 5.2 that water-use impacts from construction and operation of a wet closed-loop heat dissipation system would be SMALL, and even though a dry cooling system would eliminate water-use impacts, a dry cooling system is not environmentally preferable to the proposed system.

9.4.1.4 Combination Wet-Dry Cooling Tower System

A heat dissipation system using a combination wet-dry cooling tower system uses cooling towers that have both a wet and a dry section. Depending on ambient air temperature and relative humidity, the wet-dry cooling tower system could be run in fully wet or fully dry mode. Consumptive water use is maximized when the system is running in fully wet mode and is minimized or eliminated when operating in fully dry mode. The reduction in consumptive water use and blowdown depend on the duration for which the dry mode is active. As with the dry cooling towers, the dry portion of the cooling system is not as efficient as the wet portion and requires parasitic energy to move large amounts of cooling air through the heat exchangers. Because the wet-dry cooling tower has a dry section, land-use requirements are increased.

Because the review team has determined in Chapters 4 and 5 that water-use impacts from construction and operation of a wet closed-loop heat dissipation system would be SMALL, and even though a wet-dry cooling system would reduce water-use impacts, a wet-dry cooling system is not environmentally preferable to the proposed system.

9.4.2 Circulating Water System Alternatives

The review team evaluated alternatives to the proposed intake and discharge systems for the proposed cooling system. In this evaluation, the review team used the water requirements of the heat dissipation system, which define the capacity requirements of the intake and discharge systems. Because the final reactor design has not been chosen at this stage, several options exist for the closed-loop heat dissipation system for the PSEG Site, including wet MDCTs, NDCTs, and fan-assisted NDCTs. The makeup water for the closed-cycle heat dissipation

system would be withdrawn from the Delaware River via a new intake system, and the blowdown from the cooling tower basins would be discharged to the Delaware River via a new discharge system. The review team evaluated alternative water supply sources for the normal heat sink.

9.4.2.1 Intake Alternatives

The proposed intake system is described in Section 3.2.2.2 and would consist of a 110-ft by 200-ft intake structure on the Delaware River with a bar rack and trash rake to prevent debris from entering the structure and a traveling screen to keep smaller debris and fish out of the intake bays. As stated in Sections 4.2 and 5.2, the impacts from construction and operation of the intake system on water use and water quality of the resource would be SMALL; however, the review team considered alternatives to the proposed intake system including a radial collector well system, an intake pipe, an intake canal, and modifications to the existing HCGS service water intake system.

Radial Collector Wells

The review team considered a radial collector well system as an intake alternative because such an intake system reduces the impacts on aquatic resources by reducing or eliminating impingement and entrainment of aquatic organisms. A radial collector well system also can reduce water treatment requirements when the water source is turbid.

A radial collector well system is composed of a central shaft that acts as the collector and has lateral well screens that project radially from the central shaft. The lateral well screens typically extend below a surface-water source and slowly withdraw surface water through substrate sediments, thereby filtering out some of the suspended sediment present in the surface water. The soil properties along the shoreline of the Delaware River on the Artificial Island would support a well production capacity of about 3,500 gpm. Because the makeup water withdrawal for the proposed heat dissipation system is an average of 78,196 gpm with a maximum of 80,600 gpm, the review team determined 23 wells would be needed to withdraw the required makeup water from the Delaware River.

Spacing between the collector wells is determined by several factors, including consideration of limiting drawdown in individual wells. In general, spacing between collector wells could be 1,500 ft or more. With a 1,500-ft spacing, installation of 23 wells would require a shoreline length of more than 6 mi. The Delaware River shoreline along the Artificial Island, including the built-up areas of SGS and HCGS, is less than 4 mi. Building the radial collector well system would affect 23 locations along the shoreline. The radial collector arms of the collector wells can get plugged with sediment over time and require backflushing.

The cooling system for the PSEG Site also could require a safety-related intake, which would need to be highly reliable and continuously operational. Because of limited availability of shoreline to install the radial collector well system, the high reliability requirement of a safety-related intake, a potential for substantial building impacts at multiple well locations along the Delaware River shoreline, and the impacts of construction and operation of a new intake system

being SMALL (see Sections 4.2 and 5.2), the review team has determined that a radial collector well system would not be environmentally preferable to the proposed intake system.

Intake Pipe

The review team considered an intake pipe that would connect the forebay of the intake structure to the intake point located a significant distance offshore in deeper waters because such an intake system has the potential to reduce the impacts on aquatic organisms by placing the intake point in less productive habitat.

The intake pipe connecting the forebay of the intake structure to the intake point would be a reinforced concrete pipe placed on a crushed stone bedding in a dredged area along the pipe in the Delaware River. The pipe would also be protected with riprap or armoring. The pipe would be designed to balance flow velocities to minimize sediment deposition within the pipe, which requires a relatively higher flow, and to minimize impacts to aquatic life, which requires lower flows. The pipe would be designed with a velocity cap or an array of wedge wire screens. Two coal-fired plants along the Delaware River use intake pipes with wedge wire screens, but these systems are located in deeper waters in a freshwater portion near the transition zone. Some power plant cooling water intakes use wedge wire screens effectively, but no power plants with intake flows exceeding 100 Mgd have installed these screens (EPA 2001-TN2384). The makeup water withdrawal for the proposed heat dissipation system is an average of 78,196 gpm (about 113 Mgd) with a maximum of 80,600 gpm (about 116 Mgd). Near the PSEG Site, where the Delaware River flow is dominated by tidal fluctuations and biofouling is a significant concern, frequent cleaning of wedge wire screens may become necessary (EPA 2001-TN2384). Therefore, the review team determined that an intake pipe with a velocity cap may be preferable to one with wedge wire screens.

The intake pipe would require dredging of the Delaware River and building activity along the pipe that may affect aquatic resources. There is no significant difference between the impacts on aquatic resources during operations of the intake pipe and those of the proposed intake system because both would be equipped with measures protective of aquatic organisms. Because the impacts of construction and operation of the proposed intake system would be SMALL (see Sections 4.2 and 5.2) and the intake pipe would not result in any significant difference compared to the proposed intake system, the review team determined an intake pipe would not be environmentally preferable to the proposed intake system.

Intake Canal

The review team considered an intake canal connected to the Delaware River on which an intake structure could be located. The intake structure would still be required to meet the regulatory requirements of the CWA 316(b) rule for protection of aquatic resources. The intake canal would result in greater land use and could also result in favorable habitat conditions for aquatic life over time. Therefore, the review team determined an intake canal would not provide significant advantages compared to the proposed intake system, and because the impacts of construction and operation of the proposed intake system would be SMALL (see Sections 4.2 and 5.2), an intake canal would not be environmentally preferable to the proposed intake system.

Hope Creek Service Water Intake System

The review team considered modifications to the existing HCGS service water intake system (SWIS) as an alternative to the proposed intake system because the SWIS has empty bays that were intended for the use of the cancelled HCGS Unit 2, and using this existing facility, if feasible, would reduce impacts from construction of a new intake system.

There are two empty bays in the HCGS SWIS. A new nuclear power plant at the PSEG Site would require up to 80,600 gpm of water withdrawal from the Delaware River. To withdraw the required water using the two existing empty bays, the through-screen velocity would exceed the CWA 316(b) requirement of 0.5 fps. It may be feasible to expand the HCGS SWIS, but the related activities may interfere with operation of HCGS. New intake piping from HCGS SWIS would need to be routed to the PSEG Site and may interfere with HCGS facilities.

Because the HCGS SWIS would need to be expanded to meet the CWA 316(b) requirements, the review team concluded this alternative to the proposed intake structure would not result in substantial reduction of impacts from construction and, therefore, this alternative would not be environmentally preferable to the proposed intake system.

9.4.2.2 Discharge Alternatives

The discharge system is described in Chapter 3. As stated in Chapters 4 and 5, the impacts from construction and operation of the proposed discharge system on the environment would be SMALL; however, the review team considered alternatives to the proposed discharge system including design modifications to the proposed system and alternative locations for the discharge pipeline.

Because the impacts from operation of the proposed discharge system on the environment would be SMALL (see Section 5.2), design modifications such as multi-port diffusors, controlled velocity of discharge, and deeper location of the discharge points would not result in significant reduction in impacts on the environment. Therefore, the review team determined the alternative design modifications would not be environmentally preferable to the proposed design.

Alternative locations for the discharge pipeline on the PSEG Site south of the proposed location of the discharge pipeline are limited because of built-up areas of SGS and HCGS. An alternative location is possible east of the SGS circulating water intake structure (CWIS). However, the discharge pipeline from the PSEG Site would need to be routed to this location, increasing land use and potential for interference with the SGS and HCGS facilities. The Delaware River is shallow at this location, limiting efficient mixing of the discharge effluent with the waters of the river. The discharge pipeline would have to be routed into the deeper portion of the Delaware River. For these reasons, the review team determined an alternative discharge location east of the SGS CWIS would not result in significant reduction in impacts to the environment and, therefore, would not be environmentally preferable.

Another alternative location for the discharge pipeline would be north of the proposed location and potentially as far north as the tip of Artificial Island. However, because the pipeline would need to be longer to reach the shoreline and would also need to be routed out in the Delaware River to deeper waters to promote efficient mixing, the construction impacts would be greater

than those for a discharge pipeline at the proposed location. Therefore, the review team determined an alternative discharge location north of the proposed location would not result in significant reduction in impacts to the environment and, therefore, would not be environmentally preferable.

9.4.2.3 Water Supplies

The proposed source of makeup water to the PSEG Site CWS and SWS is the Delaware River. Makeup water would be withdrawn using a new shoreline intake structure. Because the Delaware River water quality near the PSEG Site is influenced by tidal action, the makeup water withdrawn would be brackish.

The makeup water withdrawal for the proposed heat dissipation system would be an average of 78,196 gpm, with a maximum of 80,600 gpm. The mean annual discharge at Trenton, New Jersey, is 12,004 cfs, and the mean tidal discharge near the PSEG Site is estimated to be 400,000 to 472,000 cfs (PSEG 2015-TN4280). No surface water would be used during building of the PSEG Site, and therefore, the review team determined there would be no impact to the surface-water resource from building activities (see Section 4.2). The review team also determined that the surface-water use to support the operations of the PSEG Site would not result in a noticeable impact to the surface-water resource (see Section 5.2).

Even though the impact on the surface-water resource from the building and operation of the PSEG Site would be SMALL as stated in Sections 4.2 and 5.2, the review team considered alternatives to the makeup water supply to be withdrawn from the Delaware River. The review team considered alternative water supplies from groundwater, surface waters from streams and rivers other than the Delaware River, and municipal wastewater from nearby communities. The review team's evaluation of these alternative water supply sources is described below.

Groundwater

As stated above, the makeup water requirements for the PSEG Site would be an average of 78,196 gpm and a maximum of 80,600 gpm. A groundwater source would need to support a sustained yield of 78,196 gpm and a short-term maximum yield of 80,600 gpm to be a viable alternative to the proposed water supply.

The New Jersey Coastal Plain aquifer is designated a sole-source aquifer by EPA (2010-TN2385). The PSEG Site is located within the New Jersey Coastal Plain aquifer but is not subject to groundwater withdrawal limitations of the two Critical Water Supply Management Areas identified by the State of New Jersey. Several hydrogeologic units underlie the PSEG Site, including the Wenonah-Mount Laurel Formation and the PRM aquifer system. During building of the PSEG Site, groundwater would be withdrawn from four production wells finished in the PRM aquifer system, with two backup wells finished in the Wenonah-Mount Laurel aquifer. The groundwater withdrawal during building activities would be 119 gpm. Groundwater would be withdrawn from the PRM aquifer system to support demineralized makeup water and sanitary and potable water uses for the PSEG Site during operations. The groundwater withdrawal during operations would average 210 gpm with a short-term maximum of 953 gpm.

The total combined amount of water required during operation would be about 78,196 gpm. Groundwater could not be relied upon to provide this quantity of water on a sustained basis

without impacting the availability and quality of the groundwater resources in the area. For the period 1978–2003, the reported average groundwater pumping from the Wenonah-Mount Laurel aquifer through the entire PRM aquifer system of the Coastal Plain within the southern counties of New Jersey ranged from 106.1 to 161.7 Mgd (dePaul et al. 2009-TN2948). As discussed in Section 2.3, current groundwater use from these aquifers has been restricted by the State due to drawdown of water levels and increases in salinity caused by induced flow from the Delaware River and more saline portions of the aquifers. Obtaining all water required for site operations from groundwater would nearly double the total water use from these aquifers in southern New Jersey. This would create even greater issues related to drawdown and reduction of water quality and is very unlikely to be permitted by the State of New Jersey.

Surface Water from Streams and Rivers Other than the Delaware River

The review team considered streams and rivers near the PSEG Site as a potential source of surface water for makeup water needs at the PSEG Site. As stated above, this alternative water supply source would need to support an average withdrawal of 78,196 gpm and a short-term maximum withdrawal of 80,600 gpm to be viable.

There are several creeks and coastal streams near the PSEG Site, but most have minor streamflows. There are no USGS streamflow gages on Mill Creek, Alloway Creek, Hope Creek, Fishing Creek, and Mad Horse Creek, and therefore, no quantitative assessment regarding their suitability can be made. The Salem River, located northeast of the PSEG Site, does have a streamflow gage. Streamflow measurements between 1943 and 2011 at the Salem River USGS gage at Woodstown, New Jersey, show that annual streamflow varies from 5.7 to 34.9 cfs (2,558 to 15,664 gpm) with a mean annual flow of 20 cfs (8,977 gpm). Because the makeup water requirement of the PSEG Site far exceeds the mean annual flow of Salem River, the review team concluded that surface water from streams and rivers other than the Delaware River would not be a viable alternative.

Municipal Wastewater

The review considered municipal wastewater that could be reused to provide makeup water to the CWS and SWS at the PSEG Site. As stated above, this alternative water supply source would need to support an average withdrawal of 78,196 gpm and a short-term maximum withdrawal of 80,600 gpm to be viable.

According to USGS, water withdrawals in Salem County, New Jersey, in 2005 were 27.3 Mgd (18,951 gpm) from both freshwater and groundwater sources (USGS 2013-TN2387). Although the USGS assessment is titled *Estimated Water Use in the United States in 2005,* the report contains estimated water withdrawals by category, not consumptive water use (Kenny et al. 2009-TN2386; USGS 2013-TN2387). The corresponding water withdrawals for neighboring Gloucester and Cumberland Counties were 75 and 58.1 Mgd (52,090 and 40,333 gpm), respectively. Because these are water withdrawals, significant portions of these withdrawals are consumptively used, and the remaining are available as municipal or industrial wastewater or irrigation return flows. The combined water withdrawal for the three counties in 2005 was about 111,374 gpm, and therefore, nearly 70 percent of this withdrawal would need to be available as wastewater and return flows to make water reuse viable for the makeup water requirements of the PSEG Site. Because the consumptive fraction of water withdrawn can be

high for potable, irrigation, and power-generation use, return flows from these uses would be relatively small, and consequently a return flow fraction of 70 percent is unlikely. Therefore, it is reasonable to conclude the three counties combined would not be able to supply adequate return water for reuse at the PSEG Site. Moreover, the location of these wastewater and return flows would be scattered over the geographical area of the three counties and, therefore, would need to be aggregated and conveyed to the PSEG Site, which would result in additional land-use and environmental impacts. Therefore, the review team concluded that municipal wastewater is not a viable or environmentally preferable alternative to the proposed makeup water source for the PSEG Site.

9.4.2.4 Water Treatment

As described in Section 3.2.1.2, the hard and brackish surface water withdrawn from the Delaware River for the CWS and SWS makeup water needs of the PSEG Site would be treated. The CWS makeup water would be treated with sulfuric acid to control calcite scale formation and would be chlorinated to control microbial growth. The SWS makeup water would be clarified using polyelectrolytes and treated with sulfuric acid and sodium hypochlorite to control scaling and biofouling, respectively. Before discharge, the CWS and SWS blowdown would be treated with sodium bisulfite or equivalent to control residual chlorine. Plant makeup water for the potable and sanitary water system, demineralized water distribution system, fire protection system, and other miscellaneous uses would be withdrawn from the aquifer and would not be treated except for chlorination for the potable and sanitary water system. Makeup water for the demineralized water distribution system would use a demineralizer system such as reverse osmosis.

The review team did not identify any other environmentally preferable alternative to the proposed chemicals to be used. The effluents from cooling tower blowdown are specifically regulated by EPA under 40 CFR Part 423 (TN253).

9.4.3 Summary

The review team considered alternative system designs that included evaluation of four alternatives to the proposed heat dissipation system, as well as alternatives to the proposed intake system, the proposed discharge system, the proposed water supply, and the proposed water treatment system. As described above, the review team did not identify any alternatives to the proposed plant system designs that would be environmentally preferable.

10.0 CONCLUSIONS AND RECOMMENDATIONS

This chapter provides a discussion of the conclusions reached in earlier parts of this environmental impact statement (EIS), as well as U.S. Nuclear Regulatory Commission (NRC) staff recommendations. Section 10.1 summarizes the impacts of the proposed action, Section 10.2 discusses the unavoidable adverse impacts of the proposed action and summarizes those impacts in accompanying tables, and Section 10.3 discusses the relationship between the short-term use of resources and the long-term productivity of the human environment. Section 10.4 summarizes the irretrievable and irreversible use of resources, and Section 10.5 summarizes the alternatives to the proposed action. Section 10.6 discusses benefits and costs, and Section 10.7 presents the NRC staff recommendation.

The NRC received an application from PSEG Power, LLC, and PSEG Nuclear, LLC (PSEG), for an early site permit (ESP) for a site to be located adjacent to the existing Hope Creek Generating Station (HCGS) and Salem Generating Station (SGS) in Lower Alloways Creek Township, Salem County, New Jersey. The proposed PSEG Site is located on the southern part of Artificial Island on the east bank of the Delaware River, about 15 mi south of the Delaware Memorial Bridge; 18 mi south of Wilmington, Delaware; 30 mi southwest of Philadelphia, Pennsylvania; and 7.5 mi southwest of Salem, New Jersey. The ESP does not authorize construction or operation of a nuclear power plant and therefore these impacts will not occur without subsequent authorization. The ESP resolves certain issues associated with siting a nuclear plant. To resolve environmental issues at the ESP stage, the NRC analyzes the impacts as if a nuclear plant were to be built and operated.

As part of the permitting process for the use of the proposed PSEG Site, PSEG plans to submit an application to the U.S. Army Corps of Engineers (USACE) Philadelphia District and the New Jersey Department of Environmental Protection (NJDEP) for activities associated with the alteration of any floodplain, waterway, tidal wetland, or nontidal wetland in New Jersey.

The proposed actions related to the PSEG application are (1) the NRC issuance of an ESP for the PSEG Site and (2) the USACE issuance of a permit to perform certain construction activities on the site pursuant to Section 404 of the Federal Water Pollution Control Act (also referred to as the Clean Water Act [CWA]) (33 USC 1251 et seq. -TN662), and Section 10 of the Rivers and Harbors Appropriation Act of 1899 (33 USC 403 et seq. -TN660).

If issued, the Department of the Army (DA) permit would authorize the impact on waters of the United States, including wetlands, from various regulated activities associated with the project. The permit would include special conditions to the effect that PSEG must confirm that any wetland compensation efforts have achieved their established goals and requirements in accordance with "Compensatory Mitigation for Losses of Aquatic Resources;" Final Rule (73 FR 19594-TN1789]; Title 33 of the *Code of Federal Regulations* [CFR] Parts 325 [TN425] and 332 [TN1472]).

The USACE approach is that compensation may only be used after all appropriate and practical steps to avoid and minimize adverse impacts to aquatic resources, including wetlands and

streams, have been taken. The DA permit would be conditioned upon PSEG completing all necessary mitigation and compensation and assuming responsibility for continued success.

Section 102 of the National Environmental Policy Act of 1969, as amended (NEPA, 42 USC 4321 et seq. -TN661), directs that an EIS is required for major Federal actions that significantly affect the quality of the human environment. Section 102(2)(C) of NEPA requires that an EIS include information about the following:

- the environmental impacts of the proposed action,
- any adverse environmental effects that cannot be avoided should the proposal be implemented,
- alternatives to the proposed action,
- the relationship between local short-term uses of the environment and the maintenance and enhancement of long-term productivity, and
- any irreversible and irretrievable commitments of resources that would be involved if the proposed action were implemented.

The NRC has set forth regulations for implementing NEPA (42 USC 4321 et seq. -TN661) in 10 CFR Part 51 (TN250). Subpart A of 10 CFR Part 52 (TN251) contains the NRC regulations related to ESPs. As set forth in 10 CFR 51.18 (TN250), the Commission determined that the issuance of an ESP is an action that requires an EIS.

The environmental review described in this EIS was conducted by a joint NRC-USACE team. The review team consisted of the NRC staff; the NRC contractor staff at Oak Ridge National Laboratory, Argonne National Laboratory, Brookhaven National Laboratory, and Pacific Northwest National Laboratory; and the USACE staff. Included in this EIS are (1) the results of the review team preliminary analyses, which consider and weigh the environmental effects of the proposed actions; (2) the mitigation measures for reducing or avoiding adverse effects; (3) the environmental impacts of alternatives to the proposed action; and (4) the NRC staff preliminary recommendation regarding the proposed action based on its environmental review.

During the course of preparing this EIS, the review team reviewed the PSEG Environmental Report (ER; PSEG 2015-TN4280), the PSEG Site Safety Analysis Report (PSEG 2015-TN4283), and supplemental documentation from PSEG in response to requests from the NRC and USACE staffs for additional information. The review team consulted with Federal, State, Tribal, and local agencies and followed the guidance set forth in Regulatory Guide 4.2, Revision 2 (NRC 1976-TN89), in NUREG–1555, *Environmental Standard Review* Plan—Standard *Review Plans for Environmental Reviews for Nuclear Power Plants* (NRC 2000-TN614), and in NUREG–0800, *Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants* (NRC 2007-TN613). The review team also followed guidance provided in *Interim Staff Guidance on Environmental Issues Associated with New Reactors* (NRC 2014-TN3767).

The NRC staff also considered the public comments related to the environmental review received during the scoping process. These comments are provided in Appendix D of this EIS.

The USACE role as a cooperating agency in the preparation of this EIS is to ensure to the maximum extent practicable that the information presented is adequate to fulfill the requirements of the USACE regulations. Section 404(b)(1) of the CWA, “Guidelines for Specification of Disposal Sites for Dredged or Fill Material” (40 CFR Part 230-TN427), contains the substantive environmental criteria used by the USACE in evaluating discharges of dredged or fill material into waters of the United States. Although the USACE, as part of the review team, concurs with the designation of impact levels for terrestrial and aquatic resources, insofar as waters of the United States are concerned, the USACE must conduct a quantitative comparison of impacts on waters of the United States as part of the 404(b)(1) evaluation. In addition, the USACE regulations (33 CFR 320.4 [TN424]) direct the USACE to conduct a public interest review (PIR) that requires consideration of a number of factors as part of a balanced evaluation process. The USACE PIR and 404(b)(1) evaluation will be part of the USACE permit decision document, and such factors may not be fully addressed in this EIS. The USACE independent regulatory permit decision documentation will reference relevant analyses from the EIS and, as necessary, include a supplemental PIR, CWA 404(b)(1) evaluation, evaluation of cumulative impacts, compensatory mitigation plan that is in accordance with 33 CFR Part 332 (TN1472), “Compensatory Mitigation for Losses of Aquatic Resources,” and other information and evaluations that may be outside the NRC scope of analysis and not included in this EIS but are required by the USACE to support the USACE permit decision. The USACE permit decision will be made following issuance of the final EIS.

Environmental issues are evaluated in this EIS using the three-level standard of significance—SMALL, MODERATE, or LARGE—developed by the NRC using guidelines from the Council on Environmental Quality (CEQ) (40 CFR 1508.27 [TN428]). Table B-1 of 10 CFR Part 51, Subpart A, Appendix B (TN250), provides the following definitions of the three significance levels:

> 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.

Mitigation measures were considered for each environmental issue and are discussed in the appropriate sections. During the environmental review, the review team considered planned activities and actions that PSEG indicates it and others would likely take should PSEG receive the requested ESP. In addition, PSEG provided estimates of the environmental impacts resulting from the building and operation of a new nuclear power plant at the proposed PSEG Site.

10.1 Impacts of the Proposed Action

In a final rule dated October 9, 2007 (72 FR 57416-TN260), the Commission limited the definition of “construction” to those activities that fall within its regulatory authority in

10 CFR 51.4 (TN250). Many of the activities required to build a nuclear power plant are not part of the NRC action to license the plant. Activities associated with building the plant that are not within the purview of the NRC action are grouped under the term "preconstruction." Preconstruction activities include clearing and grading, excavating, erection of support buildings and transmission lines, and other associated activities. Because the preconstruction activities are not part of the NRC action, their impacts are not reviewed as a direct effect of the NRC action. Rather, the impacts of the preconstruction activities are considered in the context of cumulative impacts. In addition, certain activities defined as preconstruction by the NRC require authorization from the USACE and other Federal, State, and local agencies.

Chapter 4 of this EIS describes the relative magnitude of the impacts of preconstruction and construction activities associated with building a new nuclear power plant at the PSEG Site, and a summary of those impacts is given in Section 4.12, Table 4-22. Impacts associated with operating a new nuclear power plant at the PSEG Site are discussed in Chapter 5, and are summarized in Section 5.13, Table 5-33. Chapter 6 describes the impacts associated with the fuel cycle, transportation, and decommissioning. Chapter 7 describes the cumulative impacts associated with preconstruction and construction activities and operation of a new nuclear power plant at the PSEG Site when considered along with other past, present, and reasonably foreseeable future projects in the geographic region around the site. Chapter 9 includes the review team review of alternative sites and alternative power generation systems.

10.2 Unavoidable Adverse Environmental Impacts

NEPA Section 102(2)(C)(ii) (42 USC 4321 et seq. -TN661) requires that an EIS include information on any adverse environmental effects that cannot be avoided should the proposal be implemented. Unavoidable adverse environmental impacts are those potential impacts of the NRC action and the USACE action that cannot be avoided and for which no practical means of mitigation are available.

10.2.1 Unavoidable Adverse Impacts during Construction and Preconstruction

Chapter 4 discusses in detail the potential impacts from construction and preconstruction of a new nuclear power plant at the PSEG Site and presents mitigation and controls intended to lessen the adverse impacts. Table 10-1 presents the unavoidable adverse impacts associated with construction and preconstruction activities to each of the resource areas evaluated in this EIS and the mitigation measures that would reduce the impacts. Those impacts remaining after mitigation is applied (e.g., avoidance and minimization, but not compensatory mitigation) are identified in Table 10-1 as the unavoidable adverse impacts. Unavoidable adverse impacts are the result of both construction and preconstruction activities unless otherwise noted. The impact determinations in Table 10-1 are for the combined impacts of construction and preconstruction.

Table 10-1. Unavoidable Adverse Environmental Impacts During Construction and Preconstruction

Resource Area	Adverse Impacts	Actions to Mitigate Impacts	Unavoidable Adverse Impacts
Land Use	MODERATE	Minimize land disturbance and comply with requirements of applicable Federal, State, and local permits, regulations, and zoning.	About 430 ac on and adjacent to the site would be committed to the project throughout preconstruction and construction, of which 205 ac would be available for use after construction is complete. About 69 ac off the site would be committed during preconstruction for the causeway, of which 23.5 ac would be available for use after the causeway is built
Water Use	SMALL	Obtain a Clean Water Act (33 USC 1251 et seq. -TN662) Section 401 certification before site preparation activities. Comply with Federal and State regulations and permits.	Small amounts of surface water from stormwater retention ponds would be used for dust suppression during building of the new nuclear power plant. Groundwater would be obtained under the existing water-use permit for the Hope Creek and Salem Generating Stations (HCGS and SGS). Temporary and localized groundwater impacts would result from dewatering for power block construction and preconstruction and construction support (including concrete batch plant supply and dust suppression)
Water Quality	SMALL	Implement best management practices (BMPs) and a site-specific Stormwater Pollution Prevention Plan (SWPPP). Comply with Federal and State regulations and permits.	Surface-water quality would be affected by clearing vegetation, disturbing the land surface, inadvertent release of contaminants associated with building materials and equipment, building activities in the tidal marsh and tidal stream areas, and dredging activities in the Delaware River. Temporary and localized groundwater-quality impacts would result from dewatering for power block construction and discharge of groundwater to adjacent surface-water bodies

Table 10-1. (continued)

Resource Area	Adverse Impacts	Actions to Mitigate Impacts	Unavoidable Adverse Impacts
Ecological Impacts			
—Terrestrial and Wetland Resources	MODERATE	Minimize land disturbance, implement BMPs, and comply with requirements of applicable Federal and State permits and regulations. Revegetate temporarily disturbed areas. Any conditions required by the USACE, such as compensatory mitigation, would be addressed in the USACE permit, if issued. Mitigation may only be used after all appropriate and practical steps to avoid and minimize adverse impacts to aquatic resources, including wetlands and streams, have been taken. All remaining unavoidable impacts must be compensated to the extent appropriate and practicable. Onsite, in-kind mitigation such as wetland creation and enhancement would be used.	Construction and preconstruction would disturb 430 ac on and adjacent to the site and 69 ac along the proposed causeway. About 225 ac on the site would be permanently disturbed, and 205 ac on and adjacent to the site would be temporarily disturbed. Permanent disturbance on the site would include 108 ac of wetland habitat and 9 ac of old field and brush/shrubland habitat. Temporary disturbance on the site would include 80 ac of old field and *Phragmites*-dominated old field habitat and 32 ac of wetland habitat. Temporary disturbance adjacent to the site would include 30.2 ac of wetland habitat. Preconstruction would disturb 69.0 ac along the proposed causeway; of this, 45.5 ac would be permanently disturbed and 23.5 ac would be temporarily disturbed. Permanent disturbance would include 23 ac of wetland habitat and 3.5 ac of forestland habitat. Temporary disturbance would include 19.6 ac of wetland habitat
—Aquatic Resources	SMALL	Minimize marsh creek and Delaware River Estuary bottom disturbance and dredging, implement BMPs, and comply with requirements of applicable Federal and State permits and regulations.	Physical alteration of habitat (e.g., infilling, dredging, pile driving), including temporary or permanent removal of associated benthic organisms, sedimentation, changes in hydrological regimes, and changes in water quality. Aquatic habitats affected would include desilt basins (artificial lakes) and small marsh creeks, habitats associated with the Delaware River Estuary, and the interconnected system of tidal wetlands and marsh creeks primarily north of the PSEG Site.

Table 10-1. (continued)

Resource Area	Adverse Impacts	Actions to Mitigate Impacts	Unavoidable Adverse Impacts
Socioeconomic Impacts			
—Physical	SMALL (most) to MODERATE (aesthetics)	Implement standard noise-control measures for construction equipment and limit the types of construction activities during nighttime and weekend hours. Control fugitive dust through watering. Control vehicle emissions through regularly scheduled maintenance. Follow local ordinances that require mitigation of road degradation.	Minor physical impacts associated with increased noise, air pollution emissions, and vehicle traffic. Building two new cooling towers and two new reactor domes at the PSEG Site and an elevated causeway to the PSEG Site would noticeably affect aesthetic qualities from sensitive viewpoints.
—Demography	SMALL	None	The in-migration of workers and their families to support building the new nuclear power plant would increase the population of the economic impact area by about 0.16 percent. The increase would be most pronounced in Salem County, New Jersey, which would experience about a 1.24 percent increase in population.
—Economic and Tax	SMALL (beneficial) to MODERATE (beneficial)	None	None
—Infrastructure and Community Services	SMALL (most) to MODERATE (traffic and recreation)	Incorporate traffic impact analysis recommendations discussed in Section 4.4.4.1	Increase in local traffic during building resulting in increased congestion. Aesthetic impacts near recreational resources, specifically on the Delaware River and PSEG Estuary Enhancement Program viewing platforms, would not be amenable to mitigation for the increased industrialization at the PSEG Site.

Table 10-1. (continued)

Resource Area	Adverse Impacts	Actions to Mitigate Impacts	Unavoidable Adverse Impacts
Environmental Justice	No disproportionately high and adverse impacts	None	None
Historic and Cultural	SMALL to MODERATE	Inadvertent discovery procedures are in place to minimize impacts to potential historic and cultural resources. The USACE consultations with the New Jersey State Historic Preservation Office and Native American tribes are ongoing.	No unavoidable adverse impacts to historic and cultural resources are anticipated on Artificial Island. An adverse visual effect to historic properties in New Jersey could occur if natural draft cooling towers are constructed.
Air Quality	SMALL	Implement emission-specific strategies and measures to ensure compliance with the applicable regulatory limits defined by the National Primary and Secondary Ambient Air Quality Standards and the National Emission Standards for Hazardous Air Pollutants. Also, implement a dust control program and require contractors, vendors, and subcontractors to adhere to appropriate Federal and State regulations governing construction activities and construction vehicle emissions.	Fugitive dust and emissions of criteria pollutants, hazardous air pollutants, and greenhouse gases from land-disturbing and building activities and equipment and from additional vehicle traffic, but impacts would be temporary
Nonradiological Health	SMALL	Comply with Federal, State, and local regulations governing construction activities and construction vehicle emissions; comply with Federal and local noise-control ordinances; comply	Fugitive dust, occupational injuries, noise, and the transport of materials and personnel to the site

Table 10-1. (continued)

Resource Area	Adverse Impacts	Actions to Mitigate Impacts	Unavoidable Adverse Impacts
		with Federal and State occupational safety and health regulations. Use causeway for construction traffic; implement traffic management plan; implement proposed improvements to roads and install traffic signals to improve traffic patterns.	
Radiological Health	SMALL	Maintain doses to construction workers below the NRC public dose limits	Radiological doses to the public and to construction workers at the PSEG Site from the adjacent SGS and HCGS would be below the NRC public dose limits.
Nonradiological Wastes	SMALL	Manage wastes according to existing practices currently used at HCGS and SGS and in compliance with Federal, State, and county regulations. Implement SWPPP to manage stormwater runoff	Solid, liquid, and gaseous wastes would be generated when building the new nuclear power plant at the PSEG Site. Increased consumption of landfill space for disposition of wastes

The unavoidable adverse environmental impacts identified in Table 10-1 are primarily attributable to preconstruction activities involving the initial land disturbance from clearing the site; excavation; filling areas of wetlands, intermittent streams, and waterways; dredging; adding impervious surfaces; and building the proposed causeway and pipeline corridors.

Construction and preconstruction activities would result in unavoidable adverse impacts to land use because they would disturb up to 430 ac on and adjacent to the 819-ac PSEG Site. Of this 430-ac total, 225 ac would be permanently disturbed on the PSEG Site (including 70 ac for the power block), and 205 ac would be temporarily disturbed on the PSEG Site (160 ac) and adjacent to the PSEG Site (45 ac in the Artificial Island Confined Disposal Facility [CDF]). Preconstruction activities would disturb up to 69.0 ac along the proposed causeway corridor of which 45.5 ac would be permanently disturbed and 23.5 ac would be temporarily disturbed.

Unavoidable adverse surface-water-use impacts during construction and preconstruction would result from the use of small amounts of water from onsite stormwater retention ponds for dust suppression. Groundwater would be obtained under the existing water-use permit for HCGS and SGS, and unavoidable groundwater-use impacts would result from the use of small amounts of water for preconstruction and construction support (including concrete batch plant supply and dust suppression) and from dewatering for power block construction.

Unavoidable adverse impacts to surface-water quality during construction and preconstruction would result from clearing vegetation, disturbing the land surface, inadvertent release of contaminants associated with building materials and equipment, building activities in the tidal marsh and tidal stream areas, and dredging activities in the Delaware River. Temporary and localized groundwater-quality impacts would result from dewatering for power block construction and discharge of groundwater to adjacent surface-water bodies.

Unavoidable adverse impacts to terrestrial ecology during construction and preconstruction would result from the disturbance of 430 ac on and adjacent to the site and 69 ac along the proposed causeway. Of the 430-ac total disturbance, 225 ac on the site would be permanently disturbed and 205 ac on and adjacent to the site would be temporarily disturbed. The 225 ac of permanent disturbance on the site would include 108 ac of wetland habitat (primarily *Phragmites*-dominated coastal and interior wetlands) and 9 ac of old field and brush/shrubland habitat. The 160 ac of temporary disturbance on the site would include 80 ac of old field and *Phragmites*-dominated old field habitat and 32 ac of wetland habitat (primarily *Phragmites*-dominated interior wetlands). The 45 ac of temporary disturbance adjacent to the site would occur in the Artificial Island CDF and include 30.2 ac of wetland habitat (primarily *Phragmites*-dominated interior wetlands and disturbed wetlands).

Of the 69.0 ac of total disturbance associated with the proposed causeway, 45.5 ac would be permanently disturbed and 23.5 ac would be temporarily disturbed. The 45.5 ac of permanent disturbance along the causeway would include 23 ac of wetland habitat (primarily *Phragmites*-dominated coastal wetlands) and 3.4 ac of old field habitat. The 23.5 ac of temporary disturbance along the causeway would include 19.6 ac of wetland habitat (primarily *Phragmites*-dominated coastal wetlands and freshwater tidal marshes).

Unavoidable adverse impacts to aquatic ecology would include some physical alteration of habitat (e.g., infilling, dredging, pile driving) including temporary or permanent removal of associated benthic organisms, sedimentation, changes in hydrological regimes, and changes in water quality. These impacts would result from installing the cooling water intake and discharge structures, building the barge facility on the Delaware River Estuary shoreline, preparing the power plant site, and building the causeway. Aquatic habitats affected would include desilt basins and small marsh creeks, habitats associated with the Delaware River, and the interconnected system of tidal wetlands and marsh creeks primarily north of the PSEG Site.

For socioeconomic resources, unavoidable adverse physical impacts to workers and the local public would include increased noise, air pollution emissions, and vehicle traffic. The addition of two new cooling towers and two new reactor domes at the PSEG Site, and an elevated causeway to the PSEG Site, would noticeably affect the aesthetic qualities from sensitive viewpoints in New Castle County, Delaware, and Salem County, New Jersey. This impact to visual resources would be moderate and not amenable to mitigation.

No unavoidable adverse impacts to historic and cultural resources are anticipated on Artificial Island. An adverse visual effect to historic properties in New Jersey could occur if natural draft cooling towers are constructed. However, consultation between the USACE and the New Jersey State Historic Preservation Office (SHPO) is ongoing.

Unavoidable adverse impacts to air quality from construction and preconstruction would include fugitive dust and emissions of criteria pollutants and greenhouse gases (GHGs) from land-disturbing and building activities and equipment and from additional vehicle traffic.

Unavoidable nonradiological health impacts to the public and construction workers at the site would result from fugitive dust, occupational injuries, noise, and traffic impacts from the transport of materials and personnel to the site.

Unavoidable radiological doses to the public would be below annual exposure limits set by the NRC and the U.S. Environmental Protection Agency (EPA) to protect the general public. Radiological doses to construction workers at the PSEG Site from the adjacent SGS and HCGS would be below the NRC regulatory limits.

Solid, liquid, and gaseous wastes would be generated by construction and preconstruction activities at the PSEG Site. These wastes would be managed by following the existing practices currently used at HCGS and SGS. Solid waste would be recycled or disposed of in existing, permitted landfills. Sanitary wastes would be treated on the site and discharged locally after being treated to the levels stipulated in the New Jersey Pollutant Discharge Elimination System (NJPDES) permit.

The review team concludes that the unavoidable adverse impacts of preconstruction and construction activities at and near the PSEG Site would range from SMALL to MODERATE, depending on the affected resource. Similarly, the NRC staff concludes that the incremental contribution of the NRC-authorized construction activities to these unavoidable adverse impacts would range from SMALL to MODERATE.

10.2.2 Unavoidable Adverse Impacts during Operation

Chapter 5 provides a detailed discussion of the potential impacts from operating a new nuclear power plant at the PSEG Site. Table 10-2 lists the unavoidable adverse impacts associated with operating the new nuclear power plant to each of the resource areas evaluated in this EIS and the mitigation measures that would reduce the impacts. The impacts remaining after mitigation is applied (e.g., avoidance and minimization, but not compensatory mitigation) are identified in Table 10-2 as the unavoidable adverse impacts.

Operation of the new nuclear power plant would result in unavoidable adverse impacts to land use because the areas of permanent disturbance (225 ac on the site and 45.5 ac along the causeway route) would be unavailable for other uses for the operational life of the new nuclear power plant.

Unavoidable adverse surface-water-use impacts during operations would result from surface-water withdrawals from the Delaware River. Consumptive use mitigation requirements may exceed the PSEG current storage allocation of water in the Merrill Creek reservoir. Groundwater would be obtained from new wells in the Potomac-Raritan-Magothy aquifer system, and unavoidable groundwater-use impacts would result from withdrawals for sanitary and potable water systems and for the demineralized water distribution system.

Unavoidable adverse impacts to surface-water quality in the Delaware River during operations would result from thermal discharges and discharges of nonradioactive liquid effluents from the cooling water system, as well as potable and sanitary discharges and liquid radioactive wastes. PSEG does not plan routine discharges to groundwater for the new nuclear power plant, but impacts could result from chemical or radiological spills that could migrate to shallow water (brackish) zones or saline intrusion to deep aquifers due to groundwater withdrawals.

Unavoidable adverse impacts to terrestrial ecological resources during operations would include the permanent disturbance on the site of 108 ac of wetland habitat (primarily *Phragmites*-dominated coastal and interior wetlands) and 9 ac of old field and brush/shrubland habitat and the permanent disturbance along the causeway of 23 ac of wetland habitat (primarily *Phragmites*-dominated coastal wetlands) and 3.4 ac of old field habitat. Other unavoidable adverse impacts would include the increased risk of bird collisions with structures, wildlife avoidance due to increased noise and artificial light, and potential impacts of salt deposition on vegetation near the cooling towers.

Unavoidable adverse impacts to aquatic ecological resources during operations would include impacts to aquatic biota in the Delaware River Estuary from impingement and entrainment due to cooling system operations, heat stress due to the thermal discharge plume, and chemicals in the discharged blowdown from the new nuclear power plant.

Unavoidable adverse impacts to socioeconomic and environmental justice resources would include physical aesthetic impacts from the increased industrialization at the PSEG Site. These aesthetic impacts would also contribute to the adverse impacts on recreational resources near the PSEG Site and cannot be reduced by mitigation.

Table 10-2. Unavoidable Adverse Environmental Impacts from Operations

Resource Area	Adverse Impact	Actions to Mitigate Impacts	Unavoidable Adverse Impacts
Land Use	SMALL	None	Areas of permanent disturbance (225 ac on the site and 45.5 ac along the causeway) would be unavailable for other uses for the operational life of the new nuclear power plant.
Water Use	SMALL	PSEG could (1) revise the consumptive use allocations of other plants it owns and supports through its allocation in Merrill Creek reservoir or (2) temporarily or permanently acquire additional storage from the existing rights of other Merrill Creek co-owners.	Surface-water withdrawals from the Delaware River could result in consumptive use mitigation requirements that exceed the PSEG current storage allocation of water in the Merrill Creek reservoir. Groundwater withdrawals for sanitary and potable water systems and for the demineralized water distribution system
Water Quality	SMALL	Implement best management practices (BMPs) and a Stormwater Pollution Prevention Plan (SWPPP) and maintain compliance with Federal and State regulations and permit requirements.	Impacts to the Delaware River surface water from thermal discharge and discharge of nonradioactive liquid effluents from the cooling water system, as well as potable and sanitary discharges and liquid radioactive waste discharge. Possible groundwater impacts from chemical or radiological spills that could migrate to shallow water (brackish) zones or saline intrusion to deep aquifers due to groundwater withdrawals
Ecological Impacts			
—Terrestrial and Wetland Resources	SMALL	Implement BMPs to limit potential impacts from vegetation control, road maintenance, and other activities.	Permanent disturbance on the site of 108 ac of wetland habitat and 9 ac of old field and brush/shrubland habitat, and permanent disturbance along the causeway of 23 ac of wetland habitat and 3.4 ac of old field habitat. Increased risk of bird collisions with structures, wildlife avoidance due to increased noise and artificial light, and potential impacts of salt deposition on vegetation near the cooling towers

Table 10-2. (continued)

Resource Area	Adverse Impact	Actions to Mitigate Impacts	Unavoidable Adverse Impacts
—Aquatic Resources	SMALL	Implement BMPs and SWPPP and maintain compliance with Federal and State regulations and permit requirements. Use of closed-cycle cooling system would reduce impingement and entrainment of aquatic biota.	Impacts to aquatic biota in the Delaware River Estuary from impingement and entrainment due to cooling system operations, heat stress due to the thermal discharge plume, and chemicals in the discharged blowdown from the new nuclear power plant.
Socioeconomic Impacts			
—Physical	SMALL (most) to MODERATE (aesthetics)	None	Minor physical impacts associated with increased noise, air pollution emissions, and vehicle traffic. Operating two new cooling towers and two new reactor domes at the PSEG Site and an elevated causeway to the PSEG Site would noticeably affect aesthetic qualities from sensitive viewpoints.
—Demography	SMALL	None	The in-migration of workers and their families to support operating the new nuclear power plant would increase the population of the economic impact area by about 0.05 percent. The increase would be most pronounced in Salem County, New Jersey, which would experience about a 0.39 percent increase in population.
—Economic and Tax	None; all impacts are beneficial	None	None
—Infrastructure and Community Services	SMALL (most) to MODERATE (recreation)	None	Aesthetic impacts near recreational resources, specifically on the Delaware River and PSEG Estuary Enhancement Program viewing platforms, from increased industrialization at the PSEG Site that would not be amenable to mitigation strategies
Environmental Justice	No disproportionately high and adverse impacts	None	None

Table 10-2. (continued)

Resource Area	Adverse Impact	Actions to Mitigate Impacts	Unavoidable Adverse Impacts
Historic and Cultural	SMALL to MODERATE	The NRC executed a Memorandum of Agreement (NRC 2015-TN4377) to resolve any effect to historic properties in New Jersey resulting from construction and operation of natural draft cooling towers. In the event that significant historic and cultural resources were encountered, procedure EN-AA-602-0006 for considering inadvertent discovery of cultural resources during normal operations would be followed. The USACE will continue consultation with the New Jersey State Historic Preservation Office and Native American tribes.	The NRC executed a Memorandum of Agreement (NRC 2015-TN4377) to resolve any effect to historic properties in New Jersey from construction and operation of natural draft cooling towers.
Air Quality	SMALL	Comply with Federal, State, and local air-quality permits and regulations, including Clean Air Act (CAA, 42 USC 7401 et seq. – TN1141) requirements and requirements of the New Jersey Department of Environmental Protection (NJDEP) Division of Air Quality. Obtain a modification to NJDEP Air Operating Permit under Title V of CAA.	Criteria pollutant, hazardous air pollutant, greenhouse gas, and cooling system emissions. Operations would increase gaseous and particulate emissions by a small amount, primarily from equipment associated with auxiliary systems and the cooling towers. The primary sources of emissions from auxiliary systems would be the auxiliary boilers, standby power units such as diesel generators and/or gas turbines, and engine-driven emergency equipment. The cooling towers would be the primary source of particulate emissions
Nonradiological Health	SMALL	Adhere to permits and authorizations issued by State and local agencies. Comply with Occupational Safety and Health Administration standards and other Federal, State, and local safety regulations. Stagger arrival and departure times and outage schedules to minimize impacts to transportation routes. Control vehicle emissions by regularly	Exposure to etiologic microorganisms through cooling systems, noise generated by unit operations, and accidents during transportation of operations and outage workers to and from the site

Table 10-2. (continued)

Resource Area	Adverse Impact	Actions to Mitigate Impacts	Unavoidable Adverse Impacts
		scheduled maintenance. Use standard sound attenuation measures for mechanical draft cooling towers. These should be sufficient to limit the noise impact.	
Radiological Health	SMALL	Doses to members of the public would be maintained below the U.S. Nuclear Regulatory Commission (NRC) and U.S. Environmental Protection Agency standards; workers' doses would be maintained below the NRC limits and as low as reasonably achievable; mitigative actions instituted for members of the public would also ensure that doses to biota other than humans would be well below National Council on Radiation Protection and International Atomic Energy Agency guidelines	Small radiation doses to members of the public, operations workers, and biota other than humans
Nonradiological Wastes	SMALL	Maintain compliance with National Pollutant Discharge Elimination System permit requirements; adhere to local, State, and Federal permits and regulations regarding the classification and disposition of wastes	Increased consumption of landfill space for disposition of wastes; increased consumption of fuels for the transportation and disposition of wastes
Fuel Cycle, Transportation, and Decommissioning	SMALL	Industrywide changes in technology are reducing fuel cycle impacts. Implement waste-minimization program. Comply with the NRC and U.S. Department of Transportation (DOT) regulations	Small impacts from fuel cycle as presented in Table S-3, 10 CFR Part 51 (TN250). Small impacts from carbon dioxide, radon, and technetium-99. Small radiological doses that are within the NRC and DOT regulations from transportation of fuel and radioactive waste. Small impacts from decommissioning as presented in NUREG–0586 (NRC 2002-TN665)

No unavoidable adverse impacts to historic and cultural resources are anticipated on Artificial Island or to historic properties in Delaware. The NRC executed a Memorandum of Agreement (NRC 2015-TN4377) to resolve any effect to historic properties in New Jersey from construction and operation of natural draft cooling towers. However, consultation is ongoing between the USACE and the New Jersey SHPO.

Unavoidable adverse impacts to air quality during operations would include emissions of criteria pollutants, GHG emissions, and cooling system emissions. Operations would increase gaseous and particulate emissions by a small amount, primarily from equipment associated with auxiliary systems and the cooling towers. The primary sources of emissions from auxiliary systems would be the auxiliary boilers, standby power units such as diesel generators and/or gas turbines, and engine-driven emergency equipment. The cooling towers would be the primary source of particulate emissions.

Unavoidable nonradiological health impacts to the public and operations workers at the site would result from exposure to etiologic microorganisms through cooling systems, noise generated by unit operations, and transportation of operations and outage workers to and from the site. Health risks to workers would be dominated by occupational injuries and would likely occur at rates below the average U.S. industrial rates.

Unavoidable radiological doses to the public would be below the NRC and EPA limits set to protect the general public. Radiological doses to operations workers at the PSEG Site would also be below the NRC limits and would be maintained as low as reasonably achievable. The radiation protection measures designed to maintain doses to members of the public below the NRC and EPA standards would also ensure that doses to biota other than humans would be well below the guidelines of the National Council on Radiation Protection and Measurements and the International Atomic Energy Agency.

Solid, liquid, and gaseous wastes would be generated by operations at the PSEG Site. These wastes would be managed by following the existing practices currently used at HCGS and SGS. Solid waste would be recycled or disposed of in existing, permitted landfills. Sanitary wastes would be treated on the site and discharged locally after being treated to the levels stipulated in the NJPDES permit.

Operation of the new nuclear power plant at the PSEG Site would also contribute to unavoidable adverse impacts related to the uranium fuel cycle, transportation of fuels and wastes, and decommissioning. Fuel cycle impacts would be small, as presented in Table S-3, 10 CFR Part 51 (TN250). There would be small impacts from carbon dioxide, radon, and technetium-99. There would be small radiological doses from transportation of fuel and radioactive waste that are within the NRC and U.S. Department of Transportation regulations. The impacts of decommissioning would be small, as presented in NUREG–0586 (NRC 2002-TN665).

The NRC staff concludes that the unavoidable adverse impacts of operating the new nuclear power plant at the PSEG Site would range from SMALL to MODERATE, depending on the affected resource.

10.3 Relationship Between Short-Term Uses and Long-Term Productivity of the Human Environment

NEPA Section 102(2)(C)(iv) (42 USC 4321 et seq. -TN661) requires that an EIS include information on the relationship between local short-term uses of the environment and the maintenance and enhancement of long-term productivity.

The local use of the human environment by developing a new nuclear power plant at the PSEG Site can be summarized as the unavoidable adverse environmental impacts of preconstruction, construction, and operations along with the irreversible and irretrievable commitments of resources. With the exception of the consumption of depletable resources as a result of preconstruction, construction, and operation, these uses may be categorized as short-term. The principal short-term benefit of developing the new nuclear power plant would be the production of electrical energy. The economic productivity of the PSEG Site, when used for the production of electrical energy, would be extremely large when compared to the current short-term productive use of the undeveloped site, which is not available for agricultural or industrial uses until the existing SGS and HCGS units are decommissioned.

The maximum long-term impact on productivity at the PSEG Site would result if the new nuclear power plant were not immediately dismantled at the end of its period of operation, and consequently the land occupied by the plant structures would thus be unavailable for any other use. However, it is expected that the enhancement of regional productivity resulting from the electrical energy produced by the new nuclear power plant would lead to a correspondingly large increase in regional long-term productivity that would not be equaled by any other long-term use of the site. In addition, most long-term impacts resulting from land-use preemption by plant structures could be eliminated by removing these structures or by converting them to other productive uses at the end of operations. Once operations at the new nuclear power plant cease and it is shut down, plant structures would be decommissioned according to the NRC regulations. Once decommissioning was completed and the NRC license was terminated, the site would become available for other uses.

The NRC staff concludes that the negative impacts of plant construction and operation as they affect the human environment would be outweighed by the positive long-term enhancement of regional productivity through the generation of electrical energy.

10.4 Irreversible and Irretrievable Commitments of Resources

NEPA Section 102(2)(C)(v) (42 USC 4321 et seq. -TN661) requires that an EIS include information on any irreversible and irretrievable commitments of resources that would occur if the proposed actions were implemented. The term “irreversible commitments of resources” refers to environmental resources that would be irreparably changed by the building or operation activities authorized by the NRC licensing decisions or the USACE permitting decisions and that could not be restored at some later time to the resource state before the relevant activity occurred. “Irretrievable commitments of resources” refers to materials that would be used for or consumed by the new nuclear power plant in such a way that they could not, by practical means, be recycled or restored for other uses. The environmental resources summarized in this section are discussed in Chapters 4, 5, and 6 of this EIS. The irretrievable

commitments of resources to building the new nuclear power plant generally would be similar to those of any major construction project (see Section 10.4.2). The following sections discuss the irreversible commitments of resources to preconstruction, construction, and operation of a new nuclear power plant at the PSEG Site.

10.4.1 Irreversible Commitments of Resources

The irreversible commitments of environmental resources resulting from preconstruction, construction, and operation of the new nuclear power plant, in addition to the materials used for the nuclear fuel, are discussed below.

10.4.1.1 Land Use

Land committed to the disposal of radioactive and nonradioactive wastes is committed to that use and cannot be used for other purposes. The land used for a new nuclear power plant at the PSEG Site, with the exception of any permanently filled wetlands, would not be irreversibly committed because the land supporting the facilities could be returned to other industrial or nonindustrial uses once the nuclear power plant ceased operations and was decommissioned in accordance with the NRC requirements. Therefore, the review team considers that construction and preconstruction activities would result in the permanent loss, through infilling, of about 108 ac of wetlands on the PSEG Site and 23 ac of wetlands along the causeway route.

10.4.1.2 Water Use and Quality

The brackish waters of the Delaware River and tidal creeks and marshes near the PSEG Site are not desirable for use during building, so the applicant would not use waters from these sources. However, small amounts of water from onsite stormwater retention ponds would be used for dust suppression during building activities. Because there would be no surface water used during building from surface-water bodies near the PSEG Site, and the use of some stormwater collected in retention ponds is expected to be negligible compared to the surface-water resource, the review team determined that there would be no irreversible commitments of surface-water resources during preconstruction and construction.

Preconstruction and construction activities at the PSEG Site are not expected to result in any irreversible commitments of groundwater resources. Because dewatering for power block construction would be temporary and not from aquifers used for potable purposes, the impact would be minor. Also, because the increased groundwater withdrawal for preconstruction and construction uses would be temporary and within the limits of the current NJDEP water allocation permit, the impacts would be minor.

The anticipated consumptive use of water withdrawn from the Delaware River to support operation of the new nuclear power plant at the PSEG Site is 26,420 gpm of brackish water and an equivalent 4,756 gpm of freshwater. The consumed water would be irreversibly lost from the Delaware River Basin and would not be available to downstream users.

Groundwater would be used during operation of the new nuclear power plant to supply makeup to the demineralizer system, fire protection system, and sanitary and potable systems and for other miscellaneous uses. The increased use of groundwater for the new nuclear power plant

would be 210 gpm with a maximum rate of 953 gpm. The portion of this groundwater that is consumed would be irreversibly lost and would not be available to other groundwater users.

10.4.1.3 Terrestrial and Aquatic Biota

Preconstruction and construction activities would permanently convert some portions of terrestrial and aquatic habitats on the PSEG Site, which would temporarily adversely affect the abundance and distribution of local terrestrial and aquatic species. Irreversible commitments of resources would include the permanent loss on the site of about 108 ac of wetland habitat (primarily *Phragmites*-dominated coastal and interior wetlands) and 9 ac of old field and brush/shrubland habitat. Permanent losses along the causeway route would include 23 ac of wetland habitat (primarily *Phragmites*-dominated coastal wetlands) and 3.4 ac of old field habitat. Permanent losses of onsite aquatic habitats include filling of approximately 40 ac of desilt basins and 7,265 linear ft of creek channels, and isolation of 2,320 linear ft of marsh creek channels. Dredging activities for the installation of the cooling water intake structure would permanently remove about 225,000 yd^3 of sediment; installation of the new barge storage area and unloading facility would require dredging of 440,000 yd^3 of sediment, and up to 5,800 yd^3 of sediment would be dredged and removed for improvements to the HCGS barge slip. Benthic organisms present in these sediment habitats would be lost. Additional fill impacts to the river bottom habitat would result from the installation of seven mooring caissons (0.05 ac), a new discharge structure (0.24 ac) and a shoreline bulkhead (1.03 ac).

10.4.1.4 Socioeconomic Resources

The review team expects that no irreversible commitments would be made to socioeconomic resources because they would be reallocated for other purposes once the plant was decommissioned.

10.4.1.5 Historic and Cultural Resources

There would not be any irreversible commitments of historic or cultural resources. However, the USACE consultation with the New Jersey SHPO is ongoing.

10.4.1.6 Air Quality

Air emission releases during preconstruction/construction activities and operations would conform to applicable Federal and State regulations, so the impact on public health and the environment would be limited. The review team expects no irreversible impacts on air quality because all releases would be made in accordance with duly issued permits.

10.4.2 Irretrievable Commitments of Resources

Irretrievable commitments of resources during the building of the proposed new nuclear power plant generally would be similar to those of any major construction project. The actual commitment of construction resources (e.g., concrete, steel, and other building materials) would depend on the reactor design selected by PSEG at the construction permit (CP)/combined license (COL) stage. Nevertheless, a study by the U.S. Department of Energy (DOE 2004-TN2240) on new reactor construction estimated that about 12,239 yd^3 of concrete;

3,107 tons of steel reinforcement (i.e., rebar); 13,000,000 ft of cable; and 275,000 ft of piping would be required for the reactor building of a typical new 1,300-MW(e) nuclear power plant. Historical records of operating reactors suggest a total of about 182,900 yd^3 of concrete and 20,512 tons of structural steel would be required to construct the reactor building, major auxiliary buildings, turbine generator building, and turbine generator pedestal (DOE 2005-TN2358).

The upper limit on the electrical generating capacity of the types of reactor units under consideration in this ESP review is 2,200 MW(e); hence, the quantities of construction materials required for such a nuclear power plant would be about twice the amounts discussed in the preceding paragraph.

The quantities of construction materials estimated by PSEG in the ER (PSEG 2015-TN4280) include 920,000 yd^3 of concrete, 92,000 tons of reinforcing steel, 50,000 tons of structural steel, 1,380,000 ft of piping, 440,000 ft of cable tray, 2,400,000 ft of conduit, 2,800,000 ft of power cable, 10,800,000 ft of control wire, and 1,480,000 ft of process and instrument tubing. The actual estimate of construction materials would be performed at the CP/COL stage when the reactor design is selected.

The review team expects that the use of construction materials in the quantities associated with those expected for a new nuclear power plant, while irretrievable, would be of small consequence with respect to the availability of such resources.

The main resource that would be irretrievably committed during operation of a new nuclear power plant at the PSEG Site would be uranium. The availability of uranium ore and existing stockpiles of highly enriched uranium in the United States and Russia that could be processed into fuel are sufficient (WNA 2012-TN1498) so that the irreversible and irretrievable commitment would be negligible.

10.5 Alternatives to the Proposed Action

Alternatives to the proposed actions are discussed in Chapter 9 of this EIS. The alternatives considered are the no-action alternative, energy production alternatives, system design alternatives, and alternative sites. For the purposes of the USACE permit evaluation, onsite alternatives will be addressed as part of the USACE least environmentally damaging practicable alternative (LEDPA) determination.

The no-action alternative, as described in Section 9.1, refers to a scenario in which the NRC would deny the PSEG ESP request and the USACE would either take no action or deny the Section 404 CWA permit. If such actions were to occur, the construction and operation of a new nuclear plant at the PSEG Site in accordance with 10 CFR Part 52 (TN251) process referencing an approved ESP would not occur, and the environmental impacts predicted in this EIS would not occur. A comparison of the proposed action with the no-action alternative is presented in Section 9.1.

Alternative energy sources are described in Section 9.2. Alternatives that would not require additional generating capacity are described in Section 9.2.1. Alternatives that require

additional generating capacity are discussed in Section 9.2.2. Detailed analyses of individual alternatives that could meet the project purpose and need (coal-fired and natural-gas-fired alternatives) are provided in Section 9.2.3. A combination of energy alternatives is discussed in Section 9.2.4. The NRC staff concluded that none of the alternative energy options were both (1) consistent with the purpose and need for the project, as defined in Section 1.3.1, and (2) environmentally preferable to the construction and operation of a new nuclear power plant.

Alternative sites are discussed in Section 9.3. The cumulative impacts of building and operating a new nuclear power plant at each of the four alternative sites are compared in Section 9.3.6 to the impacts of such facilities at the proposed PSEG Site. Table 9-24 contains the review team characterization of cumulative impacts at the proposed PSEG Site and the four alternative sites. Based on this review, the NRC staff concludes that while there are differences in cumulative impacts at the proposed and alternative sites, none of the alternative sites would be environmentally preferable or obviously superior to the proposed PSEG Site. The NRC staff determination is independent of the USACE LEDPA determination pursuant to CWA Section 404(b)(1) Guidelines (40 CFR Part 230-TN427). The USACE will conclude its analysis of both offsite and onsite alternatives in its Record of Decision.

In Section 9.4, the NRC staff considered alternative system designs including alternative heat dissipation systems and alternative intake, discharge, and water supply systems. The NRC staff did not identify any alternative that was environmentally preferable to the plant systems design currently under consideration for use at the PSEG Site.

10.6 Benefit-Cost Balance

NEPA (42 USC 4321 et seq. -TN661]) requires that all agencies of the Federal government prepare detailed EISs on proposed major Federal actions that can significantly affect the quality of the human environment. A principal objective of NEPA is to require each Federal agency to consider, in its decision-making process, the environmental impacts of each proposed major action and the available alternative actions. In particular, NEPA Section 102 (B) requires that all Federal agencies, to the fullest extent possible, “identify and develop methods and procedures, in consultation with the CEQ established by Title II of this Act, which will ensure that presently unquantified environmental amenities and values may be given appropriate consideration in decision-making along with economic and technical considerations.” However, neither NEPA nor CEQ requires the costs and benefits of a proposed action to be quantified in dollars or any other common metric.

10 CFR 51.50, Section (b)(2) (TN250) does not require an assessment of benefits and costs for an ESP application. However, in the PSEG ER (PSEG 2015-TN4280), PSEG included a benefit-cost assessment as a part of its ESP application, and therefore the review team includes this benefit-cost balancing section in this EIS and will reference it in any future COL application for the PSEG Site.

Although the analysis in this section is conceptually similar to a purely economic benefit-cost analysis, which determines the net present dollar value of a given project, it is not possible to quantify and assign a value to all internal (i.e., private, or societal) benefits and costs of the proposed action. This section focuses primarily on the monetized values of only those activities closely related to the building and operational activities at the PSEG Site and does not provide

monetary estimates of all potential societal benefits and costs. Instead, the review team offers quantified assessments for external benefits and costs that are of sufficient magnitude or importance that their inclusion in this analysis can inform the NRC and USACE decision-making processes.

In this section, the review team compiled and compared the pertinent analytical conclusions reached in previous chapters of this EIS. All of the expected impacts from building and operational activities at the PSEG Site are gathered and aggregated into two final categories: the expected social costs and the expected social benefits to be derived from approval of the proposed action. The intent of this EIS is not to identify potential societal benefits of proposed activities and compare them to their potential internal and external costs, but to generally inform the ESP application process by gathering and reviewing information that demonstrates the likelihood that the aggregate benefits of the proposed activities outweigh the aggregate costs.

General issues related to PSEG's financial viability are outside the scope of the NRC EIS process and are thus not considered in this EIS. Issues related to financial qualifications will be addressed in the NRC safety evaluation report for the COL and are not required during the ESP review per 10 CFR 52.16 (TN251).

Section 10.6.1 discusses the benefits associated with the proposed action. Section 10.6.2 discusses the costs associated with the proposed action. In accordance with the NRC guidance in NUREG–1555 (NRC 2000-TN614), the internal costs of the proposed project are presented in monetary terms. Internal costs include all of the costs included in a total capital cost assessment: the direct and indirect costs of preconstruction and construction plus the annual costs of operation and maintenance. Section 10.6.3 provides a summary of the impact assessments, bringing previous sections together to establish a general impression of the relative magnitude of the proposed project's costs and benefits.

10.6.1 Benefits

A summary of the benefits discussed in greater detail in the following subsections is shown in Table 10-3. The most obvious benefit from building and operating nuclear power plants is the power generation—providing residential, commercial, and industrial consumers with electricity. The social and economic benefits of maintaining an adequate supply of electricity in any given region could be great, given that reliable electricity supplies are key to economic stability and growth in a region. Table 10-3 reports the upper and lower bounds of the electric output based on a single or dual units as 1,350 MW(e) at the lower end for a single unit and 2,200 MW(e) for the dual units at the upper end of the range. The discussion focuses primarily on the relative benefits of those values rather than the broader, more generic benefits of electricity supply.

10.6.1.1 Societal Benefits

For the production of electricity to be beneficial to a society, there must be a corresponding demand or need for power in the region. Chapter 8 of this EIS discusses that need for power in more detail. From a societal perspective, the power itself is the primary benefit because it provides energy for economic growth and helps maintain the nation's standard of living. However, price stability and longevity, energy security, and fuel diversity are also key benefits associated with nuclear power generation relative to the benefits from most other alternative generating technologies. These benefits are described in this section.

Table 10-3. Benefits of Building and Operating a New Nuclear Power Plant at the PSEG Site (in 2013 U.S. dollars)

Category of Benefit	Description of Benefit	Impact Assessment
Electricity Generated	10.6 to 17.3 million MWh per year for the 40-year life of the plant[(a)]	–
Generating Capacity	1,350 to 2,200 MW(e)[(a)]	–
Electricity Price Reduction to Customers	While the determination of the price of electricity is beyond the scope and authority of the NRC, the review team determined that for every penny of price reduction (cents per kilowatt-hour) produced by the proposed PSEG plant's participation in the electricity market, the total savings to all customers would amount to between $106 million and $173 million per year	SMALL to MODERATE
Fuel Diversity and Energy Security	Nuclear power generation provides diversity to both New Jersey's and PJM Interconnection, LLC's, baseload generation inventory. Also reduces amount of imported power into New Jersey and fossil-fueled generation	SMALL
Air-Quality Improvements	The goals set forth in the New Jersey Energy Master Plan indicate a strong preference for the construction of new baseload generating capacity. The next best alternative would most likely include the expansion of New Jersey's fossil fuel fleet, which would involve significantly greater emissions of criteria and greenhouse gas pollutants.	SMALL
Tax Revenues	Building-related sales taxes of about $100 million annually paid by PSEG for local purchases and divided between New Jersey and Pennsylvania, and operations-related sales taxes of about $30 million annually during operations. About $3.83 million in Federal income taxes would be paid by in-migrating workers during building and about $1.25 million would be paid annually by in-migrating operations workers.	SMALL to MODERATE
	Property taxes paid by PSEG to Salem County of about $71 million to $120 million during the first year of operations, with about $1.4 billion to $2.5 billion over the life of the plant and $144 million to $244 million annually for corporate income taxes to New Jersey during operations[(a)]	MODERATE to LARGE
Local Economy	Increased jobs and spending on services and supplies would benefit the area economically.	SMALL to MODERATE
Traffic	Minor upgrades to roads around the PSEG Site to mitigate anticipated traffic quality degradation from PSEG worker commutes	SMALL
Public Services and Education	Additional tax revenues and philanthropic dollars to the community expected from PSEG corporate donations as well as donations of time and money from its employees	SMALL

(a) At a 90 percent capacity factor for one Advanced Boiling Water Reactor unit as the smallest reactor design and two Advanced Passive 1000 units as the largest reactor design.

Price Stability and Longevity

Because of nuclear power's relatively low and nonvolatile fuel costs and a projected capacity utilization rate of 85 to 93 percent, nuclear energy is a dependable source of electricity that is provided at relatively stable prices. Because of the low cost of uranium, the fuel price elasticity of electricity demand (how the consumer's demand for electricity changes as the price of uranium causes the cost of producing the electricity to change) is very low. The price of uranium fuel is between 3 and 5 percent of the cost of a kilowatt-hour of nuclear-generated electricity. Doubling the price of uranium increases the cost of electricity by about 9 percent. In contrast, doubling the price of natural gas adds about 66 percent to the price of electricity, and doubling the cost of coal adds about 31 percent to the price of electricity (WNA 2013-TN2689).

Unlike some other energy sources, nuclear energy is generally not subject to unreliable weather or climate conditions, unpredictable cost fluctuations, or dependence on foreign suppliers. The combination of low fuel prices, the relative lack of volatility in fuel prices when compared to the prices of other alternative fuels, and capacity utilization rates of 85 to 93 percent mean that nuclear energy is a dependable source of electricity that can be provided to the consumer at relatively stable prices over a long period of time.

Energy Security and Fuel Diversity

Currently about 70 percent of the electricity generated in the United States is generated using fossil-based technologies. Nuclear power adds diversity and flexibility to the U.S. energy mix, thereby hedging the risk of shortages and price fluctuations that would result from an overdependence on any one power-generating system or foreign-produced fuels.

A diverse fuel mix helps protect consumers from contingencies such as fuel shortages or disruptions, price fluctuations, and changes in regulatory practices. The PSEG Site's generating capacity could provide additional nuclear power-generating capacity to the generation mix and thus give the region a hedge against risks of future shortages and price fluctuations associated with alternative generating systems and power importation.

10.6.1.2 Regional Benefits

Regional benefits of building and operations at the PSEG Site include enhanced tax revenues at the State, county, and local levels; opportunities for increased regional productivity in industry, manufacturing, and other business categories; increased employment opportunities within the region; and improvements in local infrastructure and services derived from the increased tax base.

Tax Revenue Benefits

Tax revenues would come from various sources during preconstruction, construction, and operations at the PSEG Site, including (1) State taxes on worker incomes, (2) State sales taxes on materials and supplies, (3) State sales taxes on worker expenditures, (4) local property taxes or payments in lieu of taxes, and (5) corporate income tax payments. The tax structure of the region is discussed in Section 2.5.2.2 of this EIS.

State income tax revenue during the peak employment period of building at the PSEG Site would be about $3.8 million annually for in-migrating workers (about $0.9 million annually for the State of Delaware and about $2.9 million annually for the State of New Jersey—see Section 4.4.3.2). During operations, about $1.29 million in annual income taxes would be received: about $0.2 million would be received by the State of Delaware, and about $1.04 million would be received by the State of New Jersey (see Section 5.4.3.2). The States of Pennsylvania and New Jersey would also receive sales tax revenue on expenditures made by the new workers and on purchases of building materials and supplies in the local area. The review team estimated, on the basis of information provided by PSEG and the review team's independent analysis, that the State of New Jersey would receive new sales tax revenue of about $72.8 million over the 6-year building period at the PSEG Site and that the State of Pennsylvania would receive about $29.9 million. During operations, New Jersey would receive $23.7 million annually and Pennsylvania would receive $9.7 million annually in sales tax revenue from purchases. Delaware does not impose a sales tax.

Salem County and Lower Alloways Creek Township would benefit from increased property taxes associated with operations at the PSEG Site. Neither jurisdiction imposes property taxes during construction. However, assuming a $1.207 per hundred dollars of assessed value property tax on all improvements, PSEG would pay about $77 million for the first year of operation and $1.6 billion over the life of the permit for an Advanced Boiling Water Reactor (ABWR). PSEG would pay $125 million in property taxes during the first year of operations and about $2.5 billion in property taxes over the 40-year lifetime of a pair of Advanced Passive 1000 (AP1000) reactors. Therefore, the proposed project would add between 82 (ABWR) and 140 percent (AP1000) to the current Salem County budget in the first year.

PSEG would also pay to the State of New Jersey a corporate energy receipts tax of 9 percent of its annual revenue each year during operations. PSEG would pay about $229 million annually to the State of New Jersey in corporate income taxes for the AP1000 design and about $140 million per year for an ABWR (based on an average 14.68 cents per kilowatt-hour).

Regional Productivity and Community Impacts

Building at the PSEG Site would require an average workforce of about 2,722 workers per year over the 6-year construction period, with a peak building employment of about 4,100 workers. The building workforce would produce, on average, about $142 million in income each year over the entire preconstruction and construction periods and $214 million during peak building (see Section 4.4.3.1). Stimulus from these new jobs and income would induce a multiplier effect that would create additional indirect jobs in the economic impact area. Because it is anticipated that the majority of the needed workers already reside in the economic impact area and region and are part of the baseline discussed in Section 2.5, the review team analyzed the indirect effects from the estimated 617 in-migrating workers and 512 unemployed workers that would be hired to work at the PSEG Site. These 1,129 construction workers would produce about 928 new indirect jobs during building at the PSEG Site. Operations would create 600 direct jobs and $57.5 million in income annually that would be maintained throughout the life of the plant (see Section 5.4.3.1). Additional annual indirect jobs and indirect income would be created in the economic impact area by the 198 in-migrating and 22 recently unemployed local workers that would be employed at the PSEG Site for a total of 286 indirect jobs during operations. An

estimated 1,000 workers would also be employed at the PSEG Site during scheduled refueling outages, which would occur every 18–24 months and require outage workers for a period of 30 days, producing an additional $4.4 million.

10.6.2 Costs

Internal costs to PSEG as well as external costs to the surrounding region and environment would be incurred during preconstruction, construction, and operations at the PSEG Site. Internal costs would include the costs to build the power plant (capital costs); operating and maintenance costs; and the costs of fuel, waste disposal, and decommissioning. External costs would include all costs imposed on the environment and region surrounding the plant and could include the loss of regional productivity, environmental degradation, or loss of wildlife habitat. Internal and external costs of building and operations at the PSEG Site are presented in Table 10-4.

Table 10-4. Internal and External Costs of Building and Operations at the PSEG Site (in 2013 U.S. dollars)

Benefit-Cost Category	Description	Impact Assessment[(a)]
	Internal Costs[(b)]	
Construction cost[(c)]	AP1000: $9.879 billion (overnight capital cost) ABWR: $6.062 billion (overnight capital cost)	–
Operating cost	At 7.5–8.1 cents/kilowatt-hour (levelized cost of electricity) (PSEG 2015-TN4280) AP1000: $1.3 to $1.4 billion per year ABWR: $798.3 to $862.1 million per year	–
Spent fuel management	At 0.1 cent/kilowatt-hour[(d)] AP1000: $17.3 million per year ABWR: $10.6 million per year	–
Decommissioning	0.1–0.2 cent/kilowatt-hour[(e)] AP1000 $17.3 to $34.6 million per year ABWR $10.6 to $21.2 million per year	–
Material and resources[(f)]	920,000 yd^3 of concrete 92,000 tons of rebar 50,000 tons of structural steel 1,380,000 ft of piping 440,000 ft of cable tray 2,400,000 ft of conduit 2,800,000 ft of power cable 10,800,000 ft of control wire 1,480,000 ft of process and instrument tubing	–
Tax payments	Building-related sales taxes of about $100 million annually paid by PSEG for local purchases and divided between New Jersey and Pennsylvania, and operations-related sales taxes of about $30 million annually during operations. About $3.83 million in Federal income taxes would be paid by in-migrating workers during building and about $1.25 million would be paid annually by in-migrating operations workers	–

Table 10-4. (continued)

Benefit-Cost Category	Description	Impact Assessment[a]
	Property taxes paid by PSEG to Salem County of about $71 million to $120 million during the first year of operations, with about $1.4 billion to $2.5 billion over the life of the plant and $144 million to $244 million annually for corporate income taxes to New Jersey during operations[a]	–
Salaries	Average of $142 million annually during the peak employment period of building, $57.5 million annually during operations, and an additional $4.4 million during outages	–
Land use	270 ac of onsite lands	–
	External Costs	
Air-quality impacts	During the construction period, potential impacts associated with operations of equipment and vehicles on ambient air quality would be small. During the operation period, air emissions from diesel generators and/or gas turbines, auxiliary boilers, engine-driven emergency equipment, and vehicles would have a small impact on workers and local residents. Cooling tower drift would deposit some salt on the surrounding vicinity, but at a level unlikely to result in any measurable impact on plants and vegetation. Cooling towers would produce visible plumes for some distance downwind of the plant depending on the meteorological conditions (see Sections 4.7 and 5.7)	SMALL
Water-related impacts	26,420 gpm of brackish water and an equivalent 4,756 gpm of freshwater would be withdrawn from the Delaware River and would not be available to downstream users. The increased use of groundwater for the new plant would be 210 gpm. This portion would not be available to other groundwater users. These amounts are within permitted limits, are a small percentage of the available amounts, and are not expected to impact uses or users.	SMALL
Ecological impacts	Some cost to wildlife and aquatic biota is anticipated due to mortality and from the loss or alteration of habitats (including wetlands) during preconstruction and construction. However, these costs are not expected to adversely affect regional wildlife and aquatic biota populations. Mortality to wildlife and aquatic biota during operations is expected to be minimal. PSEG's adherence to the USACE and NJPDES permit requirements would likely result in minimal effects to aquatic populations. About 108 acres of wetland habitats would be affected by building a nuclear power plant on the PSEG Site. The impact to these important resources would be a noticeable effect on wildlife species but would not be destabilizing. No Federally or State-threatened or endangered species are likely to be adversely affected. Minimal adverse effect or no	SMALL to MODERATE (Terrestrial) SMALL (Aquatic)

Table 10-4. (continued)

Benefit-Cost Category	Description	Impact Assessment[(a)]
	adverse effect is likely for the essential fish habitat of managed fish species	
Demographics	Minor impacts to the populations of the local communities	SMALL
Physical impacts on community	Some physical impacts on road network during building; aesthetic impacts from increased industrial character of site during building and operations	SMALL to MODERATE
Housing	Minor impacts on housing stock	SMALL
Traffic	Localized and temporary impacts during building, but minor impacts during operations	SMALL to MODERATE
Public services	Minor impacts on police and fire departments, emergency medical services, water and wastewater utilities, and education	SMALL
Recreation	Some aesthetic impacts during building and operations as well as some traffic impacts around recreational resources during building	MODERATE
Historic and cultural resources	Visual intrusion on landscape but would be consistent with existing landscape. Potential alteration of archaeological sites by USACE permitted activities. The USACE evaluation is ongoing. The contribution to impacts associated with the NRC-authorized activities would be SMALL.	SMALL to MODERATE
Health impacts (nonradiological and radiological)	Radioactive waste would be generated. The proposed reactors would produce radioactive air emissions. Relatively small levels of radioactive liquid effluents would be introduced into the Delaware River (see Sections 4.9 and 5.9). Nonradiological health impacts from noise, air quality, and transportation of personnel and materials to the site would be introduced at a minimal level and be mitigated by the use of the proposed causeway for construction traffic and proposed improvements to roads and traffic patterns	SMALL
Nonradioactive waste	Solid, liquid, and gaseous nonradiological waste would be generated. The small quantities generated would be handled with existing systems and according to county, State, and Federal regulations and have a minimal impact on cost	SMALL
Radioactive waste	Storage, treatment, and disposal of radioactive spent nuclear fuel. Commitment of geological resources for disposal of radioactive spent fuel (see Section 6.1.6)	SMALL

(a) Impact assessments are listed for all impacts evaluated in detail as part of this environmental impact statement (EIS). The details on impact assessments are found in the indicated sections of this EIS.
(b) Internal costs are costs incurred by PSEG to implement proposed construction and operations at the PSEG Site. Note that no impact assessments are provided for these private financial impacts.
(c) The PPE for the ESP includes two AP1000 units and one ABWR unit; see Section 3.2. These examples were chosen to be representative of the costs to build single-unit and dual-unit plants.
(d) Based on Yucca Mountain waste maintenance levy (WNA 2013-TN2689).
(e) Decommissioning costs are included in total operating costs (WNA 2013-TN2689).
(f) Based upon the AP1000 design.

10.6.2.1 Internal Costs

The most substantial monetary cost associated with nuclear energy is the cost of capital. Nuclear power plants typically have high capital costs but low fuel costs relative to other alternative power generation systems. Because of the high capital costs for nuclear power and because of the relatively long construction period before revenue is returned, servicing the capital costs of a nuclear power plant is an important factor in determining the economic competitiveness of nuclear energy. Because a power plant does not yield profits during construction, longer construction times can add significantly to the cost of a plant through higher interest expenses on borrowed construction funds.

Preconstruction and Construction Costs

In evaluating monetary costs related to building at the PSEG Site, the review team relied on the analysis presented in Section 4.4.3.1. A phrase commonly used to describe the monetary cost of constructing a nuclear plant is “overnight capital cost.” Capital costs are those incurred during construction and include engineering, procurement, and construction costs measured during the periods when the actual outlays for equipment, construction, and engineering are expended. Overnight costs assume that the plant is constructed “overnight,” with no construction loan interest included in the capital cost estimate. Studies of new power plant construction indicate that the estimated overnight capital costs of a nuclear power plant average about $4,000 per kilowatt of electrical generating capacity (MIT 2009-TN2481). Assuming 2013 dollars, the inflation adjusted amount is $4,490.61 per megawatt for an overnight capital cost of $9.879 billion for two AP1000 reactor units and $6.062 billion for an ABWR.

Operation Costs

Operation costs are frequently expressed in terms of the levelized cost of electricity, which is the price per kilowatt-hour of producing electricity, including the cost needed to cover operating costs and annualized capital costs. Overnight capital costs account for a third of the levelized cost, and interest costs on the overnight costs account for another 25 percent (University of Chicago 2004-TN719). PSEG concluded that generation costs vary between 7.5 and 8.1 cents per kilowatt-hour (PSEG 2015-TN4280).

Fuel Costs

From the outset, the basic attraction of nuclear energy has been its low fuel costs when compared to those of coal-, oil-, and gas-fired plants. Uranium, however, has to be processed, enriched, and fabricated into fuel elements, and about half of the cost results from enrichment and fabrication. Allowances must also be made for the management of low- and intermediate-level nuclear wastes created as a part of normal operations, management of radioactive spent fuel, and cost of ultimate disposal of this spent fuel or the wastes separated from it. Even with these costs included, the total fuel costs of a nuclear power plant are typically about a third of those for a coal-fired plant and between a quarter and a fifth of those for a combined-cycle natural gas plant (WNA 2013-TN2689).

Waste Disposal

The backend costs of nuclear power contribute a very small share to total cost, both because of the long lifetime of a nuclear reactor and the fact that provisions for waste-related costs can be accumulated over that time. It should also be recognized, however, that radioactive nuclear waste poses unique disposal challenges for long-term management. While spent fuel and radioactive nuclear waste are being stored successfully in onsite facilities, the United States and other countries have yet to implement final disposition of spent fuel or high-level radioactive waste streams created at various stages of the nuclear fuel cycle.

Decommissioning

Issues related to decommissioning financial assurance will be addressed in the NRC safety evaluation report for the COL and are not required during the ESP review per 10 CFR 52.16 (TN251). The NRC requirements related to reasonable assurance that funds would be available for the decommissioning process are discussed in 10 CFR 50.75 (TN249).

However, for the purposes of this analysis, the review team notes that because of the effect of discounting the decommissioning cost that would occur as much as 40 years in the future, decommissioning costs have relatively little effect on the levelized cost of electricity generated by a nuclear power plant (WNA 2013-TN2689). Therefore, the review team estimates that decommissioning costs are between 0.1 and 0.2 cents per kilowatt-hour, which is no more than 5 percent of the cost of the electricity produced (WNA 2013-TN2689).

10.6.2.2 External Costs

External costs are adverse social and/or environmental effects caused by the proposed construction and operations at the PSEG Site. This EIS includes the NRC staff's analysis that weighs the environmental impacts of construction and operations at the PSEG Site and mitigation measures available for reducing or avoiding these adverse impacts.

Environmental and Social Costs

Chapter 4 of this EIS describes the impacts on the environment from building at the PSEG Site with respect to land use, air quality, water, terrestrial and aquatic ecosystems, socioeconomics, historic and cultural resources, environmental justice, and nonradiological and radiological health effects. It also describes measures and controls to limit adverse impacts during building at the PSEG Site. Chapter 5 examines the impacts on these same topic areas associated with operating a new nuclear power plant at the PSEG Site for 40 years, as well as postulated accidents. The review team also considered applicable measures and controls that would limit the adverse impacts of station operation during the 40-year operating period.

Chapter 6 similarly addresses the environmental impacts from (1) the uranium fuel cycle and solid-waste management, (2) transportation of radioactive material, and (3) decommissioning at the PSEG Site. Chapter 7 of this EIS places all of the potential impacts of the new nuclear power plant in the context of all past, present, and reasonably foreseeable future activities in the general area. Chapter 9 includes the review team's assessment of alternative sites, alternative power generation systems, and alternative cooling system designs. In Chapter 9, impacts were

also compared to the adverse impacts for the alternative sites. Section 10.2 identifies unavoidable adverse impacts of the proposed action (i.e., impacts after consideration of proposed mitigation actions), and Section 10.4 identifies irretrievable commitments of resources.

Unlike the situation when electricity is generated from coal and natural gas, the normal operation of a nuclear power plant does not result in significant emissions of criteria air pollutants (e.g., nitrogen oxides or sulfur dioxide), methyl mercury, or GHGs associated with global warming and climate change. Chapter 9 of this EIS analyzes coal- and natural-gas-fired alternatives to building and operating a new nuclear power plant at the PSEG Site. Air emissions from the proposed project and its alternatives are summarized in Chapters 4 and 5, and Chapter 9, respectively.

Table 10-4 summarizes the external costs associated with building and operating a new nuclear power plant at the proposed PSEG Site. Table 4-22 summarizes the impacts from construction and preconstruction. The adverse impacts to surface-water use and quality, groundwater use and quality, aquatic ecology, socioeconomics (with the exception of road quality, aesthetics, and traffic during building activities near the site), air quality, nonradiological health, radiological health, and waste management would all be SMALL. There could be an indirect adverse effect to historic properties in New Jersey if natural draft cooling towers are are selected; therefore, impacts could range from SMALL to MODERATE. There would be no construction-, preconstruction-, or operations-related environmental justice impacts. Economic impacts during building would all be beneficial and would vary by county between SMALL and LARGE. Impacts from the NRC action (i.e., construction as defined in 10 CFR 51.4 [TN250]) and operation of the proposed new nuclear power plant would also be SMALL. The impacts to land use would be MODERATE for preconstruction activities; however, impacts to these resources from the NRC portion of the project would be SMALL. Aesthetic and road impacts (i.e., physical socioeconomic impacts) would be MODERATE for preconstruction activities as well as for the NRC portion of the project. The impacts to terrestrial and wetland resources would be SMALL to MODERATE. The MODERATE impact level is based on the impacts to 108 ac of important wetland habitats. For traffic near the PSEG Site (an infrastructure socioeconomic impact), the review team determined that the combined construction and preconstruction impact would be MODERATE, and the NRC portion of the project would also have a MODERATE impact on traffic in the vicinity of the PSEG Site.

10.6.3 Summary of Benefits and Costs

PSEG's business decision to pursue building a new nuclear power plant at the PSEG Site would be an economic decision based on private financial factors subject to regulation by the State of New Jersey Board of Public Utilities. The internal costs of building a new nuclear power plant at the PSEG Site appear to be substantial; however, PSEG's decision to pursue this expansion would be an indication that the company had concluded that the private, or internal, benefits of the proposed facility outweigh the internal costs. Although the identified societal benefits were not specifically monetized, the review team determined that the potential societal benefits of a new nuclear power plant at the PSEG Site would be substantial. In comparison, the external socioeconomic and environmental costs that would be imposed on the region appear to be relatively small.

Table 10-3 and Table 10-4 include summaries of benefits and costs (internal and external) of the activities related to a new nuclear power plant at the PSEG Site. The tables include references to other sections of this EIS when more detailed analyses and impact assessments are available for specific topics. The external costs listed in Table 10-4 summarize environmental impacts to resources that could result from construction, preconstruction, and operation of a new nuclear power plant at the PSEG Site. Because Table 10-4 includes costs for preconstruction activities and for the NRC-authorized construction and operation, the costs presented for an individual resource may be greater than the costs solely for the NRC-authorized portion of the project.

On the basis of the assessments in this EIS, building and operating a new nuclear power plant at the PSEG Site, with mitigation measures identified by the review team, would accrue benefits that most likely would outweigh the economic, environmental, and social costs. For the NRC-proposed action (i.e., NRC-authorized construction and operation), the accrued benefits would also outweigh the costs of construction, preconstruction, and operation of a new nuclear power plant at the PSEG Site.

10.7 Staff Conclusions and Recommendations

The NRC staff recommendation to the Commission, after consideration of the environmental impacts described in this EIS, is that an ESP should be issued for a new nuclear power plant at the PSEG Site in Lower Alloways Creek Township, Salem County, New Jersey. The NRC staff evaluation of the safety and emergency preparedness aspects of the proposed action are addressed in the NRC staff safety evaluation report NRC 2015-TN4369.

The NRC staff recommendation is based on (1) the PSEG ER (PSEG 2015-TN4280); (2) consultation with Federal, State, Tribal, and local agencies; (3) the review team's independent review; (4) the NRC staff consideration of public scoping comments; and (5) the assessments summarized in this EIS, including the potential mitigation measures identified in the ER and in this EIS. In addition, in making its recommendation, the NRC staff has concluded that none of the alternative sites considered is obviously superior to the proposed PSEG Site.

The NRC determination is independent of the USACE determination of a LEDPA pursuant to CWA Section 404(b)(1) Guidelines (40 CFR Part 230-TN427). The USACE will conclude its analysis of both offsite and onsite alternatives in its Record of Decision.

A comparative summary showing the environmental impacts of constructing and operating a new nuclear power plant at the proposed PSEG Site or at any of the alternative sites is shown in Section 9.3.6.1, Table 9-24. This table shows that the significance of the environmental impacts of the proposed action ranges from SMALL to LARGE at the PSEG Site and at each of the alternative sites, depending on the resource category affected.

The range of impacts estimated by the NRC staff for resolved issues is predicated on certain assumptions that are identified in each section and summarized in Appendix J. If the Commission issues an ESP for the PSEG Site, and if that ESP is referenced in an application for a CP or COL, the NRC staff will verify that the assumptions identified in the final EIS remain applicable. In addition, certain issues are not resolved because of a lack of information. An

applicant for a CP or COL referencing an ESP for the PSEG Site would need to provide the necessary information to resolve these issues if the proposed action ultimately would affect the resources associated with these issues.

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12.0 Index

A

Access road, 2-5, 2-15, 2-18, 2-20, 2-53, 2-56, 2-57, 2-58, 2-59, 2-60, 2-66, 2-67, 2-68, 2-77, 2-82, 2-164, 2-165, 2-166, 2-188, 3-16, 4-22, 4-35, 4-84, 5-26, 9-12, 9-28, 9-52, 9-61, 9-64, 9-74, 9-78, 9-85, 9-110, 9-112, 9-116, 9-121, 9-124, 9-125, 9-132, 9-151, 9-152, 9-156, 9-161, 9-164, 9-171, 9-190, 9-192, 9-196, 9-201, 9-204, 9-211, D-17, D-21, D-23, D-39, D-40, D-44, D-50, D-56, D-61, D-65, D-78, D-79, D-82, D-83, D-104, D-105, E-37, E-66, E-70, E-137, E-192, F-29, F.3.3-57, F.3.3-14, F.3.3-29

Accident, x, xi, xviii, xx, xxi, xxvi, xxvii, xxxvii, xl, xlv, 2-175, 2-179, 2-187, 2-189, 3-3, 3-10, 3-13, 3-25, 3-26, 4-77, 4-93, 4-95, 4-96, 4-105, 5-45, 5-60, 5-81, 5-82, 5-97, 5-98, 5-99, 5-100, 5-101, 5-102, 5-103, 5-104, 5-105, 5-106, 5-107, 5-108, 5-109, 5-110, 5-111, 5-112, 5-113, 5-114, 5-115, 5-116, 5-117, 5-118, 5-123, 5-129, 6-17, 6-18, 6-20, 6-25, 6-26, 6-27, 6-28, 6-29, 6-30, 6-35, 6-36, 6-37, 6-38, 6-39, 6-40, 6-41, 6-42, 6-43, 7-40, 7-41, 7-45, 7-46, 7-52, 9-26, 9-33, 9-103, 9-105, 9-106, 9-144, 9-146, 9-147, 9-183, 9-185, 9-186, 9-224, 9-226, 9-227, 9-229, 10-15, A-1, A-2, D-91, E-9, E-21, E-24, E-33, E-34, E-37, E-135, E-136, E-150, E-153, E-154, E-158, E-159, E-160, E-161, E-162, E-187, E-191, E-231, E-237, F.3.1-52, I-6, I-16, I-17, I-18, I-20, I-21, J-14

Advisory Council on Historic Preservation, xxiii, xxxv, 2-157, B-1, C-4, C-15, C-16, E-139, F-2, F-3, F-31

Aesthetic, 4-55, 4-59, 4-73, 4-78, 4-79, 4-110, 5-45, 5-48, 5-56, 5-57, 5-71, 5-126, 5-127, 7-31, 7-33, 9-12, 9-28, 9-29, 9-39, 9-40, 9-87, 9-92, 9-95, 9-135, 9-136, 9-138, 9-139, 9-174, 9-175, 9-176, 9-177, 9-178, 9-214, 9-216, 9-218, 9-219, 10-7, 10-11, 10-12, 10-14, 10-29, 10-32, E-132, E-133, E-134, J-8

Air quality, xxiv, xxvi, xxvii, xxviii, 2-1, 2-176, 2-177, 2-178, 2-179, 2-186, 3-31, 4-3, 4-57, 4-59, 4-79, 4-86, 4-87, 4-88, 4-89, 4-90, 4-95, 4-97, 4-101, 4-102, 4-106, 4-111, 5-1, 5-44, 5-45, 5-62, 5-64, 5-67, 5-68, 5-69, 5-70, 5-75, 5-76, 5-95, 5-96, 5-122, 5-128, 6-45, 7-36, 7-37, 7-39, 7-40, 7-44, 7-48, 9-21, 9-24, 9-27, 9-32, 9-39, 9-45, 9-50, 9-54, 9-87, 9-101, 9-102, 9-103, 9-135, 9-142, 9-143, 9-144, 9-174, 9-181, 9-182, 9-183, 9-214, 9-222, 9-223, 9-224, 9-228, 9-230, 10-11, 10-15, 10-17, 10-20, 10-28, 10-29, 10-31, 10-32, C-7, C-9, C-14, D-18, D-86, D-88, E-34, E-145, E-149, E-190

Alternatives, iii, v, x, xi, xii, xvii, xxi, xxiv, xxviii, xxix, xxx, xxxiii, 1-3, 1-4, 1-6, 1-11, 1-12, 1-13, 2-162, 4-41, 5-16, 5-100, 5-117, 5-118, 6-1, 6-38, 7-39, 9-1, 9-2, 9-3, 9-4, 9-6, 9-8, 9-12, 9-14, 9-19, 9-20, 9-36, 9-37, 9-38, 9-39, 9-41, 9-42, 9-43, 9-44, 9-64, 9-227, 9-232, 9-234, 9-235, 9-237, 9-238, 9-240, 10-1, 10-2, 10-21, 10-22, 10-32, 10-33, A-1, A-2, C-7, C-8, C-9, C-10, C-11, D-6, D-11, D-15, D-19, D-31, D-41, D-42, D-44, D-45, D-46, D-47, D-50, D-51, D-65, D-67, D-71, D-76, D-85, D-91, D-93, D-96, D-98, D-100, D-104, D-105, D-106, D-107, E-9, E-10, E-21, E-31, E-32, E-34, E-38, E-75, E-80, E-141, E-148, E-175, E-177, E-178, E-180, E-181, E-182, E-184, E-185, E-186, E-189, E-233, F-33, F-35, J-15

Aquatic biota, 4-46, 4-47, 4-54, 5-31, 5-38, 5-39, 5-120, 9-85, 9-133, 9-172, 9-212, 10-12, 10-14, 10-28, D-32, D-61, D-67, D-76, D-89, D-105, D-106, E-108, E-116, E-119, E-120, E-127, E-186, E-194, F.3.1-15, F.3.1-24, F.3.1-69, F.3.1-70, F.3.1-74, F.3.2-14, F.3.2-23, F.3.2-76, G-15

Aquatic resources, 1-9, 2-83, 4-25, 4-41, 4-44, 4-45, 4-48, 4-50, 4-53, 4-104, 4-109, 5-3, 5-30, 5-39, 5-42, 5-121, 5-126, 7-20, 7-25, 7-26, 7-27, 7-28, 7-30, 7-50, 9-11, 9-29, 9-39, 9-40, 9-81, 9-82, 9-85, 9-86, 9-129, 9-133, 9-134, 9-168, 9-169, 9-172, 9-173, 9-209, 9-212, 9-213,

9-231, 9-235, 9-236, 10-1, 10-3, 10-6, D-41, D-42, D-51, D-59, D-60, D-61, D-62, D-63, D-64, D-67, D-69, D-70, D-71, D-75, D-92, D-99, D-101, D-104, E-36, E-76, E-78, E-85, E-102, E-106, E-107, E-108, E-110, E-115, E-116, E-117, E-118, E-121, E-123, E-124, E-127, E-189, F.3.1-13, F.3.1-15, F.3.1-37, F.3.1-42, F.3.1-43, F.3.1-68, F.3.1-71, F.3.1-74, F.3.1-76, F.3.1-81, F.3.2-13, F.3.2-14, F.3.2-44, F.3.2-45, F.3.2-46, F.3.2-47, F.3.2-48, F.3.2-75, F.3.2-76, F.3.2-83, F.3.2-84, F.3.3-79, F.3.3-37, J-7

Aquifer, xiv, xxviii, xliii, 2-36, 2-37, 2-38, 2-40, 2-41, 2-42, 2-44, 2-49, 2-50, 2-51, 2-138, 3-7, 3-8, 3-11, 3-15, 3-25, 4-17, 4-18, 4-19, 4-20, 4-23, 4-24, 4-76, 4-104, 4-109, 5-5, 5-6, 5-8, 5-9, 5-10, 5-15, 5-16, 5-17, 5-59, 5-124, 5-125, 7-10, 7-12, 7-13, 7-16, 7-17, 7-49, 7-50, 9-67, 9-68, 9-70, 9-71, 9-72, 9-73, 9-116, 9-117, 9-118, 9-119, 9-120, 9-155, 9-156, 9-158, 9-159, 9-160, 9-195, 9-196, 9-198, 9-199, 9-200, 9-238, 9-239, 9-240, 10-12, 10-13, 10-19, D-27, D-35, E-49, E-54, E-56, E-57, E-58, E-59, E-60, E-61, E-62, E-63, E-64, E-65, E-119, E-155, E-156, J-4, J-5

Archaeological resources, 4-85, 5-67, 7-36, 9-12, 9-180

Area of potential effects (APE), xxxv, 2-157, 2-159, 2-162, 2-163, 4-83, 4-84, 7-34, 7-35, 9-99, 9-100, 9-140, 9-178, 9-179, 9-220, D-83, D-84, D-85, E-137, E-139, F-30, F-31, F-33, J-9

B

Best management practices (BMPs), xxxvi, 2-186, 3-7, 3-20, 3-27, 4-15, 4-16, 4-21, 4-22, 4-23, 4-24, 4-39, 4-45, 4-46, 4-50, 4-51, 4-53, 4-54, 4-55, 4-56, 4-80, 4-81, 4-102, 4-103, 4-104, 4-105, 4-106, 4-109, 4-109, 5-5, 5-10, 5-15, 5-22, 5-39, 5-41, 5-43, 5-118, 5-119, 5-120, 5-121, 7-16, 7-24, 7-25, 7-26, 9-21, 9-27, 9-29, 9-30, 9-34, 9-35, 9-69, 9-70, 9-72, 9-73, 9-84, 9-85, 9-86, 9-117, 9-118, 9-120, 9-132, 9-133, 9-134, 9-157, 9-158, 9-160, 9-171, 9-172, 9-173, 9-196, 9-197, 9-198, 9-200, 9-212, 9-213, 10-5, 10-6, 10-13, 10-14, D-24, D-30, D-39, D-56, D-88, E-32, E-51, E-116, E-124, E-209, F.3.1-4, F.3.1-14, F.3.1-15, F.3.1-24, F.3.1-37, F.3.1-44, F.3.1-60, F.3.1-69, F.3.1-75, F.3.1-82, F.3.2-4, F.3.2-13, F.3.2-14, F.3.2-24, F.3.2-33, F.3.2-34, F.3.2-35, F.3.2-36, F.3.2-37, F.3.2-38, F.3.2-39, F.3.2-40, F.3.2-41, F.3.2-43, F.3.2-44, F.3.2-64, F.3.2-72, F.3.2-75, F.3.2-76, F.3.2-85, F.3.3-46, F.3.3-67, F.3.3-68, F.3.3-69, F.3.3-78, F.3.3-4, F.3.3-24, F.3.3-25, F.3.3-26, F.3.3-36, J-4, J-7

Biological assessment (BA), xxxv, 2-67, 2-113, 2-114, 2-115, 2-116, 4-31, 4-50, 4-51, 5-23, 5-41, E-30, E-113, E-114, E-115, F-1, F.3.1-1, F.3.1-7, F.3.1-61, F.3.1-62, F.3.1-63, F.3.3-46, F.3.3-49, F.3.3-70, F.3.3-1, F.3.3-4, F.3.3-6, F.3.3-7, F.3.3-27, J-6, J-7

Biological Opinion (BO), E-114, E-115, F.3.1-38, F.3.1-39, F.3.1-40, F.3.1-51, F.3.1-62, F.3.1-75, F.3.1-77, F.3.1-78, F.3.1-79, F.3.1-85, F.3.1-87

Birds, xxxv, xxxvi, 2-57, 2-58, 2-59, 2-60, 2-61, 2-63, 2-64, 2-66, 2-68, 2-70, 2-71, 2-72, 2-73, 2-74, 2-75, 2-76, 2-77, 2-78, 2-82, 2-136, 4-29, 4-30, 4-32, 4-33, 4-34, 4-35, 4-36, 4-37, 4-42, 4-59, 5-17, 5-20, 5-21, 5-22, 5-23, 5-24, 5-25, 5-26, 5-27, 5-29, 5-30, 5-48, 5-91, 5-126, 7-22, 7-23, 7-28, 7-29, 9-11, 9-74, 9-75, 9-76, 9-78, 9-122, 9-124, 9-125, 9-162, 9-164, 9-165, 9-201, 9-202, 9-204, 9-205, 10-12, 10-13, D-28, D-39, D-41, D-42, D-44, D-47, D-56, D-61, D-70, D-97, D-99, D-101, D-104, E-72, E-74, E-75, E-91, E-93, E-94, E-96, E-98, E-99, E-101, E-118, E-120, E-131, E-177, E-180, E-182, E-183, E-210, F.3.1-41, F.3.1-42, F.3.1-80, F.3.2-31, F.3.2-46, F.3.2-47, F.3.3-63, F.3.3-64, F.3.3-67, F.3.3-68, F.3.3-69, F.3.3-70, F.3.3-71, F.3.3-73, F.3.3-74, F.3.3-77, F.3.3-79, F.3.3-80, F.3.3-83, F.3.3-1, F.3.3-20, F.3.3-21, F.3.3-24, F.3.3-25, F.3.3-26, F.3.3-27, F.3.3-29, F.3.3-35, F.3.3-40, H-3

Burnup, 3-12, 6-7, 7-46, I-26

C

Candidate species, xxi, 2-62, 2-97, 2-113, 4-42, 5-39, 8-10, 9-45, 9-46, 9-47, 9-48, 9-50, 9-51, 9-52, 9-53, 9-54, 9-228, D-48, D-52, E-72, E-80, E-81, E-84, E-186, F.3.1-7, F.3.1-25, F.3.1-55, F.3.1-62, F.3.1-73, F.3.1-92, F.3.2-58, F.3.2-84, F.3.3-48, F.3.3-73, F.3.3-6
Chronic effects, 2-190, 5-18, 5-80, 7-41, 7-42, E-92, F.3.3-65, F.3.3-22
Clean Air Act (CAA), xxxvi, 2-177, 2-186, 3-27, 3-31, 4-86, 4-102, 5-64, 5-69, 5-128, 7-36, 9-22, 9-23, 9-31, 9-42, 10-15, D-86, D-87, D-88, E-145, E-146, H-6
Clean Water Act (CWA), iii, xxiv, xxxiii, xxxvi, 1-1, 1-2, 1-7, 1-8, 1-9, 1-11, 1-12, 1-13, 2-6, 2-47, 2-79, 3-14, 3-21, 3-26, 3-30, 4-2, 4-12, 4-16, 4-22, 4-38, 4-42, 4-102, 4-112, 5-4, 5-14, 5-29, 5-31, 5-96, 5-119, 5-125, 7-26, 9-1, 9-227, 9-236, 9-237, 10-1, 10-3, 10-5, 10-21, 10-22, 10-33, D-20, D-26, D-33, D-49, D-51, D-58, D-60, D-62, D-64, D-68, D-71, D-92, D-105, D-106, E-5, E-7, E-26, E-42, E-47, E-48, E-50, E-69, E-70, E-89, E-107, E-109, E-110, E-119, E-127, E-189, F.3.1-6, F.3.1-15, F.3.1-36, F.3.1-46, F.3.1-61, F.3.1-83, F.3.2-7, F.3.2-15, F.3.2-44, F.3.2-53, F.3.2-65, F.3.2-84, F.3.2-87, H-2, H-4, H-5
Climate change, 2-69, 2-90, 2-177, 7-9, 7-11, 7-12, 7-14, 7-15, 7-16, 7-17, 7-21, 7-25, 7-26, 7-29, 7-30, 7-39, 7-42, 7-50, 9-22, 9-31, 9-38, 9-66, 9-72, 9-81, 9-86, 9-104, 9-115, 9-119, 9-121, 9-128, 9-133, 9-145, 9-154, 9-159, 9-161, 9-167, 9-173, 9-183, 9-194, 9-198, 9-200, 9-208, 9-213, 9-225, 10-32, D-33, D-102, D-103, E-32, E-33, E-67, E-75, E-89, E-95, E-110, E-115, E-126, E-141, E-142, E-143, E-144, E-149, E-155, E-167, E-201, E-209, E-227, E-228, E-229, E-230, E-231, E-232, E-233, E-234, F.3.1-12, F.3.1-28, F.3.1-37, F.3.1-42, F.3.1-43, F.3.1-76, F.3.1-80, F.3.1-81, F.3.2-11, F.3.2-44, F.3.2-47, F.3.2-48, F.3.3-73, F.3.3-78, F.3.3-35, K-3
Closed-cycle cooling, 2-43, 5-31, 5-32, 5-34, 5-36, 5-37, 5-40, 5-41, 5-42, 5-77, 5-120, 5-121, 5-126, 7-27, 9-20, 9-37, 9-42, 9-82, 9-85, 9-133, 9-172, 9-212, 10-14, D-31, D-33, D-54, D-57, D-66, D-67, D-106, E-105, E-108, E-109, E-114, E-123, F.3.1-15, F.3.1-16, F.3.1-19, F.3.1-20, F.3.1-21, F.3.1-35, F.3.1-38, F.3.1-44, F.3.1-77, F.3.2-15, F.3.2-16, F.3.2-18, F.3.2-19, F.3.2-20, F.3.2-33, F.3.2-35, F.3.2-36, F.3.2-45, F.3.2-48, F.3.2-49, F.3.2-50, J-7
Coastal Zone Management Act (CZMA), xxxvii, 1-13, 2-12, 4-12, 5-4, E-42
Consumptive use, 2-44, 4-81, 5-7, 5-8, 5-31, 5-124, 7-11, 7-49, 9-69, 9-71, 9-117, 9-119, 9-157, 9-197, 9-199, 10-12, 10-13, 10-19, F.3.1-16, F.3.2-15, J-5
Continued storage, 6-15, 6-16, E-166, E-167
Cooling system, iii, 2-43, 2-91, 2-185, 3-7, 3-15, 3-25, 4-85, 5-11, 5-17, 5-31, 5-34, 5-36, 5-38, 5-40, 5-67, 5-71, 5-76, 5-77, 5-78, 5-82, 5-128, 7-21, 7-27, 7-30, 7-42, 9-13, 9-28, 9-35, 9-39, 9-232, 9-233, 9-234, 9-235, 10-12, 10-14, 10-15, 10-17, 10-31, D-15, D-26, D-27, D-31, D-32, D-33, D-50, D-53, D-58, D-60, D-62, D-65, D-66, D-67, D-68, D-82, D-91, D-92, D-105, D-106, D-107, E-47, E-48, E-103, E-104, E-106, E-125, E-127, E-139, E-182, E-186, E-225, F-30, F-32, F.3.1-12, F.3.1-15, F.3.1-16, F.3.1-19, F.3.1-21, F.3.1-22, F.3.1-38, F.3.1-43, F.3.1-77, F.3.1-81, F.3.2-12, F.3.2-14, F.3.2-15, F.3.2-18, F.3.2-20, F.3.2-21, F.3.2-45, F.3.2-47, F.3.2-74, F.3.3-64, F.3.3-73, F.3.3-77, F.3.3-21, F.3.3-31, F.3.3-35, J-8
Cooling tower, xv, xxv, xxvii, xl, xlii, 2-24, 2-61, 2-98, 2-105, 2-114, 2-136, 2-163, 2-164, 2-168, 2-178, 2-180, 2-188, 3-1, 3-3, 3-4, 3-7, 3-8, 3-9, 3-10, 3-11, 3-13, 3-14, 3-15, 3-24, 3-25, 3-26, 3-30, 3-31, 4-13, 4-25, 4-39, 4-44, 4-45, 4-59, 4-73, 4-84, 4-85, 4-109, 4-111, 5-2, 5-10, 5-17, 5-18, 5-20, 5-21, 5-24, 5-29, 5-30, 5-37, 5-38, 5-44, 5-45, 5-48, 5-56, 5-63, 5-64, 5-67, 5-68, 5-71, 5-72, 5-73, 5-74, 5-75, 5-77, 5-78, 5-79, 5-94, 5-95, 5-120, 5-124, 5-126, 5-127, 5-128, 6-2, 6-9, 7-21, 7-22, 7-33, 7-34, 7-37, 7-42, 7-51, 9-28, 9-35, 9-39, 9-40, 9-42, 9-67, 9-71,

9-79, 9-80, 9-92, 9-100, 9-101, 9-102, 9-126, 9-127, 9-141, 9-143, 9-166, 9-180, 9-181, 9-206, 9-207, 9-221, 9-222, 9-232, 9-233, 9-234, 9-235, 9-240, 10-7, 10-8, 10-11, 10-12, 10-13, 10-14, 10-15, 10-16, 10-17, 10-28, 10-32, D-26, D-27, D-31, D-32, D-33, D-57, D-58, D-59, D-61, D-62, D-66, D-68, D-77, D-81, D-85, D-86, D-105, D-106, D-107, E-47, E-48, E-50, E-52, E-67, E-92, E-95, E-100, E-101, E-103, E-104, E-108, E-126, E-133, E-134, E-138, E-139, E-140, E-142, E-186, E-194, E-214, F-29, F-30, F-31, F-32, F-33, F.3.1-7, F.3.1-13, F.3.1-22, F.3.1-24, F.3.1-27, F.3.1-29, F.3.2-15, F.3.2-21, F.3.2-23, F.3.2-29, F.3.2-39, F.3.3-45, F.3.3-46, F.3.3-49, F.3.3-58, F.3.3-63, F.3.3-64, F.3.3-65, F.3.3-67, F.3.3-73, F.3.3-77, F.3.3-3, F.3.3-4, F.3.3-7, F.3.3-15, F.3.3-20, F.3.3-21, F.3.3-22, F.3.3-24, F.3.3-31, F.3.3-35, F.3.3-37, H-6, I-11, I-12, I-13, I-14, I-15, I-16, I-17, I-18, J-3, J-5, J-6, J-7, J-8, J-9, J-10, J-12

Core damage frequency (CDF), xxxvi, 1-10, 2-1, 2-5, 2-6, 2-10, 2-12, 2-25, 2-35, 2-79, 2-80, 2-83, 2-192, 2-193, 3-1, 3-21, 4-4, 4-7, 4-8, 4-13, 4-14, 4-25, 4-32, 4-38, 4-39, 4-41, 4-107, 5-107, 5-108, 5-115, 5-116, 7-6, 7-7, 7-19, 7-20, 7-28, 9-114, 9-153, 9-193, 10-10, D-15, D-19, D-20, D-21, D-25, D-46, D-49, D-52, D-62, D-64, D-68, D-69, D-76, D-89, D-105, E-29, E-40, E-41, E-42, E-43, E-44, E-45, E-83, E-99, E-100, E-101, E-109, E-209, F.3.1-4, F.3.1-42, F.3.2-4, F.3.2-7, F.3.2-46, F.3.2-64, F.3.2-67, F.3.2-72, F.3.2-82, F.3.2-83, F.3.3-46, F.3.3-58, F.3.3-4, F.3.3-15, F.3.3-33, J-3

Council on Environmental Quality (CEQ), xxxvi, 1-5, 1-8, 2-145, 9-1, 9-36, 9-229, 10-3, 10-22, E-143, E-144, E-171, E-227

Cultural resources, iii, xxiv, xxvi, xxvii, xxviii, 1-6, 2-1, 2-10, 2-156, 2-157, 2-159, 2-162, 4-2, 4-3, 4-83, 4-84, 4-85, 4-105, 5-1, 5-66, 5-67, 5-128, 6-15, 7-34, 7-35, 7-36, 9-12, 9-28, 9-34, 9-38, 9-39, 9-45, 9-50, 9-54, 9-96, 9-99, 9-100, 9-101, 9-140, 9-141, 9-142, 9-178, 9-179, 9-180, 9-181, 9-220, 9-221, 9-222, 9-231, 10-8, 10-11, 10-15, 10-17, 10-20, 10-29, 10-31, C-6, C-9, D-84, D-85, E-28, E-137, E-140, E-189, E-191, F-1

D

Decommissioning, x, xi, xxvi, xxvii, xxxix, 1-13, 2-117, 4-1, 6-1, 6-4, 6-8, 6-44, 6-45, 7-1, 7-2, 7-5, 7-21, 7-38, 7-39, 7-43, 7-46, 7-48, 7-52, 9-6, 9-42, 9-44, 9-55, 9-56, 9-145, 9-184, 9-225, 10-4, 10-16, 10-17, 10-18, 10-27, 10-29, 10-31, A-1, A-2, C-7, C-10, E-10, E-21, E-31, E-33, E-34, E-145, E-148, E-163, E-169, E-170, E-191, E-233, F.3.3-76, F.3.3-34, J-13, J-17, K-1, K-2, K-3, K-5

Delaware Department of Natural Resources and Environmental Control (DNREC), xxxvii, 2-63, 2-67, 2-81, 2-82, 2-113, 2-115, 2-136, 9-130, 9-132, 9-170, 9-210, B-1, D-88, E-22, E-107, E-197, E-205, E-207, E-208

Delaware River Basin Commission (DRBC), xxxvii, 2-26, 2-27, 2-32, 2-43, 2-44, 2-45, 2-47, 2-48, 2-51, 2-90, 2-98, 4-22, 4-101, 4-102, 4-112, 5-4, 5-5, 5-7, 5-8, 5-10, 5-14, 5-15, 5-37, 5-77, 5-95, 5-96, 5-119, 5-125, 7-10, 7-11, 7-12, 7-15, 7-26, 7-29, 9-67, 9-70, 9-71, 9-72, 9-73, 9-83, 9-115, 9-118, 9-120, 9-129, 9-155, 9-158, 9-160, 9-169, 9-195, 9-197, 9-198, 9-199, 9-209, B-1, E-33, E-53, E-58, F.3.1-4, F.3.1-8, F.3.1-12, F.3.1-22, F.3.1-36, F.3.1-43, F.3.1-47, F.3.1-60, F.3.1-64, F.3.1-81, F.3.1-84, F.3.2-4, F.3.2-11, F.3.2-21, F.3.2-34, F.3.2-35, F.3.2-36, F.3.2-37, F.3.2-38, F.3.2-40, F.3.2-42, F.3.2-43, F.3.2-44, F.3.2-47, F.3.2-54, F.3.2-64, F.3.2-71, F.3.2-88, H-3

Direct impacts, 1-10, 2-124, 4-38, 4-39, 4-41, 4-44, 9-28, 9-34, 9-39, 9-124, D-66, E-117, F.3.1-13, F.3.1-68, F.3.2-13, F.3.2-75, F.3.2-83

Discharge structure, xxv, 1-12, 3-4, 3-12, 3-23, 4-13, 4-44, 4-45, 4-46, 4-50, 4-51, 4-53, 4-54, 5-119, 9-69, 9-82, 9-84, 9-85, 9-86, 9-116, 9-117, 9-130, 9-133, 9-134, 9-156, 9-157, 9-169, 9-172, 9-173, 9-196, 9-210, 9-212, 9-213, 9-233, 10-11, 10-20, D-27, E-101, E-114, E-123, E-127, F.3.1-7, F.3.1-13, F.3.1-14, F.3.1-34,

F.3.1-36, F.3.1-44, F.3.1-61, F.3.1-63, F.3.1-68, F.3.1-69, F.3.2-13, F.3.2-14, F.3.2-33, F.3.2-66, F.3.2-67, F.3.2-75, H-2, J-7

Discharges, 1-2, 1-6, 1-8, 2-27, 2-28, 2-45, 2-51, 2-187, 3-25, 3-30, 3-31, 4-1, 4-12, 4-15, 4-21, 4-23, 4-24, 4-97, 4-98, 4-101, 5-4, 5-6, 5-10, 5-12, 5-14, 5-15, 5-38, 5-64, 5-76, 5-77, 5-94, 5-95, 5-119, 5-120, 5-121, 5-122, 5-123, 5-125, 6-9, 6-10, 7-5, 7-15, 7-16, 7-41, 7-44, 7-49, 9-11, 9-25, 9-26, 9-56, 9-60, 9-67, 9-70, 9-72, 9-73, 9-85, 9-103, 9-109, 9-120, 9-132, 9-144, 9-150, 9-160, 9-172, 9-183, 9-189, 9-200, 9-212, 9-224, 9-233, 10-3, 10-12, 10-13, D-26, D-54, D-61, D-66, D-67, D-88, E-26, E-51, E-53, E-54, E-55, E-59, E-118, E-119, E-120, E-225, F.3.1-24, F.3.2-23, H-4, H-5

Dose, radiation, viii, ix, x, xix, xx, xxxv, xxxvi, xl, xlii, xliii, xliv, xlv, 1-14, 2-177, 2-181, 2-185, 2-190, 3-28, 4-80, 4-97, 4-98, 4-99, 4-100, 4-106, 4-112, 5-63, 5-79, 5-82, 5-83, 5-86, 5-87, 5-88, 5-89, 5-90, 5-91, 5-92, 5-93, 5-100, 5-101, 5-102, 5-103, 5-104, 5-105, 5-106, 5-107, 5-108, 5-109, 5-110, 5-111, 5-112, 5-113, 5-115, 5-116, 5-122, 5-123, 5-128, 5-129, 6-5, 6-11, 6-12, 6-13, 6-14, 6-17, 6-18, 6-19, 6-20, 6-21, 6-22, 6-23, 6-24, 6-25, 6-26, 6-29, 6-30, 6-31, 6-32, 6-33, 6-34, 6-35, 6-36, 6-37, 6-38, 6-41, 6-45, 7-42, 7-43, 7-45, 7-47, 7-48, 7-51, 9-25, 9-26, 9-104, 9-105, 9-146, 9-184, 9-225, 9-233, 10-9, 10-11, 10-16, 10-17, A-1, A-2, C-7, C-9, D-90, E-150, E-151, E-152, E-153, E-154, E-155, E-156, E-161, E-169, E-223, G-7, G-8, G-9, G-10, G-11, G-12, G-13, G-14, G-15, G-16, I-6, I-7, I-8, J-11, J-12, J-16

Dredging, xliii, 2-1, 2-5, 2-34, 2-38, 2-68, 2-78, 2-163, 2-166, 2-193, 4-2, 4-8, 4-12, 4-13, 4-16, 4-21, 4-22, 4-44, 4-46, 4-47, 4-48, 4-50, 4-51, 4-52, 4-53, 4-81, 4-83, 4-84, 4-104, 4-107, 4-108, 4-109, 5-4, 5-5, 5-6, 5-15, 5-39, 5-41, 5-42, 5-66, 5-95, 5-119, 5-120, 5-126, 7-7, 7-15, 7-19, 7-20, 7-25, 7-26, 7-28, 7-30, 7-50, 9-84, 9-114, 9-127, 9-131, 9-132, 9-153, 9-167, 9-170, 9-171, 9-193, 9-207, 9-211, 9-212, 9-236, 10-5, 10-6, 10-10, 10-11, 10-20, D-11, D-15, D-18, D-19, D-20, D-21, D-25, D-28, D-29, D-30, D-31, D-50, D-65, D-66, D-67, D-68, D-69, D-70, D-71, D-72, D-73, D-76, D-107, E-37, E-38, E-42, E-43, E-50, E-51, E-54, E-101, E-110, E-112, E-113, E-114, E-118, E-119, E-124, E-127, E-189, F-29, F.3.1-2, F.3.1-3, F.3.1-8, F.3.1-13, F.3.1-14, F.3.1-15, F.3.1-24, F.3.1-27, F.3.1-34, F.3.1-36, F.3.1-37, F.3.1-41, F.3.1-43, F.3.1-44, F.3.1-55, F.3.1-58, F.3.1-62, F.3.1-63, F.3.1-68, F.3.1-69, F.3.1-71, F.3.1-73, F.3.1-74, F.3.1-75, F.3.1-81, F.3.1-82, F.3.1-92, F.3.1-93, F.3.2-2, F.3.2-13, F.3.2-14, F.3.2-24, F.3.2-33, F.3.2-34, F.3.2-35, F.3.2-36, F.3.2-37, F.3.2-38, F.3.2-39, F.3.2-40, F.3.2-41, F.3.2-42, F.3.2-43, F.3.2-44, F.3.2-46, F.3.2-48, F.3.2-49, F.3.2-50, F.3.2-51, F.3.2-52, F.3.2-58, F.3.2-62, F.3.2-67, F.3.2-74, F.3.2-75, F.3.2-76, F.3.2-82, F.3.2-84, F.3.2-85, F.3.2-86, F.3.2-91, F.3.2-92, F.3.3-50, F.3.3-75, F.3.3-7, F.3.3-33, H-2, H-6, J-3, J-5, J-7

drilling, 2-191, 4-12, 4-56, 5-5, E-35, H-5

E

Electromagnetic fields, xxxviii, 2-185, 2-189, 2-190, 5-76, 5-79, 5-80, 5-81, 5-82, 7-41, 7-42, 9-103, 9-144, 9-182, 9-183, 9-223, 9-224, F.3.3-46, F.3.3-70, F.3.3-4, F.3.3-27

Emissions, vii, xi, xviii, xix, xxi, xxviii, 2-177, 2-178, 2-179, 2-186, 2-188, 3-27, 3-30, 3-31, 4-55, 4-56, 4-57, 4-80, 4-81, 4-86, 4-87, 4-88, 4-89, 4-90, 4-91, 4-92, 4-94, 4-101, 4-102, 4-105, 4-106, 4-111, 5-20, 5-43, 5-44, 5-45, 5-62, 5-64, 5-67, 5-68, 5-69, 5-70, 5-71, 5-72, 5-75, 5-76, 5-81, 5-94, 5-95, 5-96, 5-118, 5-121, 5-122, 5-123, 5-128, 6-2, 6-9, 6-10, 6-11, 6-17, 6-45, 7-5, 7-11, 7-33, 7-37, 7-38, 7-39, 7-40, 7-41, 7-44, 7-48, 7-51, 8-2, 8-4, 8-17, 8-21, 9-5, 9-12, 9-16, 9-17, 9-19, 9-20, 9-21, 9-22, 9-23, 9-24, 9-25, 9-26, 9-27, 9-30, 9-31, 9-32, 9-33, 9-36, 9-37, 9-38, 9-41, 9-42, 9-43, 9-44, 9-59, 9-81, 9-101, 9-102, 9-103, 9-104, 9-109, 9-128, 9-142, 9-143, 9-144, 9-145, 9-150, 9-181, 9-182, 9-183, 9-189, 9-208, 9-222,

9-223, 9-224, 9-229, 10-7, 10-8, 10-11, 10-14, 10-15, 10-17, 10-24, 10-28, 10-29, 10-32, D-16, D-18, D-34, D-85, D-87, D-88, D-98, D-99, D-101, D-103, E-105, E-140, E-141, E-142, E-143, E-144, E-145, E-146, E-147, E-148, E-149, E-150, E-153, E-168, E-177, E-178, E-199, E-200, E-201, F.3.3-63, F.3.3-20, J-9, K-1, K-2, K-3, K-4, K-5

Endangered species, xvii, xxi, xxii, xxxviii, xlv, 1-7, 2-56, 2-57, 2-62, 2-63, 2-66, 2-67, 2-70, 2-71, 2-72, 2-73, 2-74, 2-75, 2-78, 2-79, 2-97, 2-110, 2-112, 2-113, 2-114, 2-115, 2-116, 4-2, 4-30, 4-31, 4-33, 4-34, 4-35, 4-36, 4-38, 4-50, 4-51, 4-52, 4-95, 5-20, 5-21, 5-22, 5-23, 5-24, 5-25, 5-26, 5-27, 5-28, 5-39, 5-41, 5-79, 5-126, 7-22, 7-24, 7-28, 9-2, 9-26, 9-29, 9-34, 9-35, 9-50, 9-74, 9-75, 9-81, 9-83, 9-86, 9-121, 9-122, 9-124, 9-129, 9-130, 9-132, 9-134, 9-161, 9-162, 9-168, 9-169, 9-170, 9-171, 9-173, 9-201, 9-202, 9-208, 9-210, 9-211, 9-213, 10-28, C-13, D-42, D-47, D-57, D-59, D-63, D-66, D-73, D-74, D-76, E-28, E-29, E-36, E-52, E-90, E-91, E-99, E-105, E-106, E-111, E-120, E-124, E-125, E-224, F-1, F-3, F-43, F.3.1-3, F.3.1-4, F.3.1-6, F.3.1-7, F.3.1-25, F.3.1-26, F.3.1-27, F.3.1-28, F.3.1-29, F.3.1-30, F.3.1-31, F.3.1-32, F.3.1-34, F.3.1-38, F.3.1-40, F.3.1-42, F.3.1-44, F.3.1-45, F.3.1-50, F.3.1-51, F.3.1-59, F.3.1-60, F.3.1-61, F.3.1-62, F.3.1-63, F.3.1-73, F.3.1-77, F.3.1-79, F.3.1-83, F.3.1-87, F.3.2-7, F.3.2-46, F.3.2-65, F.3.3-46, F.3.3-48, F.3.3-49, F.3.3-63, F.3.3-64, F.3.3-67, F.3.3-70, F.3.3-80, F.3.3-4, F.3.3-6, F.3.3-7, F.3.3-20, F.3.3-21, F.3.3-24, F.3.3-27, F.3.3-28, F.3.3-30, F.3.3-36, F.3.3-37, F.3.3-38, H-3, J-6, J-7

Endangered Species Act (ESA), xxxviii, 1-7, 2-97, 2-110, 2-112, 2-113, 4-2, 4-31, 4-51, 5-23, 5-41, 9-2, D-66, D-73, D-74, D-76, E-29, E-30, E-111, E-114, E-115, E-120, E-121, E-126, F.3.1-2, F.3.1-3, F.3.1-4, F.3.1-7, F.3.1-26, F.3.1-27, F.3.1-28, F.3.1-30, F.3.1-31, F.3.1-32, F.3.1-34, F.3.1-38, F.3.1-45, F.3.1-51, F.3.1-60, F.3.1-61, F.3.1-62, F.3.1-63, F.3.1-77, F.3.1-81, F.3.1-83, F.3.1-86, F.3.3-45, F.3.3-46, F.3.3-48, F.3.3-49, F.3.3-72, F.3.3-73, F.3.3-80, F.3.3-3, F.3.3-4, F.3.3-6, F.3.3-28, F.3.3-30, F.3.3-38, H-3

Entrainment, 2-91, 2-94, 2-117, 5-31, 5-36, 5-37, 5-40, 5-42, 5-121, 5-126, 6-2, 6-3, 7-27, 9-85, 9-133, 9-172, 9-212, 9-213, 9-233, 9-235, 10-12, 10-14, D-25, D-26, D-54, D-58, D-61, D-66, D-67, D-68, D-105, E-108, E-110, E-114, E-117, E-125, E-126, E-127, E-186, E-194, F.3.1-3, F.3.1-12, F.3.1-15, F.3.1-16, F.3.1-20, F.3.1-21, F.3.1-34, F.3.1-35, F.3.1-37, F.3.1-38, F.3.1-76, F.3.1-77, F.3.2-2, F.3.2-12, F.3.2-14, F.3.2-15, F.3.2-19, F.3.2-20, F.3.2-33, F.3.2-35, F.3.2-36, F.3.2-40, F.3.2-42, F.3.2-45, F.3.2-50, F.3.2-51, F.3.2-74

Environmental justice (EJ), xxvi, 2-1, 2-145, 2-146, 2-149, 2-155, 2-156, 4-3, 4-82, 4-83, 5-1, 5-65, 5-66, 7-30, 7-33, 7-34, 7-52, 9-45, 9-54, 9-96, 9-139, 9-178, 9-219, 9-231, 10-12, 10-31, 10-32, E-28, E-135, E-136, E-158, E-164, E-167, E-168, E-226, E-230

Erosion, xlv, 1-6, 2-170, 3-18, 3-19, 3-20, 4-2, 4-4, 4-15, 4-16, 4-21, 4-22, 4-23, 4-25, 4-38, 4-39, 4-44, 4-45, 4-50, 4-51, 4-53, 4-81, 4-102, 4-103, 4-104, 4-105, 5-5, 5-10, 5-39, 5-118, 5-119, 5-120, 6-45, 7-9, 7-25, 7-26, 7-29, 9-11, 9-17, 9-26, 9-66, 9-69, 9-76, 9-85, 9-115, 9-117, 9-132, 9-154, 9-157, 9-171, 9-194, 9-196, 9-212, D-16, D-24, D-30, E-116, E-231, F.3.1-13, F.3.1-14, F.3.1-24, F.3.1-29, F.3.1-36, F.3.1-37, F.3.1-43, F.3.1-68, F.3.1-69, F.3.1-75, F.3.1-80, F.3.2-13, F.3.2-43, F.3.2-44, F.3.2-47, F.3.2-75, F.3.3-58, F.3.3-15, H-4, J-4, J-6, J-7

Essential fish habitat (EFH), iii, xxxviii, 2-97, 2-117, 4-50, 4-53, 5-42, 9-130, 9-169, 9-209, 10-29, D-51, D-71, D-74, D-75, D-76, E-110, E-112, E-113, E-124, F.3.2-2, F.3.2-3, F.3.2-4, F.3.2-6, F.3.2-12, F.3.2-13, F.3.2-24, F.3.2-25, F.3.2-26, F.3.2-27, F.3.2-32, F.3.2-33, F.3.2-34, F.3.2-35, F.3.2-36, F.3.2-37, F.3.2-38, F.3.2-39, F.3.2-40, F.3.2-41, F.3.2-42, F.3.2-43, F.3.2-45, F.3.2-48, F.3.2-49, F.3.2-50, F.3.2-51, F.3.2-52,

F.3.2-56, F.3.2-62, F.3.2-63, F.3.2-64, F.3.2-66, F.3.2-67, F.3.2-71, F.3.2-72, F.3.2-79, F.3.2-80, F.3.2-81, F.3.2-82, F.3.2-83, F.3.2-84, F.3.2-85, F.3.2-86, F.3.2-89, J-7
Evaporative loss, 7-12, 9-233

F

Farmland, xiv, xv, xvi, 2-10, 2-15, 2-16, 2-75, 4-7, 4-10, 4-42, 5-2, 5-107, 5-124, 9-60, 9-61, 9-62, 9-64, 9-65, 9-110, 9-111, 9-113, 9-151, 9-189, 9-190, 9-201, E-160, J-4
Fish, xvii, xviii, xxxvii, xxxviii, 1-6, 1-7, 2-47, 2-48, 2-67, 2-74, 2-75, 2-76, 2-77, 2-78, 2-79, 2-82, 2-85, 2-86, 2-87, 2-90, 2-91, 2-92, 2-94, 2-95, 2-97, 2-98, 2-99, 2-100, 2-101, 2-102, 2-103, 2-104, 2-105, 2-106, 2-107, 2-109, 2-110, 2-111, 2-112, 2-113, 2-116, 2-117, 2-190, 4-2, 4-44, 4-45, 4-46, 4-47, 4-48, 4-50, 4-51, 4-52, 4-53, 4-99, 5-31, 5-32, 5-34, 5-35, 5-36, 5-38, 5-40, 5-42, 5-83, 5-86, 5-91, 5-92, 5-93, 5-115, 5-120, 5-126, 7-15, 7-25, 7-26, 7-27, 7-28, 9-24, 9-73, 9-82, 9-83, 9-84, 9-108, 9-120, 9-130, 9-131, 9-132, 9-150, 9-160, 9-169, 9-171, 9-199, 9-202, 9-209, 9-211, 9-212, 9-235, 10-29, C-3, D-28, D-32, D-37, D-38, D-40, D-42, D-43, D-47, D-49, D-52, D-53, D-54, D-55, D-56, D-57, D-58, D-59, D-60, D-62, D-63, D-64, D-66, D-67, D-70, D-71, D-72, D-73, D-74, D-75, D-76, D-81, D-82, D-91, D-92, D-106, E-8, E-48, E-49, E-65, E-66, E-67, E-68, E-72, E-74, E-75, E-80, E-87, E-89, E-90, E-97, E-102, E-103, E-104, E-105, E-106, E-107, E-108, E-109, E-111, E-112, E-113, E-114, E-115, E-116, E-117, E-118, E-119, E-120, E-121, E-123, E-124, E-125, E-126, E-127, E-150, E-166, E-205, E-206, E-208, E-224, E-225, E-227, E-236, F-1, F.3.1-3, F.3.1-4, F.3.1-6, F.3.1-7, F.3.1-12, F.3.1-13, F.3.1-14, F.3.1-15, F.3.1-16, F.3.1-18, F.3.1-19, F.3.1-20, F.3.1-21, F.3.1-22, F.3.1-24, F.3.1-28, F.3.1-30, F.3.1-31, F.3.1-32, F.3.1-33, F.3.1-36, F.3.1-37, F.3.1-41, F.3.1-42, F.3.1-44, F.3.1-45, F.3.1-47, F.3.1-49, F.3.1-52, F.3.1-58, F.3.1-59, F.3.1-60, F.3.1-63, F.3.1-68, F.3.1-69, F.3.1-70, F.3.1-71, F.3.1-73, F.3.1-74, F.3.1-76, F.3.1-80, F.3.1-82, F.3.1-83, F.3.1-84, F.3.1-87, F.3.2-1, F.3.2-3, F.3.2-4, F.3.2-6, F.3.2-7, F.3.2-11, F.3.2-12, F.3.2-13, F.3.2-14, F.3.2-15, F.3.2-18, F.3.2-19, F.3.2-20, F.3.2-21, F.3.2-23, F.3.2-24, F.3.2-27, F.3.2-28, F.3.2-29, F.3.2-30, F.3.2-31, F.3.2-35, F.3.2-44, F.3.2-45, F.3.2-46, F.3.2-52, F.3.2-53, F.3.2-54, F.3.2-55, F.3.2-56, F.3.2-57, F.3.2-58, F.3.2-61, F.3.2-63, F.3.2-64, F.3.2-65, F.3.2-74, F.3.2-75, F.3.2-76, F.3.2-77, F.3.2-80, F.3.2-81, F.3.2-82, F.3.2-85, F.3.2-88, F.3.2-89, F.3.2-90, F.3.3-46, F.3.3-48, F.3.3-80, F.3.3-81, F.3.3-4, F.3.3-6, F.3.3-38, F.3.3-39, G-10, G-15
Fish and Wildlife Coordination Act (FWCA), xxxviii, D-52, D-73
Floodplain, 1-1, 1-6, 2-24, 2-25, 2-63, 4-1, 4-2, 4-13, 4-15, 4-16, 4-17, 4-103, 7-18, 9-47, 9-53, 9-74, 9-80, 9-116, 9-122, 9-156, 9-196, 10-1, D-15, D-31, D-50, D-65, D-107, E-49, F.3.1-6, F.3.2-7, F.3.3-75, F.3.3-32, H-5
Fossil fuels, 2-177, 6-2, 7-20, 7-21, 7-37, 7-38, 7-40, 8-2, 8-3, 8-4, 8-19, 8-21, 9-5, 9-6, 9-12, 9-13, 9-24, 9-32, 9-36, 9-38, 9-42, 9-44, 9-80, 9-127, 9-166, 9-206, 10-24, D-96, D-97, D-101, D-103, E-148, E-177
Fugitive dust, 2-186, 4-29, 4-31, 4-38, 4-55, 4-56, 4-80, 4-81, 4-86, 4-87, 4-91, 4-94, 4-97, 4-101, 4-102, 4-105, 4-106, 4-111, 5-62, 5-70, 7-33, 7-37, 9-21, 9-30, 9-101, 9-135, 9-142, 9-174, 9-181, 9-214, 9-222, 10-7, 10-8, 10-11, D-87, D-88, F.3.3-62, F.3.3-64, F.3.3-19, F.3.3-21, J-9
Fukushima (also see Accidents – severe), 5-97, 5-98, 5-99, 5-100, E-33, E-151, E-154, E-159, E-160, E-162, E-166, E-222, E-226, E-233, E-235, E-236, E-237

G

Geology, vi, 2-1, 2-36, 2-38, 2-170, 2-172, 4-19, 5-99, A-1, D-8, D-11, D-24, D-25, D-45, E-13, E-21, E-46, E-47, E-186, E-187, I-9

Greenhouse gases, xxviii, xxxix, 2-177, 4-87, 4-111, 5-70, 5-128, 6-9, 7-37, 8-2, 8-21, 9-22, 9-43, 9-229, 10-8, 10-11, 10-15, 10-24, D-34, D-93, D-95, D-96, D-97, D-101, D-103, E-140, E-141, E-142, E-179, E-199, E-201, J-9, K-1

Groundwater, xiv, xv, xxvi, xxvii, xxviii, xxx, xxxii, xxxix, xliv, 2-24, 2-25, 2-36, 2-37, 2-38, 2-40, 2-41, 2-42, 2-43, 2-44, 2-45, 2-49, 2-50, 2-51, 2-67, 2-69, 2-138, 2-190, 2-191, 3-10, 4-17, 4-18, 4-19, 4-20, 4-21, 4-23, 4-24, 4-76, 4-81, 4-104, 4-108, 4-109, 5-4, 5-5, 5-6, 5-8, 5-9, 5-10, 5-15, 5-16, 5-17, 5-59, 5-94, 5-95, 5-106, 5-107, 5-108, 5-116, 5-117, 5-124, 5-125, 6-12, 7-5, 7-12, 7-13, 7-14, 7-16, 7-17, 7-49, 7-50, 9-25, 9-26, 9-29, 9-33, 9-35, 9-39, 9-40, 9-43, 9-47, 9-60, 9-67, 9-68, 9-69, 9-70, 9-71, 9-72, 9-73, 9-74, 9-109, 9-116, 9-117, 9-118, 9-119, 9-120, 9-150, 9-155, 9-156, 9-157, 9-158, 9-159, 9-160, 9-189, 9-195, 9-196, 9-197, 9-198, 9-199, 9-200, 9-229, 9-231, 9-238, 9-239, 10-5, 10-10, 10-12, 10-13, 10-19, 10-28, 10-32, A-1, A-2, D-8, D-11, D-17, D-25, D-35, D-36, D-89, E-13, E-21, E-49, E-54, E-57, E-58, E-59, E-60, E-61, E-62, E-63, E-64, E-65, E-89, E-156, E-157, E-233, F.3.3-28, H-3, H-5, I-8, I-9, J-4, J-5

H

Habitat, xiv, xxviii, xxxviii, xxxix, 1-7, 2-6, 2-10, 2-42, 2-49, 2-52, 2-53, 2-54, 2-58, 2-60, 2-63, 2-65, 2-66, 2-67, 2-68, 2-69, 2-70, 2-71, 2-72, 2-73, 2-74, 2-75, 2-76, 2-78, 2-79, 2-80, 2-82, 2-84, 2-90, 2-91, 2-98, 2-108, 2-109, 2-112, 2-113, 2-114, 2-115, 2-117, 3-21, 3-24, 4-2, 4-22, 4-25, 4-26, 4-27, 4-28, 4-29, 4-30, 4-31, 4-32, 4-33, 4-34, 4-35, 4-36, 4-37, 4-38, 4-40, 4-41, 4-42, 4-43, 4-44, 4-46, 4-47, 4-50, 4-51, 4-52, 4-53, 4-54, 4-104, 4-107, 4-109, 5-17, 5-23, 5-24, 5-25, 5-26, 5-27, 5-28, 5-39, 5-41, 5-42, 5-126, 7-19, 7-20, 7-21, 7-23, 7-24, 7-25, 7-26, 7-28, 7-29, 7-30, 7-50, 9-11, 9-14, 9-15, 9-17, 9-26, 9-29, 9-34, 9-35, 9-40, 9-74, 9-76, 9-78, 9-79, 9-80, 9-81, 9-82, 9-84, 9-85, 9-86, 9-121, 9-122, 9-124, 9-125, 9-126, 9-127, 9-128, 9-131, 9-132, 9-133, 9-134, 9-161, 9-164, 9-165, 9-166, 9-168, 9-170, 9-171, 9-172, 9-173, 9-201, 9-202, 9-204, 9-205, 9-206, 9-207, 9-208, 9-210, 9-212, 9-213, 9-236, 10-6, 10-10, 10-11, 10-12, 10-13, 10-20, 10-27, D-15, D-28, D-30, D-31, D-36, D-37, D-38, D-40, D-41, D-43, D-45, D-47, D-48, D-49, D-50, D-52, D-53, D-54, D-56, D-57, D-59, D-61, D-63, D-64, D-65, D-66, D-70, D-72, D-73, D-74, D-75, D-76, D-97, D-99, D-101, D-104, D-107, E-35, E-36, E-40, E-42, E-44, E-45, E-51, E-65, E-66, E-71, E-72, E-75, E-76, E-77, E-78, E-79, E-81, E-83, E-84, E-85, E-86, E-87, E-89, E-90, E-91, E-93, E-94, E-95, E-96, E-97, E-98, E-99, E-100, E-101, E-102, E-103, E-105, E-106, E-107, E-108, E-109, E-111, E-112, E-113, E-115, E-116, E-117, E-120, E-123, E-149, E-150, E-177, E-178, E-179, E-193, E-196, E-205, E-207, E-209, E-210, E-212, E-215, E-231, F-1, F.3.1-2, F.3.1-3, F.3.1-7, F.3.1-8, F.3.1-12, F.3.1-13, F.3.1-14, F.3.1-24, F.3.1-25, F.3.1-26, F.3.1-27, F.3.1-28, F.3.1-29, F.3.1-30, F.3.1-32, F.3.1-33, F.3.1-35, F.3.1-36, F.3.1-37, F.3.1-41, F.3.1-42, F.3.1-43, F.3.1-44, F.3.1-51, F.3.1-58, F.3.1-62, F.3.1-68, F.3.1-69, F.3.1-74, F.3.1-75, F.3.1-80, F.3.1-81, F.3.1-82, F.3.2-1, F.3.2-3, F.3.2-4, F.3.2-6, F.3.2-11, F.3.2-12, F.3.2-13, F.3.2-14, F.3.2-23, F.3.2-24, F.3.2-25, F.3.2-27, F.3.2-28, F.3.2-32, F.3.2-33, F.3.2-34, F.3.2-35, F.3.2-36, F.3.2-37, F.3.2-38, F.3.2-39, F.3.2-40, F.3.2-41, F.3.2-43, F.3.2-44, F.3.2-46, F.3.2-47, F.3.2-48, F.3.2-49, F.3.2-50, F.3.2-52, F.3.2-53, F.3.2-54, F.3.2-56, F.3.2-57, F.3.2-61, F.3.2-63, F.3.2-64, F.3.2-71, F.3.2-72, F.3.2-74, F.3.2-75, F.3.2-76, F.3.2-79, F.3.2-80, F.3.2-81, F.3.2-82, F.3.2-83, F.3.2-84, F.3.2-85, F.3.2-86, F.3.2-88, F.3.2-89, F.3.2-90, F.3.3-44, F.3.3-45, F.3.3-48, F.3.3-54, F.3.3-58, F.3.3-60, F.3.3-61, F.3.3-62, F.3.3-64, F.3.3-65, F.3.3-68, F.3.3-70, F.3.3-71, F.3.3-72, F.3.3-73, F.3.3-74, F.3.3-75, F.3.3-76, F.3.3-77, F.3.3-78, F.3.3-79, F.3.3-2, F.3.3-3, F.3.3-6, F.3.3-7, F.3.3-11, F.3.3-15, F.3.3-17, F.3.3-18, F.3.3-19, F.3.3-21, F.3.3-22,

F.3.3-25, F.3.3-27, F.3.3-28, F.3.3-29, F.3.3-30, F.3.3-31, F.3.3-32, F.3.3-33, F.3.3-34, F.3.3-35, F.3.3-36, F.3.3-37, J-6

Habitat, aquatic, vi, vii, viii, x, xiv, xxi, xxii, xxvi, xxvii, xxviii, xxx, xxxii, xlv, 1-6, 1-9, 1-11, 1-12, 2-42, 2-43, 2-47, 2-48, 2-49, 2-52, 2-62, 2-63, 2-76, 2-78, 2-79, 2-82, 2-83, 2-84, 2-90, 2-91, 2-96, 2-97, 2-109, 2-110, 2-111, 2-113, 2-116, 2-117, 2-132, 2-176, 4-2, 4-3, 4-22, 4-25, 4-31, 4-32, 4-33, 4-41, 4-44, 4-45, 4-46, 4-47, 4-48, 4-50, 4-51, 4-53, 4-54, 4-103, 4-104, 4-105, 4-109, 5-1, 5-3, 5-4, 5-11, 5-14, 5-15, 5-17, 5-23, 5-24, 5-30, 5-31, 5-34, 5-35, 5-36, 5-37, 5-38, 5-39, 5-40, 5-41, 5-42, 5-83, 5-86, 5-91, 5-92, 5-93, 5-115, 5-116, 5-120, 5-121, 5-125, 5-126, 6-14, 6-15, 7-10, 7-15, 7-18, 7-20, 7-25, 7-26, 7-27, 7-28, 7-29, 7-30, 7-50, 8-3, 8-7, 9-2, 9-6, 9-11, 9-14, 9-15, 9-23, 9-26, 9-29, 9-34, 9-35, 9-39, 9-40, 9-43, 9-45, 9-54, 9-70, 9-73, 9-81, 9-82, 9-83, 9-84, 9-85, 9-86, 9-124, 9-129, 9-130, 9-131, 9-132, 9-133, 9-134, 9-160, 9-168, 9-169, 9-170, 9-171, 9-172, 9-173, 9-201, 9-208, 9-209, 9-210, 9-211, 9-212, 9-213, 9-228, 9-229, 9-231, 9-233, 9-235, 9-236, 10-1, 10-3, 10-6, 10-11, 10-12, 10-14, 10-20, 10-28, 10-31, 10-32, A-1, A-2, C-6, C-8, C-10, C-11, D-3, D-7, D-11, D-26, D-28, D-29, D-31, D-32, D-33, D-34, D-39, D-40, D-41, D-42, D-43, D-44, D-47, D-49, D-51, D-52, D-53, D-54, D-56, D-57, D-58, D-59, D-60, D-61, D-62, D-63, D-64, D-65, D-66, D-67, D-68, D-69, D-70, D-71, D-72, D-74, D-75, D-76, D-89, D-92, D-93, D-94, D-95, D-96, D-98, D-99, D-101, D-104, D-105, D-106, E-4, E-10, E-21, E-33, E-36, E-47, E-48, E-51, E-65, E-66, E-67, E-75, E-76, E-78, E-80, E-81, E-83, E-85, E-89, E-97, E-102, E-103, E-104, E-105, E-106, E-107, E-108, E-109, E-110, E-111, E-112, E-114, E-115, E-116, E-117, E-118, E-119, E-120, E-121, E-123, E-124, E-125, E-126, E-127, E-131, E-140, E-141, E-161, E-186, E-189, E-194, E-199, E-201, E-202, E-207, E-225, E-231, F.3.1-7, F.3.1-12, F.3.1-13, F.3.1-14, F.3.1-15, F.3.1-19, F.3.1-20, F.3.1-22, F.3.1-24, F.3.1-25, F.3.1-34, F.3.1-37, F.3.1-38, F.3.1-41, F.3.1-42, F.3.1-43, F.3.1-48, F.3.1-62, F.3.1-63, F.3.1-68, F.3.1-69, F.3.1-70, F.3.1-71, F.3.1-73, F.3.1-74, F.3.1-75, F.3.1-76, F.3.1-77, F.3.1-80, F.3.1-81, F.3.1-82, F.3.1-84, F.3.2-11, F.3.2-12, F.3.2-13, F.3.2-14, F.3.2-18, F.3.2-19, F.3.2-21, F.3.2-23, F.3.2-24, F.3.2-34, F.3.2-35, F.3.2-36, F.3.2-37, F.3.2-39, F.3.2-40, F.3.2-42, F.3.2-43, F.3.2-44, F.3.2-45, F.3.2-46, F.3.2-47, F.3.2-48, F.3.2-58, F.3.2-67, F.3.2-74, F.3.2-75, F.3.2-76, F.3.2-81, F.3.2-83, F.3.2-84, F.3.2-87, F.3.3-48, F.3.3-61, F.3.3-79, F.3.3-6, F.3.3-18, F.3.3-37, G-8, G-9, G-15, J-7

Habitat, degradation of, xxviii, 2-37, 2-78, 2-90, 2-117, 4-53, 4-58, 4-59, 4-81, 5-10, 5-39, 5-121, 7-20, 7-21, 7-30, 7-50, 9-23, 9-31, 9-67, 9-73, 9-80, 9-84, 9-85, 9-127, 9-133, 9-167, 9-172, 9-207, 9-212, 10-7, 10-24, 10-27, D-29, D-69, E-52, E-89, E-91, E-97, E-100, E-108, E-219, F.3.1-8, F.3.1-43, F.3.2-11, F.3.2-24, F.3.2-48, F.3.2-79, F.3.3-73, F.3.3-76, F.3.3-77, F.3.3-30, F.3.3-33, F.3.3-34

Habitat, important, xix, 1-5, 1-6, 2-10, 2-47, 2-52, 2-59, 2-62, 2-63, 2-66, 2-68, 2-70, 2-75, 2-79, 2-80, 2-82, 2-83, 2-97, 2-99, 2-105, 2-106, 2-107, 2-109, 2-110, 2-113, 2-114, 3-11, 3-21, 4-2, 4-8, 4-11, 4-19, 4-28, 4-30, 4-31, 4-32, 4-33, 4-34, 4-35, 4-37, 4-38, 4-40, 4-41, 4-43, 4-44, 4-50, 4-51, 4-53, 4-83, 4-93, 4-109, 5-2, 5-3, 5-23, 5-25, 5-26, 5-28, 5-29, 5-32, 5-35, 5-39, 5-40, 5-70, 5-97, 5-126, 6-34, 6-35, 7-1, 7-9, 7-23, 7-24, 7-25, 7-27, 7-30, 7-50, 8-1, 9-25, 9-26, 9-34, 9-40, 9-45, 9-48, 9-56, 9-64, 9-65, 9-66, 9-74, 9-79, 9-81, 9-112, 9-113, 9-115, 9-121, 9-124, 9-125, 9-126, 9-128, 9-129, 9-152, 9-153, 9-155, 9-161, 9-165, 9-168, 9-169, 9-192, 9-194, 9-206, 9-208, 9-209, 9-228, 9-230, 10-3, 10-28, 10-30, 10-32, D-15, D-22, D-28, D-32, D-36, D-39, D-40, D-43, D-46, D-50, D-53, D-55, D-56, D-63, D-65, D-70, D-73, D-74, D-78, D-80, D-81, D-91, D-93, D-94, D-95, D-96, D-102, D-103, E-25, E-32, E-40, E-45, E-47, E-48, E-56, E-75, E-79, E-80, E-81, E-83, E-84, E-85, E-89, E-90, E-91, E-94, E-98, E-100, E-102, E-103, E-111,

E-112, E-114, E-115, E-119, E-120, E-121, E-126, E-128, E-129, E-130, E-131, E-141, E-144, E-148, E-155, E-162, E-178, E-186, E-192, E-197, E-199, E-200, E-201, E-202, E-203, E-205, E-207, E-211, E-212, E-218, E-221, F.3.1-3, F.3.1-12, F.3.1-16, F.3.1-17, F.3.1-18, F.3.1-19, F.3.1-26, F.3.1-27, F.3.1-38, F.3.1-43, F.3.1-76, F.3.1-81, F.3.2-3, F.3.2-11, F.3.2-16, F.3.2-17, F.3.2-18, F.3.2-30, F.3.2-31, F.3.2-45, F.3.2-47, F.3.2-48, F.3.2-71, F.3.2-84, F.3.3-61, F.3.3-68, F.3.3-69, F.3.3-71, F.3.3-77, F.3.3-78, F.3.3-18, F.3.3-25, F.3.3-26, F.3.3-29, F.3.3-30, F.3.3-35, F.3.3-36, F.3.3-37, J-6, J-7

Habitat, loss of, xxviii, xl, 2-67, 2-73, 2-74, 2-77, 2-79, 4-8, 4-11, 4-15, 4-26, 4-27, 4-29, 4-31, 4-36, 4-40, 4-42, 4-43, 4-44, 4-45, 4-50, 4-54, 4-103, 4-107, 5-17, 5-26, 5-42, 5-74, 5-97, 5-100, 5-102, 5-107, 5-108, 5-109, 5-111, 5-112, 6-36, 7-20, 7-23, 7-25, 7-27, 7-50, 9-14, 9-17, 9-34, 9-35, 9-64, 9-78, 9-79, 9-80, 9-81, 9-84, 9-125, 9-126, 9-127, 9-128, 9-165, 9-166, 9-205, 9-206, 9-207, 9-233, 9-234, 10-27, D-29, D-30, D-50, D-75, D-83, E-40, E-41, E-42, E-43, E-68, E-73, E-76, E-78, E-81, E-83, E-85, E-89, E-90, E-95, E-96, E-98, E-99, E-109, E-112, E-115, E-125, E-159, E-209, E-224, F.3.1-37, F.3.1-70, F.3.1-76, F.3.2-33, F.3.2-45, F.3.2-72, F.3.2-77, F.3.2-83, F.3.2-84, F.3.3-60, F.3.3-61, F.3.3-64, F.3.3-76, F.3.3-78, F.3.3-79, F.3.3-17, F.3.3-18, F.3.3-21, F.3.3-34, F.3.3-36, F.3.3-37

Habitat, terrestrial, vi, vii, viii, x, xxvi, xxvii, xxviii, xxx, xxxii, 2-10, 2-52, 2-60, 2-61, 2-62, 2-66, 2-76, 2-79, 2-80, 2-82, 2-83, 4-3, 4-25, 4-26, 4-29, 4-30, 4-31, 4-33, 4-37, 4-38, 4-40, 4-41, 4-43, 4-104, 4-109, 5-1, 5-17, 5-18, 5-20, 5-22, 5-23, 5-24, 5-28, 5-29, 5-30, 5-91, 5-92, 5-120, 5-121, 5-126, 6-13, 6-14, 6-15, 7-18, 7-19, 7-20, 7-21, 7-23, 7-24, 7-25, 7-50, 9-2, 9-23, 9-26, 9-29, 9-34, 9-35, 9-39, 9-40, 9-43, 9-45, 9-54, 9-74, 9-78, 9-79, 9-80, 9-81, 9-121, 9-125, 9-126, 9-127, 9-128, 9-161, 9-164, 9-165, 9-166, 9-167, 9-168, 9-200, 9-204, 9-205, 9-206, 9-207, 9-208, 9-228, 9-229, 10-3, 10-6, 10-10, 10-12, 10-13, 10-20, 10-28, 10-31, 10-32, A-1, A-2, C-6, C-8, C-13, C-14, D-7, D-11, D-23, D-31, D-33, D-36, D-39, D-41, D-42, D-44, D-45, D-46, D-47, D-50, D-53, D-57, D-63, D-83, D-99, D-101, D-104, E-11, E-21, E-35, E-36, E-45, E-65, E-78, E-79, E-83, E-84, E-85, E-89, E-90, E-91, E-93, E-94, E-95, E-98, E-99, E-100, E-101, E-102, E-105, E-111, E-112, E-131, E-178, E-188, F.3.3-49, F.3.3-58, F.3.3-60, F.3.3-63, F.3.3-65, F.3.3-67, F.3.3-68, F.3.3-69, F.3.3-70, F.3.3-74, F.3.3-75, F.3.3-76, F.3.3-77, F.3.3-78, F.3.3-79, F.3.3-80, F.3.3-83, F.3.3-7, F.3.3-15, F.3.3-17, F.3.3-20, F.3.3-22, F.3.3-24, F.3.3-25, F.3.3-26, F.3.3-27, F.3.3-32, F.3.3-33, F.3.3-34, F.3.3-35, F.3.3-36, F.3.3-38, F.3.3-40, G-15, J-6

Hazardous waste, 3-31, 3-32, 4-74, 4-103, 5-58, 5-94, 5-96, 5-118, 5-123, 7-44, 7-51, 9-56, J-10, J-13

High-level waste (HLW), xx, xxxix, 6-4, 6-5, 6-12, 6-13, 6-15, 6-33

Housing, xviii, xix, xxii, 2-124, 2-137, 2-155, 4-69, 4-73, 4-74, 4-75, 4-79, 4-82, 5-2, 5-55, 5-56, 5-57, 5-58, 5-62, 5-65, 5-127, 7-6, 7-33, 8-15, 9-7, 9-60, 9-92, 9-93, 9-95, 9-110, 9-135, 9-136, 9-138, 9-151, 9-174, 9-175, 9-176, 9-189, 9-215, 9-216, 9-217, 9-218, 10-29, D-80, E-132, E-164

Hydrology, v, xxiv, xlii, 2-10, 2-24, 2-25, 2-36, 2-80, 2-83, 4-17, 4-18, 5-5, 9-67, 9-228, A-1, A-2, C-14, D-8, D-11, D-25, D-35, D-40, D-49, D-50, D-64, D-65, E-13, E-21, E-47, E-52, E-54, E-69, E-91, E-97, E-109, I-8

I

Impingement, xix, 2-91, 2-94, 2-96, 2-97, 2-98, 2-99, 2-100, 2-101, 2-102, 2-103, 2-104, 2-105, 2-106, 2-107, 2-108, 2-111, 2-112, 2-115, 2-117, 5-30, 5-31, 5-32, 5-33, 5-34, 5-35, 5-36, 5-40, 5-42, 5-121, 5-126, 7-27, 9-85, 9-133, 9-172, 9-212, 9-213, 9-233, 9-235, 10-12, 10-14, D-25, D-26, D-32, D-54, D-57, D-58, D-61, D-66, D-67, D-68, D-105, D-106, E-103, E-104, E-106, E-108, E-114, E-121, E-123, E-124, E-125, E-126, E-127,

E-186, E-194, F.3.1-3, F.3.1-12, F.3.1-15, F.3.1-16, F.3.1-17, F.3.1-18, F.3.1-19, F.3.1-20, F.3.1-34, F.3.1-35, F.3.1-37, F.3.1-38, F.3.1-39, F.3.1-51, F.3.1-52, F.3.1-53, F.3.1-54, F.3.1-55, F.3.1-76, F.3.1-77, F.3.1-78, F.3.1-79, F.3.1-87, F.3.1-88, F.3.1-89, F.3.1-90, F.3.1-91, F.3.1-92, F.3.2-2, F.3.2-3, F.3.2-12, F.3.2-14, F.3.2-15, F.3.2-16, F.3.2-17, F.3.2-18, F.3.2-19, F.3.2-33, F.3.2-35, F.3.2-36, F.3.2-37, F.3.2-38, F.3.2-40, F.3.2-42, F.3.2-43, F.3.2-45, F.3.2-48, F.3.2-49, F.3.2-50, F.3.2-51, F.3.2-74

Important species, xix, 1-5, 1-6, 2-10, 2-47, 2-52, 2-59, 2-62, 2-63, 2-66, 2-68, 2-70, 2-75, 2-79, 2-80, 2-82, 2-83, 2-97, 2-99, 2-105, 2-106, 2-107, 2-109, 2-110, 2-113, 2-114, 3-11, 3-21, 4-2, 4-8, 4-11, 4-19, 4-28, 4-30, 4-31, 4-32, 4-33, 4-34, 4-35, 4-37, 4-38, 4-40, 4-41, 4-43, 4-44, 4-50, 4-51, 4-53, 4-83, 4-93, 4-109, 5-2, 5-3, 5-23, 5-25, 5-26, 5-28, 5-29, 5-32, 5-35, 5-39, 5-40, 5-70, 5-97, 5-126, 6-34, 6-35, 7-1, 7-9, 7-23, 7-24, 7-25, 7-27, 7-30, 7-50, 8-1, 9-25, 9-26, 9-34, 9-40, 9-45, 9-48, 9-56, 9-64, 9-65, 9-66, 9-74, 9-79, 9-81, 9-112, 9-113, 9-115, 9-121, 9-124, 9-125, 9-126, 9-128, 9-129, 9-152, 9-153, 9-155, 9-161, 9-165, 9-168, 9-169, 9-192, 9-194, 9-206, 9-208, 9-209, 9-228, 9-230, 10-3, 10-28, 10-30, 10-32, D-15, D-22, D-28, D-32, D-36, D-39, D-40, D-43, D-46, D-50, D-53, D-55, D-56, D-63, D-65, D-70, D-73, D-74, D-78, D-80, D-81, D-91, D-93, D-94, D-95, D-96, D-102, D-103, E-25, E-32, E-40, E-45, E-47, E-48, E-56, E-75, E-79, E-80, E-81, E-83, E-84, E-85, E-89, E-90, E-91, E-94, E-98, E-100, E-102, E-103, E-111, E-112, E-114, E-115, E-119, E-120, E-121, E-126, E-128, E-129, E-130, E-131, E-141, E-144, E-148, E-155, E-162, E-178, E-186, E-192, E-197, E-199, E-200, E-201, E-202, E-203, E-205, E-207, E-211, E-212, E-218, E-221, F.3.1-3, F.3.1-12, F.3.1-16, F.3.1-17, F.3.1-18, F.3.1-19, F.3.1-26, F.3.1-27, F.3.1-38, F.3.1-43, F.3.1-76, F.3.1-81, F.3.2-3, F.3.2-11, F.3.2-16, F.3.2-17, F.3.2-18, F.3.2-30, F.3.2-31, F.3.2-45, F.3.2-47, F.3.2-48, F.3.2-71, F.3.2-84, F.3.3-61, F.3.3-68, F.3.3-69, F.3.3-71, F.3.3-77, F.3.3-78, F.3.3-18, F.3.3-25, F.3.3-26, F.3.3-29, F.3.3-30, F.3.3-35, F.3.3-36, F.3.3-37, J-6, J-7

Incidental, 2-114, 5-2, F.3.1-3, F.3.1-27, F.3.1-30, F.3.1-39, F.3.1-40, F.3.1-41, F.3.1-47, F.3.1-48, F.3.1-59, F.3.1-78, F.3.1-79, F.3.1-84, F.3.1-86, H-3

Income, vi, xiv, xvi, xvii, xviii, xix, xxvii, xxviii, xxx, xxxii, 2-120, 2-122, 2-124, 2-126, 2-129, 2-130, 2-131, 2-135, 2-145, 2-146, 2-147, 2-149, 2-152, 2-154, 2-155, 2-156, 4-67, 4-68, 4-69, 4-79, 4-82, 4-110, 4-112, 5-50, 5-52, 5-53, 5-54, 5-55, 5-62, 5-65, 5-127, 5-129, 7-31, 7-34, 7-52, 8-13, 9-28, 9-29, 9-34, 9-36, 9-39, 9-41, 9-43, 9-52, 9-89, 9-90, 9-92, 9-95, 9-96, 9-98, 9-138, 9-139, 9-177, 9-178, 9-218, 9-219, 9-229, 10-24, 10-25, 10-26, 10-27, 10-28, D-77, D-80, E-127, E-129, E-135, E-193, J-8

Independent spent fuel storage installation (ISFSI), xxxix, 2-190, 4-97, 4-98, 4-99, 5-83, 5-93, 6-16, 7-36, 7-43, 7-51, D-90, D-91, J-11, J-13

Indian tribes, iii, xxiii, xxxiii, xlv, 1-4, 1-7, 2-146, 2-157, 2-160, 2-166, 3-18, 4-13, 4-82, 4-83, 4-84, 4-85, 4-111, 5-65, 5-67, 6-10, 7-35, 10-2, 10-8, 10-15, 10-33, B-1, C-3, C-4, D-1, E-1, E-30, E-136, E-167, F-1, H-1, J-9

Infiltration, 2-68, 4-14, 4-17, 4-18, 5-6, 9-70, F.3.3-29

intake structure, xxxvii, 2-24, 2-49, 2-94, 2-117, 2-193, 3-3, 3-7, 3-10, 3-12, 3-14, 3-15, 3-22, 3-24, 3-26, 4-16, 4-22, 4-25, 4-39, 4-46, 4-47, 4-50, 4-51, 5-4, 5-16, 5-23, 5-31, 5-33, 5-35, 5-95, 5-120, 5-126, 7-27, 7-36, 7-44, 9-69, 9-82, 9-84, 9-85, 9-117, 9-132, 9-133, 9-157, 9-171, 9-172, 9-196, 9-212, 9-232, 9-235, 9-236, 9-237, 9-238, 10-20, D-20, D-27, D-28, D-30, D-70, E-101, E-120, E-125, F.3.1-14, F.3.1-15, F.3.1-16, F.3.1-18, F.3.1-19, F.3.1-20, F.3.1-34, F.3.1-37, F.3.1-39, F.3.1-40, F.3.1-69, F.3.1-70, F.3.1-73, F.3.1-74, F.3.1-76, F.3.1-77, F.3.1-79, F.3.1-81, F.3.1-82, F.3.2-13, F.3.2-14, F.3.2-15, F.3.2-18, F.3.2-19, F.3.2-45, F.3.2-75, F.3.2-77, F.3.2-85,

F.3.3-49, F.3.3-58, F.3.3-68, F.3.3-7, F.3.3-15, F.3.3-25, J-3, J-7
Invasive species, 2-54, 2-69, 2-112, 4-33, 5-24, 5-37, 5-40, D-38, E-68, E-120, F.3.1-22, F.3.2-21

L

Land use, xxvi, xxvii, xxviii, xl, 1-6, 2-1, 2-5, 2-6, 2-14, 2-15, 2-18, 2-20, 2-21, 2-43, 2-53, 2-56, 2-68, 2-72, 3-4, 3-16, 3-21, 4-2, 4-3, 4-4, 4-7, 4-8, 4-9, 4-11, 4-14, 4-26, 4-30, 4-33, 4-38, 4-42, 4-44, 4-87, 4-89, 4-107, 5-1, 5-2, 5-3, 5-5, 5-24, 5-29, 5-106, 5-121, 5-124, 6-5, 6-8, 6-14, 6-15, 7-6, 7-7, 7-8, 7-9, 7-28, 7-49, 9-13, 9-14, 9-15, 9-16, 9-18, 9-25, 9-26, 9-33, 9-38, 9-39, 9-40, 9-41, 9-45, 9-47, 9-48, 9-50, 9-51, 9-54, 9-60, 9-61, 9-64, 9-65, 9-66, 9-95, 9-105, 9-110, 9-112, 9-113, 9-114, 9-115, 9-146, 9-151, 9-152, 9-153, 9-154, 9-155, 9-185, 9-189, 9-190, 9-192, 9-193, 9-194, 9-226, 9-228, 9-233, 9-234, 9-236, 9-237, 9-240, 10-10, 10-12, 10-18, 10-19, 10-28, 10-31, 10-32, C-6, C-8, C-11, C-12, D-19, D-20, D-21, D-22, D-23, D-24, D-29, D-31, D-36, E-28, E-39, E-40, E-41, E-44, E-45, E-83, E-87, E-94, E-109, E-178, E-180, E-184, E-185, F.3.1-41, F.3.1-80, F.3.2-46, F.3.2-84, F.3.3-46, F.3.3-54, F.3.3-57, F.3.3-58, F.3.3-60, F.3.3-64, F.3.3-4, F.3.3-11, F.3.3-14, F.3.3-15, F.3.3-17, F.3.3-21, F.3.3-28, J-3
Laydown areas, 1-10, 2-5, 2-51, 2-193, 3-1, 3-4, 3-19, 3-20, 3-21, 3-24, 4-4, 4-5, 4-9, 4-13, 4-24, 4-25, 4-39, 4-44, 4-45, 9-5, D-14, D-19, D-105, F.3.1-7, F.3.1-13, F.3.3-49, F.3.3-58, F.3.3-59, F.3.3-7, F.3.3-15, F.3.3-16, I-25, J-3, J-7
License renewal, 2-12, 2-63, 2-113, 2-163, 5-115, 6-6, 6-7, 9-1, 9-6, 9-9, 9-58, 9-120, 9-160, 9-199, D-83, D-84, E-100, E-101
Light pollution, 5-22, F.3.3-67, F.3.3-24
listed species, iii, 2-57, 2-59, 2-60, 2-62, 2-63, 2-66, 2-67, 2-70, 2-71, 2-72, 2-73, 2-74, 2-75, 2-76, 2-77, 2-78, 2-82, 2-97, 2-116, 4-30, 4-31, 4-33, 4-34, 4-35, 4-36, 4-37, 4-45, 4-50, 4-51, 5-20, 5-21, 5-22, 5-23, 5-24, 5-26, 5-27, 5-28, 5-41, 5-126, 7-22, 7-24, 9-74, 9-75, 9-79, 9-81, 9-83, 9-84, 9-121, 9-125, 9-126, 9-128, 9-131, 9-132, 9-161, 9-162, 9-165, 9-171, 9-201, 9-205, 9-206, 9-211, C-11, E-126, F.3.1-7, F.3.1-25, F.3.1-34, F.3.1-63, F.3.1-73, F.3.3-48, F.3.3-49, F.3.3-63, F.3.3-64, F.3.3-67, F.3.3-70, F.3.3-78, F.3.3-6, F.3.3-7, F.3.3-20, F.3.3-21, F.3.3-24, F.3.3-27, F.3.3-30, F.3.3-36, F.3.3-37, J-6, J-7
Listed species, 2-58, 2-59, 2-67, 2-97, 4-36, 4-104, 5-23, 5-24, 5-27, 5-41, 7-24, 9-75, 9-79, 9-121, 9-125, 9-126, 9-129, 9-161, 9-165, 9-201, 9-205, D-73, E-30, E-114, E-126, F.3.1-34, F.3.1-39, F.3.1-40, F.3.1-77, F.3.3-48, F.3.3-6, J-6, J-7
Low-income population, xxvii, xxviii, xxx, xxxii, 2-145, 2-146, 2-147, 2-149, 2-155, 2-156, 4-54, 4-79, 4-80, 4-81, 4-82, 4-83, 4-110, 4-112, 5-42, 5-62, 5-63, 5-64, 5-65, 5-66, 5-127, 5-129, 7-33, 7-34, 7-51, 7-52, 9-28, 9-29, 9-34, 9-35, 9-36, 9-39, 9-40, 9-41, 9-43, 9-96, 9-139, 9-178, 9-219, 9-229, E-158, J-9
Low-level waste (LLW), xl, 6-5, 6-13, 6-14, 6-17, 6-41

M

Magnuson-Stevens Fishery Conservation and Management Act (MSA), xli, 2-117, 2-132, 5-42, 9-86, 9-87, D-52, D-73, D-75, D-76, E-112, E-113, F.3.2-4, F.3.2-6, F.3.2-24, F.3.2-32, F.3.2-53, F.3.2-64, F.3.2-65, F.3.2-66, F.3.2-79, F.3.2-82, F.3.2-87
Migratory birds, 2-61, 5-21, 5-22, 9-201, 9-204, E-74, E-101, E-177, F.3.3-67, F.3.3-77, F.3.3-24, F.3.3-35
Mitigation, iii, x, xxxiii, xlv, 1-6, 1-9, 2-52, 2-91, 2-114, 2-115, 2-147, 2-167, 3-18, 4-3, 4-4, 4-20, 4-38, 4-39, 4-40, 4-41, 4-42, 4-43, 4-44, 4-47, 4-53, 4-54, 4-55, 4-56, 4-57, 4-58, 4-59, 4-71, 4-72, 4-73, 4-75, 4-76, 4-77, 4-78, 4-79, 4-82, 4-85, 4-87, 4-88, 4-89, 4-94, 4-95, 4-96, 4-97, 4-100, 4-101, 4-102, 4-103, 4-104, 4-105, 4-110, 4-112, 5-1, 5-10, 5-14, 5-16, 5-26, 5-27, 5-28, 5-30, 5-45, 5-48, 5-56, 5-57, 5-59, 5-60, 5-61, 5-62, 5-70, 5-71, 5-73, 5-74, 5-75, 5-76, 5-78, 5-79, 5-91, 5-93,

5-95, 5-96, 5-97, 5-98, 5-100, 5-117, 5-118, 5-123, 6-15, 7-16, 7-18, 7-21, 7-24, 7-25, 7-29, 7-30, 7-35, 7-36, 7-37, 7-40, 7-41, 7-42, 7-43, 7-44, 7-45, 7-46, 7-47, 7-48, 7-50, 9-12, 9-21, 9-28, 9-30, 9-34, 9-39, 9-48, 9-50, 9-79, 9-94, 9-100, 9-101, 9-102, 9-103, 9-125, 9-128, 9-133, 9-135, 9-141, 9-142, 9-143, 9-144, 9-165, 9-167, 9-172, 9-174, 9-180, 9-181, 9-182, 9-183, 9-207, 9-213, 9-214, 9-221, 9-222, 9-223, 9-224, 10-1, 10-2, 10-3, 10-4, 10-6, 10-7, 10-11, 10-12, 10-13, 10-14, 10-31, 10-32, 10-33, D-18, D-22, D-24, D-29, D-30, D-33, D-36, D-37, D-38, D-39, D-40, D-41, D-42, D-43, D-44, D-45, D-46, D-47, D-48, D-49, D-50, D-51, D-52, D-54, D-56, D-57, D-59, D-61, D-62, D-65, D-68, D-71, D-76, D-85, D-87, D-88, E-2, E-26, E-31, E-32, E-35, E-36, E-38, E-41, E-42, E-50, E-66, E-67, E-68, E-69, E-70, E-71, E-72, E-73, E-75, E-76, E-77, E-78, E-79, E-80, E-81, E-82, E-84, E-85, E-86, E-87, E-88, E-89, E-90, E-91, E-93, E-94, E-95, E-96, E-97, E-98, E-99, E-105, E-114, E-116, E-117, E-121, E-124, E-139, E-146, E-157, E-160, E-193, E-206, E-208, E-210, F-33, F-34, F.3.1-12, F.3.1-40, F.3.1-42, F.3.1-43, F.3.1-52, F.3.1-62, F.3.1-68, F.3.1-78, F.3.1-80, F.3.1-81, F.3.2-12, F.3.2-47, F.3.2-48, F.3.2-67, F.3.2-74, F.3.2-75, F.3.2-83, F.3.2-84, F.3.2-87, F.3.3-77, F.3.3-78, F.3.3-79, F.3.3-34, F.3.3-36, F.3.3-37, J-1, J-2, J-6, J-9, K-3, K-5

Mixed waste, 3-32, 5-94, 5-96, 5-129, 6-17, 7-44, 7-45, 9-56

Monitoring, v, vi, vii, viii, ix, xxxviii, xliv, 2-24, 2-49, 2-50, 2-51, 2-52, 2-56, 2-81, 2-83, 2-91, 2-117, 2-173, 2-174, 2-180, 2-181, 2-190, 3-6, 4-15, 4-22, 4-24, 4-40, 4-41, 4-53, 4-81, 4-105, 5-5, 5-16, 5-17, 5-20, 5-30, 5-42, 5-44, 5-63, 5-77, 5-93, 5-94, 5-98, 5-122, 5-123, 6-14, 7-27, 7-37, 7-43, 8-7, 9-7, 9-25, 9-70, 9-72, 9-105, 9-146, 9-184, 9-226, C-5, D-17, D-29, D-35, D-36, D-48, D-67, D-76, D-85, D-89, E-51, E-58, E-59, E-60, E-61, E-72, E-101, E-117, E-153, E-154, E-155, E-156, E-157, E-204, E-207, F.3.1-12, F.3.1-29, F.3.1-31, F.3.1-35, F.3.1-37, F.3.1-38, F.3.1-40, F.3.1-51, F.3.1-52, F.3.1-76, F.3.1-77, F.3.1-87, F.3.2-12, F.3.2-45, F.3.2-57, F.3.2-58, F.3.2-74, F.3.2-83, F.3.2-90, F.3.2-91, F.3.3-63, F.3.3-81, F.3.3-20, F.3.3-38, J-5, J-10, J-11

N

National Ambient Air Quality Standards (NAAQS), xli, 2-176, 2-177, 3-27, 4-56, 4-86, 4-87, 5-68, 5-69, 7-36, 7-37, 9-21, D-87, E-144, E-146, J-9

National Environmental Policy Act (NEPA), xlii, 1-1, 1-4, 1-5, 1-7, 1-8, 1-10, 1-12, 2-157, 2-166, 2-192, 3-13, 4-2, 4-83, 4-85, 5-67, 6-15, 6-44, 7-1, 7-7, 7-35, 9-1, 9-2, 9-36, 9-66, 9-114, 9-127, 9-153, 9-167, 9-193, 9-207, 9-227, 9-228, 10-2, 10-4, 10-18, 10-22, D-1, D-2, D-9, D-11, D-12, D-13, D-14, D-15, D-18, D-22, D-60, D-88, E-2, E-27, E-28, E-29, E-30, E-31, E-32, E-33, E-41, E-51, E-114, E-144, E-171, E-219, E-220, E-221, F-29, F.3.1-6, F.3.1-60, F.3.1-83, F.3.2-7, F.3.2-65, F.3.2-87, F.3.3-46, F.3.3-48, F.3.3-80, F.3.3-4, F.3.3-6, F.3.3-33, F.3.3-38

National Historic Preservation Act (NHPA), xlii, 1-7, 2-156, 2-157, 2-163, 2-166, 4-2, 4-83, 7-35, 9-2, 9-100, 9-141, 9-180, C-11, C-15, C-16, D-1, D-83, D-85, E-30, F-29, F-31

National Marine Fisheries Service (NMFS), xxiii, xlii, 2-110, 2-112, 2-113, 2-114, 2-115, 2-116, 2-117, 2-192, 4-47, 4-48, 4-50, 4-51, 4-52, 4-53, 5-41, 7-30, 9-82, 9-83, 9-129, 9-130, 9-134, 9-168, 9-169, 9-170, 9-173, 9-209, 9-210, 9-213, B-1, C-4, C-5, C-12, C-14, D-4, D-52, D-66, D-71, D-72, D-73, D-74, D-76, E-4, E-29, E-30, E-89, E-110, E-111, E-112, E-113, E-115, E-121, E-126, F-1, F-3, F.3.1-1, F.3.1-3, F.3.1-4, F.3.1-7, F.3.1-25, F.3.1-26, F.3.1-27, F.3.1-28, F.3.1-29, F.3.1-30, F.3.1-31, F.3.1-32, F.3.1-33, F.3.1-34, F.3.1-35, F.3.1-38, F.3.1-39, F.3.1-40, F.3.1-43, F.3.1-45, F.3.1-46, F.3.1-47, F.3.1-48, F.3.1-49, F.3.1-50, F.3.1-51, F.3.1-55, F.3.1-56, F.3.1-57, F.3.1-59, F.3.1-60, F.3.1-61,

F.3.1-62, F.3.1-63, F.3.1-70, F.3.1-71, F.3.1-73, F.3.1-74, F.3.1-75, F.3.1-77, F.3.1-78, F.3.1-79, F.3.1-81, F.3.1-82, F.3.1-83, F.3.1-84, F.3.1-85, F.3.1-91, F.3.1-92, F.3.2-1, F.3.2-4, F.3.2-6, F.3.2-24, F.3.2-33, F.3.2-34, F.3.2-36, F.3.2-37, F.3.2-38, F.3.2-39, F.3.2-41, F.3.2-42, F.3.2-48, F.3.2-54, F.3.2-55, F.3.2-56, F.3.2-57, F.3.2-58, F.3.2-61, F.3.2-64, F.3.2-66, F.3.2-77, F.3.2-79, F.3.2-82, F.3.2-85, F.3.2-88, F.3.2-89, F.3.2-90, F.3.2-91

National Pollutant Discharge Elimination System (NPDES), xlii, 4-12, 4-102, 5-4, 5-94, 5-96, 5-118, 9-26, 9-56, 9-103, 9-144, 9-183, 9-224, 10-16, E-51, F.3.1-44, F.3.1-45, F.3.2-53, J-16

Native American tribes, iii, xxiii, xxxiii, xlv, 1-4, 1-7, 2-146, 2-157, 2-160, 2-166, 3-18, 4-13, 4-82, 4-83, 4-84, 4-85, 4-111, 5-65, 5-67, 6-10, 7-35, 10-2, 10-8, 10-15, 10-33, B-1, C-3, C-4, D-1, E-1, E-30, E-136, E-167, F-1, H-1, J-9

New Jersey Administrative Code (NJAC), xlii, 1-13, 2-6, 2-12, 2-45, 2-79, 2-177, 4-87, 4-94, 5-11, 5-70, 5-78, 9-22, 9-30, E-51, E-144, H-4, H-5, H-6

New Jersey Board of Public Utilities (NJBPU), xlii, 8-1, 8-5, 8-14, 8-15, 9-7, 9-13, 9-36, 9-37, 10-32

New Jersey Bureau of Nuclear Engineering (NJBNE), xlii, D-29, D-35, D-36, D-89

New Jersey Department of Environmental Protection (NJDEP), xiv, xvii, xxiii, xlii, 1-1, 1-13, 2-6, 2-8, 2-9, 2-10, 2-12, 2-20, 2-34, 2-41, 2-44, 2-50, 2-51, 2-52, 2-53, 2-54, 2-55, 2-56, 2-62, 2-63, 2-67, 2-68, 2-71, 2-72, 2-73, 2-74, 2-75, 2-76, 2-78, 2-79, 2-80, 2-82, 2-83, 2-101, 2-113, 2-115, 2-117, 2-136, 2-138, 2-139, 2-164, 2-166, 2-167, 2-177, 2-186, 3-21, 3-31, 4-1, 4-4, 4-7, 4-10, 4-11, 4-12, 4-13, 4-14, 4-16, 4-17, 4-22, 4-23, 4-24, 4-25, 4-35, 4-38, 4-41, 4-42, 4-46, 4-52, 4-53, 4-84, 4-85, 4-87, 4-89, 4-101, 4-102, 4-107, 4-109, 4-112, 5-2, 5-3, 5-4, 5-5, 5-8, 5-14, 5-15, 5-21, 5-29, 5-31, 5-44, 5-63, 5-64, 5-66, 5-67, 5-69, 5-71, 5-77, 5-95, 5-96, 5-119, 5-121, 5-125, 5-128, 7-4, 7-13, 7-15, 7-17, 7-22, 7-29, 7-38, 7-44, 9-26, 9-59, 9-69, 9-70, 9-72, 9-74, 9-76, 9-80, 9-82, 9-83, 9-84, 9-103, 9-108, 9-117, 9-121, 9-122, 9-126, 9-129, 9-130, 9-131, 9-132, 9-144, 9-149, 9-150, 9-157, 9-158, 9-160, 9-161, 9-162, 9-166, 9-168, 9-170, 9-171, 9-183, 9-188, 9-196, 9-198, 9-201, 9-206, 9-209, 9-210, 9-211, 9-224, 10-1, 10-15, 10-19, B-1, C-2, C-4, C-13, D-3, D-11, D-12, D-20, D-21, D-25, D-26, D-30, D-31, D-36, D-51, D-68, D-69, D-74, D-88, E-5, E-7, E-32, E-35, E-42, E-43, E-45, E-50, E-51, E-52, E-53, E-58, E-62, E-83, E-89, E-90, E-91, E-92, E-96, E-99, E-107, E-123, E-124, E-125, E-127, E-145, E-156, E-174, E-186, E-217, F-3, F.3.1-4, F.3.1-6, F.3.1-14, F.3.1-15, F.3.1-32, F.3.1-42, F.3.1-48, F.3.1-60, F.3.1-63, F.3.1-69, F.3.1-74, F.3.1-80, F.3.1-81, F.3.1-82, F.3.2-4, F.3.2-7, F.3.2-14, F.3.2-15, F.3.2-47, F.3.2-64, F.3.2-67, F.3.2-72, F.3.2-76, F.3.2-83, F.3.2-84, F.3.2-85, F.3.3-45, F.3.3-46, F.3.3-54, F.3.3-55, F.3.3-56, F.3.3-57, F.3.3-69, F.3.3-77, F.3.3-81, F.3.3-83, F.3.3-3, F.3.3-4, F.3.3-11, F.3.3-12, F.3.3-13, F.3.3-14, F.3.3-26, F.3.3-28, F.3.3-35, F.3.3-39, F.3.3-40, H-4, H-5, J-5, J-7

New Jersey Department of Labor and Workforce Development (NJLWD), xlii, 2-119, 2-120, 2-121, 4-61, 5-49, 7-20, 8-13, 9-80, 9-127, 9-166, 9-207, F.3.3-47, F.3.3-76, F.3.3-81, F.3.3-5, F.3.3-34, F.3.3-39

New Jersey Department of Transportation (NJDOT), xlii, 2-134, 4-96, 5-81, 7-2, 9-55, 9-59

New Jersey Energy Master Plan (NJEMP), xlii, 8-2, 8-3, 8-10, 8-21, 9-4, 9-7, 9-36, 9-37, 10-24

New Jersey Geological Survey (NJGS), xlii, 2-38, 9-67, 9-155, 9-195, E-61

New Jersey Historic Preservation Office (NJ HPO), 2-164, B-1, C-4, C-14, C-15, C-16, D-83, F-29, F-30, F-31, F-32, F-33, F-34, F-35, F-36, F-37, F-38, F-39, F-40, F-41, F-42, J-9

New Jersey Pollutant Discharge Elimination System (NJPDES), xlii, 2-117, 3-11, 3-14, 3-15, 3-26, 3-29, 3-30, 3-31, 4-12, 4-15, 4-21, 4-23, 4-24, 4-40,

4-45, 4-101, 4-102, 4-104, 4-106, 4-112, 5-5, 5-10, 5-11, 5-14, 5-16, 5-31, 5-38, 5-39, 5-42, 5-77, 5-119, 5-120, 5-121, 5-125, 5-126, 7-15, 7-27, 9-72, 9-160, 10-11, 10-17, 10-28, D-26, D-27, D-29, E-51, E-116, E-209, F.3.1-4, F.3.1-12, F.3.1-14, F.3.1-16, F.3.1-24, F.3.1-25, F.3.1-35, F.3.1-37, F.3.1-38, F.3.1-60, F.3.1-68, F.3.1-76, F.3.1-77, F.3.2-4, F.3.2-12, F.3.2-13, F.3.2-15, F.3.2-23, F.3.2-24, F.3.2-34, F.3.2-35, F.3.2-36, F.3.2-37, F.3.2-38, F.3.2-40, F.3.2-42, F.3.2-43, F.3.2-45, F.3.2-64, F.3.2-74, F.3.2-75, H-4, H-5, J-4, J-7

New Jersey State Museum (NJSM), xlii, 2-161, 2-163

New Jersey Statutes Annotated (NJSA), xlii, 2-6, 2-12, 2-79, 2-80, 4-7, 5-5, 9-64, 9-122, 9-162, 9-192, F.3.2-72, F.3.2-88, H-4, H-5, H-6, H-7

No-action alternative, xxviii, 1-12, 9-1, 9-3, 10-21, E-175

Noise, vi, viii, ix, xix, xli, 2-61, 2-155, 2-185, 2-187, 2-188, 3-25, 4-29, 4-31, 4-32, 4-38, 4-45, 4-46, 4-47, 4-50, 4-51, 4-52, 4-53, 4-55, 4-56, 4-59, 4-79, 4-80, 4-81, 4-89, 4-90, 4-91, 4-92, 4-94, 4-95, 4-96, 4-97, 4-102, 4-105, 4-111, 5-2, 5-17, 5-20, 5-29, 5-43, 5-44, 5-61, 5-62, 5-63, 5-64, 5-65, 5-76, 5-78, 5-79, 5-81, 5-82, 5-118, 5-120, 5-121, 5-128, 7-33, 7-40, 7-41, 9-12, 9-27, 9-50, 9-78, 9-79, 9-87, 9-102, 9-103, 9-124, 9-126, 9-135, 9-143, 9-144, 9-164, 9-165, 9-174, 9-182, 9-183, 9-204, 9-206, 9-214, 9-223, 9-224, 10-7, 10-8, 10-11, 10-12, 10-13, 10-14, 10-16, 10-15, 10-17, 10-29, D-87, E-112, E-113, E-114, E-116, E-117, E-118, E-150, F.3.1-14, F.3.1-35, F.3.1-36, F.3.1-62, F.3.1-69, F.3.1-70, F.3.1-73, F.3.1-74, F.3.1-82, F.3.1-92, F.3.2-14, F.3.2-76, F.3.2-77, F.3.2-85, F.3.2-91, F.3.3-44, F.3.3-45, F.3.3-62, F.3.3-63, F.3.3-80, F.3.3-81, F.3.3-2, F.3.3-3, F.3.3-19, F.3.3-20, F.3.3-38, F.3.3-39, I-12, I-14, I-15, I-18, I-23, I-25, J-8, J-12

O

Occupational, vi, viii, ix, x, xix, xliii, 2-185, 2-186, 2-187, 4-55, 4-66, 4-80, 4-89, 4-90, 4-92, 4-93, 4-95, 4-97, 4-105, 4-111, 5-43, 5-62, 5-80, 5-81, 5-82, 5-91, 5-123, 5-128, 6-4, 6-5, 6-13, 6-14, 6-17, 6-25, 6-26, 6-45, 7-40, 7-41, 7-51, 9-102, 9-103, 9-143, 9-144, 9-182, 9-183, 9-223, 9-224, 10-9, 10-8, 10-11, 10-15, 10-17, E-149, E-169

Occupational Safety and Health Administration (OSHA), xliii, 2-186, 4-55, 4-94, 4-105, 5-43, 5-44, 5-81, 5-120, 7-41, 9-103, 9-144, 9-183, 9-224, 10-15

Ozone, xliii, 2-176, 3-31, 4-56, 4-86, 4-90, 5-68, 5-69, 5-70, 5-75, 5-128, 7-36, 9-21, 9-23, 9-24, 9-30, 9-31, 9-32, 9-33, 9-101, 9-142, 9-181, 9-222, D-86, D-87, E-145, E-146, J-9

P

Paleontological resources, 4-105, 5-122

Particulate matter (PM), xliii, 2-176, 2-186, 3-27, 3-31, 4-72, 4-86, 4-92, 4-95, 5-64, 5-68, 5-72, 5-75, 5-128, 9-21, 9-22, 9-23, 9-29, 9-30, 9-31, 9-36, 9-41, D-86, D-87

Permits, iv, iii, v, xiv, xxiii, xxiv, xxviii, xxxvi, xxxviii, 1-1, 1-2, 1-3, 1-6, 1-7, 1-8, 1-9, 1-11, 1-12, 1-13, 1-14, 2-1, 2-6, 2-12, 2-37, 2-43, 2-50, 2-79, 2-117, 2-157, 2-158, 2-159, 2-162, 2-163, 2-164, 3-1, 3-5, 3-6, 3-11, 3-14, 3-15, 3-18, 3-21, 3-26, 3-27, 3-30, 3-31, 4-1, 4-2, 4-3, 4-7, 4-8, 4-12, 4-13, 4-15, 4-16, 4-20, 4-21, 4-22, 4-23, 4-24, 4-38, 4-40, 4-41, 4-42, 4-45, 4-46, 4-48, 4-54, 4-55, 4-57, 4-76, 4-80, 4-81, 4-83, 4-85, 4-86, 4-94, 4-97, 4-100, 4-101, 4-102, 4-103, 4-104, 4-105, 4-106, 4-108, 4-109, 4-112, 5-1, 5-4, 5-5, 5-8, 5-10, 5-11, 5-14, 5-15, 5-16, 5-29, 5-30, 5-31, 5-38, 5-39, 5-40, 5-41, 5-42, 5-43, 5-44, 5-59, 5-64, 5-69, 5-70, 5-71, 5-77, 5-95, 5-96, 5-97, 5-99, 5-100, 5-118, 5-119, 5-120, 5-121, 5-122, 5-123, 5-125, 5-126, 5-128, 6-1, 6-30, 6-44, 7-1, 7-2, 7-10, 7-13, 7-14, 7-21, 7-25, 7-26, 7-27, 7-35, 7-37, 7-44, 7-49, 8-1, 9-1, 9-2, 9-3, 9-5, 9-6, 9-15, 9-16, 9-21, 9-22, 9-23, 9-26, 9-27, 9-29, 9-30, 9-31, 9-32, 9-34, 9-35, 9-42, 9-46, 9-47, 9-48, 9-50, 9-54, 9-55, 9-56, 9-69, 9-72, 9-73, 9-84, 9-85, 9-86, 9-101, 9-102, 9-103, 9-117, 9-120,

9-132, 9-133, 9-142, 9-143, 9-144, 9-156, 9-157, 9-160, 9-167, 9-171, 9-172, 9-173, 9-181, 9-182, 9-183, 9-196, 9-200, 9-207, 9-212, 9-213, 9-222, 9-223, 9-224, 9-227, 9-230, 9-232, 10-1, 10-2, 10-3, 10-5, 10-6, 10-10, 10-11, 10-13, 10-14, 10-15, 10-16, 10-17, 10-18, 10-19, 10-20, 10-21, 10-26, 10-28, C-1, C-2, C-3, C-4, C-5, C-6, C-7, C-8, C-9, C-10, C-11, C-12, C-13, C-14, C-15, C-16, D-1, D-11, D-15, D-16, D-17, D-18, D-19, D-20, D-21, D-25, D-26, D-27, D-28, D-29, D-31, D-33, D-36, D-41, D-45, D-47, D-51, D-52, D-54, D-58, D-60, D-61, D-68, D-71, D-84, D-85, D-86, D-90, D-92, D-99, D-101, D-104, D-105, D-107, E-1, E-22, E-26, E-27, E-28, E-29, E-30, E-32, E-34, E-35, E-36, E-41, E-43, E-45, E-50, E-51, E-52, E-53, E-58, E-66, E-71, E-83, E-86, E-89, E-99, E-114, E-116, E-123, E-125, E-126, E-127, E-136, E-137, E-138, E-142, E-143, E-145, E-146, E-147, E-150, E-154, E-189, E-192, E-193, E-194, E-195, E-196, E-197, E-198, E-205, E-206, E-209, E-210, E-211, E-215, E-217, E-218, E-220, E-221, E-227, E-232, E-233, E-234, E-235, E-237, F-1, F-29, F-30, F.3.1-1, F.3.1-4, F.3.1-6, F.3.1-14, F.3.1-15, F.3.1-16, F.3.1-24, F.3.1-35, F.3.1-37, F.3.1-38, F.3.1-44, F.3.1-48, F.3.1-49, F.3.1-50, F.3.1-55, F.3.1-57, F.3.1-60, F.3.1-61, F.3.1-62, F.3.1-63, F.3.1-69, F.3.1-71, F.3.1-73, F.3.1-75, F.3.1-76, F.3.1-77, F.3.1-82, F.3.1-84, F.3.1-85, F.3.1-86, F.3.1-92, F.3.2-1, F.3.2-4, F.3.2-6, F.3.2-7, F.3.2-13, F.3.2-14, F.3.2-15, F.3.2-23, F.3.2-24, F.3.2-33, F.3.2-34, F.3.2-35, F.3.2-36, F.3.2-37, F.3.2-38, F.3.2-39, F.3.2-40, F.3.2-41, F.3.2-42, F.3.2-43, F.3.2-44, F.3.2-45, F.3.2-56, F.3.2-57, F.3.2-58, F.3.2-61, F.3.2-64, F.3.2-65, F.3.2-66, F.3.2-67, F.3.2-72, F.3.2-75, F.3.2-76, F.3.2-83, F.3.2-84, F.3.2-85, F.3.2-87, F.3.2-89, F.3.2-91, F.3.3-43, F.3.3-46, F.3.3-48, F.3.3-49, F.3.3-79, F.3.3-80, F.3.3-81, F.3.3-82, F.3.3-83, F.3.3-1, F.3.3-4, F.3.3-6, F.3.3-37, F.3.3-39, F.3.3-40, F.3.3-41, G-14, G-16, H-1, H-2, H-3, H-4, H-5, H-6, H-7, I-1, J-1, J-2, J-5, J-7, J-10, J-16, J-17

Population, vi, xvii, xviii, xix, xxi, xxvii, xxx, xxxii, xxxvii, xl, 1-14, 2-71, 2-72, 2-73, 2-74, 2-75, 2-76, 2-77, 2-78, 2-113, 2-114, 2-116, 2-118, 2-119, 2-120, 2-121, 2-122, 2-123, 2-124, 2-132, 2-139, 2-141, 2-146, 2-147, 2-148, 2-149, 2-155, 2-156, 2-160, 2-175, 2-179, 2-187, 4-34, 4-36, 4-50, 4-51, 4-52, 4-62, 4-64, 4-73, 4-75, 4-76, 4-77, 4-78, 4-80, 4-81, 4-90, 4-110, 4-112, 5-21, 5-22, 5-25, 5-26, 5-30, 5-49, 5-50, 5-56, 5-58, 5-59, 5-60, 5-61, 5-62, 5-63, 5-64, 5-83, 5-86, 5-87, 5-88, 5-89, 5-90, 5-91, 5-92, 5-102, 5-103, 5-106, 5-107, 5-108, 5-109, 5-110, 5-111, 5-112, 5-113, 5-114, 5-115, 5-116, 5-122, 5-126, 5-129, 6-11, 6-12, 6-13, 6-17, 6-22, 6-23, 6-29, 6-30, 6-31, 6-32, 6-33, 6-34, 6-35, 6-37, 6-38, 6-39, 6-45, 7-10, 7-20, 7-22, 7-23, 7-25, 7-30, 7-31, 7-42, 7-45, 7-52, 8-2, 8-3, 8-4, 8-12, 8-13, 9-11, 9-12, 9-24, 9-29, 9-36, 9-41, 9-43, 9-46, 9-48, 9-52, 9-53, 9-56, 9-80, 9-87, 9-88, 9-89, 9-92, 9-93, 9-94, 9-96, 9-103, 9-105, 9-127, 9-130, 9-131, 9-132, 9-139, 9-144, 9-146, 9-166, 9-170, 9-178, 9-183, 9-185, 9-207, 9-210, 9-211, 9-219, 9-224, 9-226, 9-228, 9-229, 10-7, 10-14, D-26, D-57, D-66, D-73, D-75, E-25, E-45, E-90, E-106, E-111, E-117, E-120, E-121, E-122, E-135, E-153, E-155, E-156, E-158, E-159, E-161, E-162, E-166, E-172, E-199, E-200, E-224, F.3.1-2, F.3.1-3, F.3.1-4, F.3.1-26, F.3.1-27, F.3.1-28, F.3.1-30, F.3.1-31, F.3.1-32, F.3.1-33, F.3.1-34, F.3.1-43, F.3.1-45, F.3.1-49, F.3.1-55, F.3.1-60, F.3.1-63, F.3.1-76, F.3.1-81, F.3.1-83, F.3.2-35, F.3.2-48, F.3.2-49, F.3.3-45, F.3.3-67, F.3.3-72, F.3.3-73, F.3.3-76, F.3.3-79, F.3.3-81, F.3.3-3, F.3.3-24, F.3.3-28, F.3.3-30, F.3.3-31, F.3.3-34, F.3.3-36, F.3.3-38, F.3.3-39, G-1, G-2, G-7, G-8, G-10, G-11, G-14, I-2, I-6, I-25, I-26, J-8, J-11, J-14

Postulated accidents, 5-1, 5-101, 6-18, 6-36, 7-45, 7-46, 9-54, 9-105, 9-106, 9-146, 9-147, 9-185, 9-186, 9-226, 9-227, 9-230, 10-31, C-7, C-9, C-10, C-12, E-158, E-159, E-160, J-14

Preconstruction, v, vi, vii, viii, xii, xv, xviii, xxii, xxxiii, 1-7, 2-189, 3-1, 3-12, 3-18, 3-19, 3-20, 3-22, 3-24, 4-1, 4-2, 4-3, 4-4, 4-5, 4-6, 4-8, 4-13, 4-14, 4-15, 4-16, 4-18, 4-20, 4-21, 4-23, 4-24, 4-25, 4-26, 4-27, 4-28, 4-29, 4-30, 4-31, 4-32, 4-33, 4-34, 4-35, 4-36, 4-37, 4-38, 4-39, 4-40, 4-43, 4-54, 4-56, 4-60, 4-86, 4-87, 4-88, 4-89, 4-90, 4-94, 4-95, 4-96, 4-97, 4-101, 4-102, 4-103, 4-106, 4-107, 4-108, 4-109, 4-111, 4-112, 5-5, 5-23, 5-118, 7-1, 7-2, 7-6, 7-10, 7-12, 7-14, 7-16, 7-18, 7-25, 7-31, 7-33, 7-35, 7-36, 7-37, 7-38, 7-40, 7-42, 7-43, 7-44, 7-47, 7-48, 9-42, 9-45, 9-55, 9-57, 9-65, 9-81, 9-100, 9-103, 9-107, 9-113, 9-141, 9-148, 9-152, 9-180, 9-187, 9-192, 9-221, 9-222, 10-4, 10-5, 10-6, 10-10, 10-11, 10-18, 10-19, 10-20, 10-23, 10-25, 10-26, 10-27, 10-28, 10-30, 10-32, 10-33, D-16, D-86, E-31, E-39, E-41, E-46, E-47, E-52, E-63, E-64, E-67, E-68, E-69, E-70, E-71, E-72, E-73, E-74, E-75, E-76, E-90, E-94, E-95, E-145, E-146, E-147, E-148, E-220, F.3.1-62, F.3.2-66, F.3.3-58, F.3.3-62, F.3.3-64, F.3.3-15, F.3.3-17, F.3.3-18, F.3.3-19, F.3.3-21, F.3.3-30, F.3.3-32, F.3.3-37, H-2, H-6, J-5, K-1, K-2, K-3

R

Radiation (also see Dose), viii, ix, xx, xxxv, xlii, xliv, 2-177, 2-181, 2-185, 2-190, 3-28, 4-80, 4-97, 4-98, 4-99, 4-106, 5-63, 5-79, 5-82, 5-83, 5-86, 5-87, 5-88, 5-89, 5-90, 5-91, 5-93, 5-100, 5-101, 5-107, 5-115, 5-122, 5-123, 5-129, 5-129, 6-5, 6-12, 6-14, 6-17, 6-20, 6-21, 6-23, 6-24, 6-25, 6-26, 6-30, 6-33, 6-35, 6-36, 6-37, 6-38, 7-43, 7-47, 7-48, 7-51, 9-104, 9-105, 9-146, 9-184, 9-225, 9-233, 10-16, 10-17, A-1, A-2, C-7, C-9, D-90, E-150, E-151, E-152, E-153, E-154, E-156, E-161, E-169, E-223, G-8, G-11, G-14, G-15, J-11, J-12, J-16

Radioactive effluents, 2-42, 3-28, 4-97, 4-98, 4-99, 5-63, 5-91, 6-11, 6-13, 9-104, 9-105, 9-146, 9-184, 9-225, E-152, E-153, G-7

Radioactive wastes, 3-22, 3-27, 3-28, 4-97, 5-96, 6-4, 6-13, 6-17, 6-19, 6-20, 6-24, 6-25, 6-26, 6-40, 6-41, 6-43, 6-44, 6-45, 7-47, 10-12, 10-13, 10-16, 10-17, 10-29, 10-31, D-91, E-33, E-148, E-163, E-164, E-166, E-167, E-169, E-187, E-190, E-230, H-6, I-21, I-24, J-10, J-12

Radionuclides, xxi, 2-42, 2-191, 5-83, 5-92, 5-101, 5-106, 5-116, 6-15, 6-21, 6-35, 6-36, 6-37, E-152, E-153, E-154, E-155, G-11, I-21, I-26

Radon, 6-4, 6-6, 6-7, 6-8, 6-11, 6-12, 6-13, 6-17, 6-23, 10-16, 10-17

RADTRAN, xx, 6-19, 6-21, 6-22, 6-26, 6-29, 6-30, 6-31, 6-32, 6-34, 6-35, 6-37

rain, rainfall, 2-47, 2-79, 2-174, 2-175, 2-176, 2-181, 2-185, 4-14, 4-15, 4-44, 7-42, 9-22, D-98, D-99, D-101, D-103, E-140, E-142, E-209, F.3.3-65, F.3.3-22

Reactor, iv, xx, xxi, xxiv, xxviii, xxxv, xxxvi, xxxviii, xl, xliv, xlv, xlvi, 1-1, 1-2, 1-3, 1-6, 1-9, 1-10, 1-13, 1-14, 2-1, 2-5, 2-50, 2-126, 2-179, 2-180, 2-186, 2-189, 3-1, 3-3, 3-4, 3-5, 3-6, 3-10, 3-11, 3-12, 3-13, 3-14, 3-16, 3-18, 3-22, 3-23, 3-26, 3-28, 4-13, 4-14, 4-21, 4-25, 4-41, 4-59, 4-60, 4-64, 4-65, 4-88, 4-89, 4-92, 4-98, 4-109, 5-7, 5-45, 5-48, 5-51, 5-54, 5-79, 5-80, 5-83, 5-91, 5-97, 5-98, 5-99, 5-100, 5-101, 5-102, 5-103, 5-104, 5-105, 5-106, 5-107, 5-108, 5-109, 5-110, 5-113, 5-114, 5-115, 5-116, 5-117, 5-118, 5-123, 5-126, 5-129, 6-1, 6-2, 6-3, 6-4, 6-5, 6-6, 6-7, 6-9, 6-11, 6-12, 6-15, 6-16, 6-18, 6-19, 6-20, 6-21, 6-22, 6-24, 6-25, 6-26, 6-27, 6-28, 6-29, 6-30, 6-31, 6-33, 6-34, 6-36, 6-37, 6-38, 6-39, 6-40, 6-41, 6-42, 6-43, 6-44, 6-45, 7-2, 7-3, 7-11, 7-13, 7-15, 7-32, 7-36, 7-38, 7-45, 7-46, 7-47, 8-1, 9-1, 9-5, 9-6, 9-30, 9-56, 9-58, 9-72, 9-91, 9-105, 9-106, 9-107, 9-119, 9-137, 9-145, 9-146, 9-148, 9-159, 9-177, 9-184, 9-185, 9-187, 9-198, 9-218, 9-225, 9-226, 9-232, 9-233, 9-234, 10-2, 10-7, 10-11, 10-14, 10-20, 10-21, 10-24, 10-26, 10-29, 10-30, 10-31, A-1, A-2, C-5, D-12, D-26, D-27, D-41, D-42, D-44, D-47, D-62, D-76, D-85, D-86, D-90, D-91, D-93, D-95, D-98, D-100, D-103, D-104, D-106, E-22, E-25, E-27, E-28, E-33, E-34, E-37, E-46, E-51, E-80, E-81, E-82, E-84, E-88, E-90, E-91, E-93, E-94, E-95, E-96, E-125, E-126, E-127, E-141, E-143, E-145,

E-146, E-148, E-151, E-152, E-153, E-154, E-156, E-157, E-158, E-159, E-160, E-161, E-162, E-165, E-166, E-167, E-168, E-170, E-192, E-193, E-194, E-200, E-201, E-209, E-210, E-214, E-215, E-216, E-217, E-218, E-220, E-221, E-222, E-224, E-226, E-231, E-233, E-234, E-236, E-237, F-29, F-36, F.3.1-6, F.3.1-50, F.3.1-61, F.3.1-86, F.3.2-6, F.3.2-57, F.3.2-65, F.3.2-83, F.3.2-89, F.3.3-48, F.3.3-58, F.3.3-82, F.3.3-6, F.3.3-15, G-8, G-14, G-15, I-2, J-5, J-8, J-10, J-11, J-12, J-13, J-14, J-16, J-17, K-2, K-3, K-4, K-5

Refurbishment, 7-21, 9-5, 9-6, E-77, F.3.3-76, F.3.3-34

Renewable energy, xliv, 7-39, 8-14, 9-7, 9-9, 9-13, 9-37, D-44, D-91, D-93, D-94, D-95, D-96, D-97, D-98, D-99, D-100, D-101, D-102, E-140, E-148, E-171, E-172, E-176, E-177, E-178, E-179, E-181, E-182, E-183, E-184, E-191, E-216, E-217, K-3

Runoff, 2-24, 3-20, 3-26, 4-14, 4-15, 4-21, 4-38, 4-39, 4-44, 4-45, 4-53, 4-101, 4-102, 4-103, 4-104, 4-106, 4-112, 5-5, 5-10, 5-15, 5-64, 5-94, 5-95, 5-119, 7-12, 7-26, 9-25, 9-85, 9-116, 9-156, 9-196, 10-9, D-24, D-29, D-76, D-89, E-40, E-71, F.3.1-13, F.3.1-15, F.3.1-37, F.3.1-68, F.3.1-75, F.3.2-13, F.3.2-14, F.3.2-44, F.3.2-72, F.3.2-75, H-5, J-4

S

Salt deposition, 5-2, 5-18, 5-29, 5-30, 5-72, 5-74, 5-75, 5-124, 7-21, 10-12, 10-13, E-92, F.3.3-65, F.3.3-73, F.3.3-77, F.3.3-22, F.3.3-31, F.3.3-35, F.3.3-37, J-6, J-10

Saltwater intrusion, 2-37, 2-50, 2-68, 3-10, 5-15, 5-16, 7-17, E-57, E-63, E-233

Scoping, iii, vi, xxiii, xxiv, xxxiii, 1-5, 1-8, 1-14, 2-155, 2-156, 2-164, 2-166, 10-2, 10-33, C-2, C-3, C-4, C-5, D-1, D-2, D-88, E-30, F.3.1-48, F.3.1-50, F.3.1-84, F.3.1-85, F.3.2-56, F.3.2-89, F.3.3-82, F.3.3-40

Seismic, 2-50, 2-191, 3-22, 3-23, 5-98, 5-99, 5-100, E-59, E-156, E-187, I-9, J-14

Sensitive species, 2-63, 2-65, 2-68, 2-187, 4-37, 4-41, 4-46, 4-53, 4-59, 4-103, 4-110, 5-27, 5-45, 5-48, 5-64, 5-75, 5-121, 7-17, 7-24, 7-29, 7-38, 9-47, 9-50, 9-53, 9-67, 9-79, 9-102, 9-143, 9-165, 9-182, 9-201, 9-205, 9-223, 10-7, 10-11, 10-14, D-41, E-37, E-84, E-88, E-198, F-1, F-3, F-43, F.3.1-42, F.3.1-69, F.3.1-74, F.3.1-80, F.3.2-14, F.3.2-24, F.3.2-47, F.3.2-76, F.3.2-85, F.3.3-77, F.3.3-78, F.3.3-7, F.3.3-35, F.3.3-36

Site audit, xxiii, 2-149, C-5, C-7

Soil types, 2-79, 4-10, 4-33, 4-42, F.3.2-84

Solid waste, xli, 3-28, 3-31, 4-100, 4-102, 4-112, 5-94, 5-123, 6-45, 7-4, 7-43, 7-44, 7-51, 9-21, 9-25, 9-37, 9-38, 9-44, 9-56, 9-109, 9-150, 9-189, 10-11, 10-17, D-16, E-179, E-182, J-10, J-13

Species, iii, xvii, xix, xxi, xxii, xxviii, xxxviii, 2-52, 2-53, 2-54, 2-55, 2-56, 2-57, 2-58, 2-59, 2-60, 2-61, 2-62, 2-63, 2-64, 2-66, 2-67, 2-68, 2-69, 2-70, 2-72, 2-73, 2-74, 2-75, 2-76, 2-77, 2-78, 2-79, 2-80, 2-81, 2-82, 2-83, 2-85, 2-86, 2-87, 2-88, 2-90, 2-91, 2-92, 2-94, 2-95, 2-96, 2-97, 2-98, 2-99, 2-100, 2-101, 2-104, 2-105, 2-106, 2-107, 2-108, 2-109, 2-110, 2-111, 2-112, 2-113, 2-114, 2-115, 2-116, 2-117, 4-28, 4-29, 4-30, 4-31, 4-32, 4-33, 4-34, 4-35, 4-36, 4-37, 4-38, 4-40, 4-42, 4-43, 4-44, 4-45, 4-46, 4-47, 4-48, 4-50, 4-51, 4-52, 4-53, 4-54, 4-95, 4-103, 5-18, 5-20, 5-21, 5-22, 5-23, 5-24, 5-25, 5-26, 5-27, 5-28, 5-29, 5-30, 5-31, 5-32, 5-33, 5-36, 5-37, 5-38, 5-39, 5-40, 5-41, 5-42, 5-74, 5-79, 5-91, 5-92, 5-121, 5-126, 7-21, 7-22, 7-23, 7-24, 7-25, 7-26, 7-27, 7-28, 7-29, 7-30, 7-50, 9-11, 9-26, 9-29, 9-34, 9-35, 9-50, 9-74, 9-75, 9-76, 9-78, 9-79, 9-81, 9-82, 9-83, 9-84, 9-86, 9-121, 9-122, 9-124, 9-125, 9-126, 9-128, 9-129, 9-130, 9-131, 9-132, 9-133, 9-134, 9-161, 9-162, 9-165, 9-168, 9-169, 9-170, 9-171, 9-172, 9-173, 9-201, 9-202, 9-204, 9-205, 9-206, 9-208, 9-209, 9-210, 9-211, 9-213, 10-20, 10-28, C-11, C-13, D-15, D-31, D-32, D-37, D-38, D-41, D-42, D-43, D-45, D-47, D-48, D-50, D-53, D-56, D-57, D-59, D-62, D-63, D-65, D-66, D-67, D-70, D-72, D-73, D-74, D-75, D-76, D-82, D-92, D-106, D-107, E-28, E-36,

E-52, E-68, E-72, E-73, E-74, E-76, E-77, E-78, E-84, E-85, E-87, E-89, E-90, E-91, E-92, E-93, E-94, E-95, E-96, E-97, E-99, E-101, E-105, E-106, E-108, E-109, E-111, E-112, E-113, E-114, E-116, E-117, E-118, E-120, E-121, E-123, E-124, E-125, E-126, E-174, E-178, E-210, E-224, F-1, F-3, F-43, F.3.1-2, F.3.1-3, F.3.1-4, F.3.1-6, F.3.1-7, F.3.1-12, F.3.1-13, F.3.1-14, F.3.1-15, F.3.1-16, F.3.1-17, F.3.1-18, F.3.1-20, F.3.1-21, F.3.1-22, F.3.1-25, F.3.1-26, F.3.1-27, F.3.1-28, F.3.1-29, F.3.1-30, F.3.1-31, F.3.1-32, F.3.1-33, F.3.1-34, F.3.1-35, F.3.1-36, F.3.1-37, F.3.1-38, F.3.1-39, F.3.1-40, F.3.1-41, F.3.1-42, F.3.1-43, F.3.1-44, F.3.1-45, F.3.1-46, F.3.1-47, F.3.1-48, F.3.1-50, F.3.1-51, F.3.1-58, F.3.1-59, F.3.1-60, F.3.1-62, F.3.1-63, F.3.1-68, F.3.1-69, F.3.1-71, F.3.1-73, F.3.1-74, F.3.1-75, F.3.1-76, F.3.1-77, F.3.1-78, F.3.1-79, F.3.1-80, F.3.1-81, F.3.1-82, F.3.1-83, F.3.1-84, F.3.1-87, F.3.2-2, F.3.2-3, F.3.2-6, F.3.2-7, F.3.2-11, F.3.2-12, F.3.2-13, F.3.2-14, F.3.2-16, F.3.2-17, F.3.2-19, F.3.2-20, F.3.2-21, F.3.2-24, F.3.2-25, F.3.2-26, F.3.2-27, F.3.2-28, F.3.2-29, F.3.2-30, F.3.2-31, F.3.2-32, F.3.2-33, F.3.2-34, F.3.2-35, F.3.2-36, F.3.2-37, F.3.2-38, F.3.2-39, F.3.2-40, F.3.2-41, F.3.2-42, F.3.2-43, F.3.2-44, F.3.2-45, F.3.2-46, F.3.2-47, F.3.2-48, F.3.2-49, F.3.2-50, F.3.2-51, F.3.2-52, F.3.2-54, F.3.2-55, F.3.2-56, F.3.2-57, F.3.2-62, F.3.2-63, F.3.2-65, F.3.2-66, F.3.2-67, F.3.2-72, F.3.2-74, F.3.2-76, F.3.2-79, F.3.2-80, F.3.2-81, F.3.2-82, F.3.2-84, F.3.2-85, F.3.2-86, F.3.2-88, F.3.2-89, F.3.2-90, F.3.3-44, F.3.3-45, F.3.3-46, F.3.3-48, F.3.3-49, F.3.3-56, F.3.3-57, F.3.3-61, F.3.3-62, F.3.3-63, F.3.3-64, F.3.3-65, F.3.3-67, F.3.3-68, F.3.3-69, F.3.3-70, F.3.3-71, F.3.3-72, F.3.3-73, F.3.3-77, F.3.3-78, F.3.3-79, F.3.3-80, F.3.3-81, F.3.3-1, F.3.3-2, F.3.3-3, F.3.3-4, F.3.3-6, F.3.3-7, F.3.3-13, F.3.3-14, F.3.3-18, F.3.3-19, F.3.3-20, F.3.3-21, F.3.3-22, F.3.3-24, F.3.3-25, F.3.3-26, F.3.3-27, F.3.3-28, F.3.3-29, F.3.3-30, F.3.3-35, F.3.3-36, F.3.3-37, F.3.3-38, F.3.3-39, G-15, H-3, J-6, J-7

Spent fuel, xxxix, 2-50, 2-191, 3-13, 5-98, 5-100, 6-4, 6-5, 6-7, 6-15, 6-16, 6-17, 6-20, 6-24, 6-25, 6-26, 6-28, 6-29, 6-30, 6-32, 6-33, 6-34, 6-35, 6-36, 6-37, 6-38, 6-40, 6-41, 7-46, 7-47, 10-27, 10-29, 10-30, 10-31, D-90, D-91, E-59, E-156, E-160, E-166, E-167, E-168, E-169, E-228, E-233, J-12, J-13

State Historic Preservation Officer (SHPO), xlv, 2-161, 2-163, 2-164, 2-165, 2-166, 2-167, 2-168, 2-169, 4-84, 4-85, 4-86, 4-105, 4-111, 5-67, 7-35, 9-99, 9-100, 9-140, 9-141, 9-178, 9-179, 9-180, 9-220, 10-11, 10-17, 10-20, C-13, D-85, E-137, E-138, E-139, F-30

Storage, xxxvi, xxxix, xliv, 2-33, 2-34, 2-186, 2-187, 3-19, 3-20, 3-22, 3-28, 3-32, 4-25, 4-44, 4-45, 4-46, 4-50, 4-51, 4-53, 4-98, 5-7, 5-8, 5-9, 5-39, 5-41, 5-96, 5-102, 5-119, 5-123, 5-124, 6-4, 6-5, 6-7, 6-13, 6-14, 6-15, 6-16, 6-17, 6-29, 6-44, 7-10, 7-11, 7-47, 7-49, 9-10, 9-11, 9-13, 9-14, 9-15, 9-17, 9-18, 9-25, 9-26, 9-28, 9-38, 9-70, 9-71, 9-118, 9-157, 9-197, 10-12, 10-13, 10-20, 10-29, C-8, D-90, D-91, E-33, E-51, E-89, E-114, E-118, E-142, E-148, E-163, E-164, E-165, E-166, E-167, E-169, E-185, E-199, E-223, E-233, E-235, F.3.1-7, F.3.1-13, F.3.1-14, F.3.1-24, F.3.1-34, F.3.1-36, F.3.1-44, F.3.1-61, F.3.1-63, F.3.1-68, F.3.1-69, F.3.1-73, F.3.1-81, F.3.2-13, F.3.2-14, F.3.2-23, F.3.2-24, F.3.2-33, F.3.2-34, F.3.2-36, F.3.2-37, F.3.2-38, F.3.2-39, F.3.2-40, F.3.2-41, F.3.2-43, F.3.2-66, F.3.2-67, F.3.2-75, F.3.3-58, F.3.3-15, I-24, J-4, J-5, J-7, J-12, J-13, J-16

storm water, xlv, 2-5, 2-24, 2-55, 2-68, 3-20, 3-26, 3-31, 4-12, 4-13, 4-14, 4-15, 4-17, 4-18, 4-21, 4-24, 4-29, 4-39, 4-44, 4-45, 4-53, 4-101, 4-102, 4-103, 4-104, 4-108, 4-112, 5-4, 5-5, 5-10, 5-14, 5-15, 5-39, 5-64, 5-94, 5-95, 5-118, 5-119, 10-5, 10-9, 10-10, 10-13, 10-19, D-17, D-24, D-29, E-40, E-58, E-71, E-209, F.3.1-5, F.3.1-14, F.3.1-25, F.3.1-68, F.3.2-5, F.3.2-13, F.3.2-24, F.3.2-64, F.3.2-72, F.3.2-75, F.3.3-57, F.3.3-64,

F.3.3-14, F.3.3-21, F.3.3-28, H-4, H-6, J-4, J-7
Streams, xiv, xvii, 1-9, 2-14, 2-24, 2-25, 2-27, 2-28, 2-33, 2-34, 2-47, 2-51, 2-52, 2-60, 2-66, 2-85, 2-98, 2-112, 2-170, 3-8, 3-14, 3-21, 3-24, 3-26, 3-28, 3-29, 4-15, 4-21, 4-25, 4-31, 4-41, 4-42, 4-45, 4-50, 4-71, 4-104, 4-108, 5-6, 5-10, 5-16, 5-30, 5-37, 5-42, 5-56, 5-99, 5-116, 7-14, 7-24, 7-26, 7-44, 9-11, 9-15, 9-21, 9-70, 9-74, 9-82, 9-83, 9-84, 9-85, 9-121, 9-129, 9-132, 9-161, 9-162, 9-168, 9-171, 9-172, 9-177, 9-201, 9-209, 9-211, 9-212, 9-238, 9-239, 10-2, 10-5, 10-6, 10-10, 10-31, E-51, E-165, F.3.1-15, F.3.1-22, F.3.1-37, F.3.1-75, F.3.2-14, F.3.2-21, F.3.2-44, F.3.2-72, F.3.2-83, F.3.2-84, F.3.3-58, F.3.3-78, F.3.3-15, F.3.3-36, I-12, I-13, I-14, I-15, I-16, I-17, I-18, I-20, I-21, J-10, J-11
Subsistence, vii, ix, 2-146, 2-155, 4-82, 5-65, 9-24, 9-139, 9-178, 9-219
Surface runoff, 3-20, 4-15, 4-21, 4-108
Surface water, xxiv, xxvi, xxvii, xxviii, 2-24, 2-42, 2-43, 2-45, 2-47, 2-48, 2-51, 2-53, 2-83, 2-114, 2-138, 2-190, 3-10, 3-15, 3-20, 4-12, 4-13, 4-14, 4-15, 4-18, 4-21, 4-22, 4-23, 4-24, 4-39, 4-44, 4-53, 4-81, 4-101, 4-105, 4-108, 4-109, 5-3, 5-4, 5-5, 5-6, 5-8, 5-10, 5-15, 5-16, 5-39, 5-74, 5-93, 5-95, 5-106, 5-107, 5-108, 5-115, 5-116, 5-119, 5-124, 7-5, 7-10, 7-11, 7-12, 7-14, 7-15, 7-16, 7-49, 9-25, 9-26, 9-33, 9-39, 9-60, 9-67, 9-68, 9-69, 9-70, 9-72, 9-73, 9-86, 9-109, 9-115, 9-116, 9-117, 9-118, 9-119, 9-120, 9-133, 9-150, 9-155, 9-156, 9-157, 9-158, 9-159, 9-160, 9-172, 9-189, 9-195, 9-196, 9-197, 9-199, 9-200, 9-213, 9-231, 9-235, 9-238, 9-239, 9-240, 10-5, 10-10, 10-12, 10-13, 10-19, 10-32, D-25, D-28, D-29, D-30, D-31, D-54, D-70, D-76, D-89, E-50, E-53, E-54, E-89, E-115, E-119, E-120, F.3.1-15, F.3.1-25, F.3.1-27, F.3.2-11, F.3.2-14, F.3.2-24, F.3.2-39, F.3.2-71, F.3.2-72, I-9, J-5

T

Taxes, xviii, xix, xxvii, xxviii, 2-124, 2-129, 2-130, 2-131, 4-3, 4-55, 4-64, 4-67, 4-68, 4-69, 4-74, 4-79, 4-106, 4-110, 5-1, 5-43, 5-50, 5-52, 5-53, 5-54, 5-55, 5-58, 5-62, 5-122, 5-123, 5-127, 7-31, 7-32, 7-33, 7-51, 8-21, 9-27, 9-28, 9-29, 9-34, 9-35, 9-40, 9-89, 9-90, 9-91, 9-95, 9-135, 9-137, 9-138, 9-174, 9-177, 9-215, 9-216, 9-218, 9-219, 9-229, 9-230, 10-7, 10-14, 10-24, 10-25, 10-26, 10-27, 10-28, D-77, D-79, D-80, D-81, D-95, D-102, E-25, E-127, E-129, E-131, E-133, E-134, E-190, J-8
Threatened species, xvii, xxi, xxii, xlv, 2-56, 2-57, 2-62, 2-63, 2-66, 2-67, 2-68, 2-69, 2-70, 2-71, 2-72, 2-73, 2-74, 2-75, 2-76, 2-77, 2-78, 2-79, 2-97, 2-110, 2-112, 2-113, 2-114, 2-116, 2-117, 4-30, 4-31, 4-33, 4-34, 4-35, 4-36, 4-37, 4-50, 4-51, 4-95, 5-20, 5-21, 5-22, 5-23, 5-24, 5-26, 5-27, 5-28, 5-39, 5-41, 5-79, 5-126, 7-22, 7-24, 9-26, 9-29, 9-34, 9-35, 9-50, 9-74, 9-75, 9-76, 9-81, 9-83, 9-84, 9-86, 9-121, 9-122, 9-124, 9-129, 9-130, 9-131, 9-132, 9-134, 9-161, 9-162, 9-165, 9-168, 9-169, 9-170, 9-171, 9-173, 9-201, 9-202, 9-205, 9-208, 9-210, 9-211, 9-213, 10-28, D-42, D-47, D-57, D-63, D-66, D-73, E-36, E-111, E-167, F-1, F-3, F-43, F.3.1-3, F.3.1-6, F.3.1-7, F.3.1-25, F.3.1-26, F.3.1-27, F.3.1-30, F.3.1-31, F.3.1-32, F.3.1-38, F.3.1-45, F.3.1-50, F.3.1-51, F.3.1-59, F.3.1-60, F.3.1-62, F.3.1-63, F.3.1-73, F.3.1-77, F.3.1-83, F.3.1-87, F.3.2-7, F.3.2-65, F.3.3-48, F.3.3-49, F.3.3-63, F.3.3-64, F.3.3-67, F.3.3-70, F.3.3-72, F.3.3-73, F.3.3-78, F.3.3-79, F.3.3-80, F.3.3-1, F.3.3-6, F.3.3-20, F.3.3-21, F.3.3-24, F.3.3-27, F.3.3-28, F.3.3-30, F.3.3-36, F.3.3-37, F.3.3-38, J-6, J-7
Traffic, vii, xviii, xix, xxvii, xlv, 2-35, 2-61, 2-132, 2-134, 2-186, 2-188, 2-189, 3-20, 4-48, 4-52, 4-53, 4-58, 4-69, 4-70, 4-71, 4-72, 4-73, 4-77, 4-78, 4-79, 4-81, 4-82, 4-86, 4-88, 4-89, 4-91, 4-95, 4-96, 4-97, 4-102, 4-105, 4-106, 4-109, 4-110, 4-111, 5-3, 5-17, 5-22, 5-45, 5-56, 5-57, 5-62, 5-70, 5-73, 5-78, 5-81, 5-82, 5-95, 5-121, 5-122, 5-127, 6-20, 6-22, 6-26, 6-27, 6-29, 6-30, 6-31, 6-41, 7-23, 7-32, 7-33, 7-37, 7-40, 7-41, 7-51, 9-12, 9-26, 9-27, 9-28, 9-29, 9-33, 9-34, 9-39, 9-40, 9-69,

9-92, 9-95, 9-102, 9-103, 9-136, 9-138, 9-143, 9-144, 9-175, 9-176, 9-177, 9-181, 9-183, 9-216, 9-218, 9-219, 9-222, 9-224, 10-7, 10-8, 10-9, 10-11, 10-14, 10-24, 10-29, 10-32, D-17, E-38, E-114, E-116, E-117, E-118, E-119, E-120, E-130, E-131, E-149, F.3.1-3, F.3.1-24, F.3.1-34, F.3.1-36, F.3.1-58, F.3.1-62, F.3.1-71, F.3.1-73, F.3.1-75, F.3.1-76, F.3.1-81, F.3.1-82, F.3.1-92, F.3.2-23, F.3.2-33, F.3.2-34, F.3.2-35, F.3.2-36, F.3.2-38, F.3.2-39, F.3.2-40, F.3.2-41, F.3.2-43, F.3.2-62, F.3.2-76, F.3.2-92, F.3.3-44, F.3.3-45, F.3.3-67, F.3.3-73, F.3.3-74, F.3.3-2, F.3.3-3, F.3.3-24, F.3.3-30, F.3.3-31, F.3.3-37, J-8

Transmission line corridors, xxviii, 2-5, 2-15, 2-18, 2-62, 2-82, 7-8, 7-9, 7-21, 7-25, 7-35, 7-36, 7-40, 9-12, 9-61, 9-78, 9-86, 9-100, 9-103, 9-112, 9-114, 9-115, 9-125, 9-127, 9-130, 9-134, 9-136, 9-141, 9-144, 9-151, 9-152, 9-154, 9-155, 9-164, 9-167, 9-169, 9-173, 9-180, 9-183, 9-190, 9-193, 9-194, 9-205, 9-207, 9-210, 9-213, 9-216, 9-221, 9-224, E-46, F.3.3-70, F.3.3-76, F.3.3-27, F.3.3-34

Transmission lines, xxviii, 1-2, 1-7, 2-5, 2-15, 2-18, 2-20, 2-60, 2-61, 2-62, 2-82, 2-96, 2-189, 2-190, 3-4, 3-16, 3-18, 4-4, 5-67, 5-75, 5-76, 5-78, 5-79, 5-80, 5-82, 7-4, 7-8, 7-9, 7-21, 7-22, 7-24, 7-25, 7-26, 7-33, 7-34, 7-35, 7-36, 7-40, 7-41, 7-49, 7-50, 7-51, 8-3, 9-11, 9-12, 9-29, 9-35, 9-38, 9-39, 9-40, 9-45, 9-46, 9-47, 9-52, 9-53, 9-57, 9-59, 9-61, 9-66, 9-69, 9-78, 9-79, 9-80, 9-85, 9-86, 9-87, 9-99, 9-100, 9-101, 9-103, 9-104, 9-107, 9-108, 9-110, 9-112, 9-114, 9-115, 9-116, 9-125, 9-126, 9-127, 9-130, 9-132, 9-133, 9-134, 9-135, 9-136, 9-138, 9-140, 9-141, 9-142, 9-144, 9-145, 9-148, 9-149, 9-151, 9-152, 9-154, 9-155, 9-156, 9-164, 9-165, 9-166, 9-167, 9-169, 9-171, 9-172, 9-173, 9-174, 9-178, 9-179, 9-180, 9-183, 9-186, 9-188, 9-190, 9-193, 9-194, 9-196, 9-205, 9-206, 9-207, 9-210, 9-211, 9-213, 9-214, 9-216, 9-220, 9-221, 9-222, 9-224, 9-225, 10-4, C-11, D-12, D-18, D-23, E-31, E-37, E-45, E-46, E-101, E-134, E-147, E-181, E-183, E-185, E-192, E-228, F.3.1-37, F.3.1-62, F.3.1-75, F.3.2-44, F.3.2-66, F.3.3-63, F.3.3-68, F.3.3-69, F.3.3-70, F.3.3-74, F.3.3-76, F.3.3-78, F.3.3-20, F.3.3-25, F.3.3-26, F.3.3-27, F.3.3-31, F.3.3-34, F.3.3-36, H-4, H-5, H-6, J-15

Transportation, vi, x, xi, xiv, xx, xxi, xxvi, xxvii, xxxvii, xlii, xlvi, 1-13, 2-6, 2-9, 2-12, 2-17, 2-18, 2-21, 2-53, 2-124, 2-127, 2-132, 2-134, 2-135, 2-144, 2-185, 2-188, 3-16, 4-5, 4-7, 4-48, 4-58, 4-69, 4-70, 4-79, 4-86, 4-89, 4-95, 4-96, 4-97, 4-100, 4-111, 5-2, 5-44, 5-45, 5-48, 5-55, 5-56, 5-81, 5-82, 5-100, 5-114, 5-126, 5-127, 5-128, 6-1, 6-4, 6-5, 6-14, 6-17, 6-18, 6-19, 6-20, 6-21, 6-23, 6-25, 6-26, 6-27, 6-28, 6-29, 6-30, 6-31, 6-32, 6-33, 6-34, 6-35, 6-36, 6-37, 6-38, 6-39, 6-40, 6-41, 6-43, 6-45, 7-2, 7-31, 7-33, 7-37, 7-38, 7-40, 7-41, 7-46, 7-47, 7-48, 7-52, 8-13, 8-19, 9-25, 9-26, 9-27, 9-28, 9-29, 9-33, 9-42, 9-43, 9-44, 9-46, 9-47, 9-50, 9-51, 9-53, 9-55, 9-56, 9-59, 9-66, 9-92, 9-102, 9-103, 9-136, 9-143, 9-144, 9-175, 9-182, 9-183, 9-216, 9-223, 9-224, 10-4, 10-15, 10-16, 10-17, 10-29, 10-31, A-1, A-2, B-1, C-7, C-10, D-17, D-80, D-96, E-20, E-21, E-31, E-33, E-38, E-148, E-150, E-161, E-162, E-163, E-169, E-226, F.3.1-15, F.3.1-71, F.3.1-83, F.3.2-14, F.3.2-76, F.3.2-88, F.3.3-55, F.3.3-59, F.3.3-12, F.3.3-16, H-2, H-6, H-7, J-12, K-1, K-2

Tritium, 2-45, 2-48, 2-49, 2-50, 2-52, 2-191, 2-192, 5-17, 5-94, 6-3, 7-16, D-35, D-89, E-58, E-59, E-60, E-156, E-157, E-225, I-21

U

U.S. Army Corps of Engineers (USACE), iii, v, xii, xiv, xxiii, xxiv, xxviii, xxxiii, xlvi, 1-1, 1-3, 1-6, 1-7, 1-8, 1-9, 1-10, 1-11, 1-12, 1-14, 2-1, 2-5, 2-6, 2-10, 2-11, 2-12, 2-25, 2-32, 2-33, 2-35, 2-79, 2-80, 2-83, 2-113, 2-157, 2-158, 2-159, 2-163, 2-164, 2-165, 2-166, 2-167, 2-192, 2-193, 3-1, 3-3, 3-18, 3-21, 3-24, 4-1, 4-2, 4-3, 4-4, 4-5, 4-7, 4-8, 4-12, 4-14, 4-22, 4-23, 4-25, 4-38, 4-39, 4-40, 4-41, 4-42, 4-44, 4-46, 4-51, 4-52, 4-53, 4-83, 4-84, 4-85, 4-86, 4-102, 4-107, 4-111, 5-1, 5-4, 5-29, 5-66, 5-79, 6-15, 7-1, 7-2, 7-4, 7-6, 7-7, 7-10, 7-12, 7-15, 7-19, 7-20, 7-26, 7-28, 7-35,

9-1, 9-2, 9-3, 9-4, 9-55, 9-69, 9-106, 9-109, 9-114, 9-117, 9-127, 9-150, 9-153, 9-157, 9-167, 9-188, 9-193, 9-196, 9-207, 9-227, 9-232, 10-1, 10-2, 10-3, 10-4, 10-6, 10-8, 10-11, 10-15, 10-17, 10-18, 10-20, 10-21, 10-22, 10-23, 10-28, 10-29, 10-33, A-1, B-2, C-1, C-5, C-11, D-2, D-19, D-20, D-21, D-25, D-29, D-30, D-52, D-68, D-69, E-1, E-25, E-26, E-28, E-29, E-30, E-32, E-33, E-35, E-36, E-37, E-40, E-41, E-42, E-43, E-44, E-45, E-50, E-51, E-54, E-55, E-60, E-61, E-76, E-77, E-78, E-79, E-80, E-81, E-82, E-83, E-84, E-85, E-86, E-87, E-89, E-90, E-91, E-96, E-101, E-109, E-137, E-139, E-146, E-189, E-192, E-229, E-237, F-1, F-2, F-4, F-29, F-30, F.3.1-1, F.3.1-5, F.3.1-6, F.3.1-8, F.3.1-12, F.3.1-14, F.3.1-37, F.3.1-41, F.3.1-47, F.3.1-55, F.3.1-57, F.3.1-60, F.3.1-61, F.3.1-62, F.3.1-63, F.3.1-64, F.3.1-68, F.3.1-69, F.3.1-71, F.3.1-73, F.3.1-74, F.3.1-82, F.3.1-84, F.3.1-86, F.3.1-92, F.3.2-5, F.3.2-7, F.3.2-12, F.3.2-14, F.3.2-44, F.3.2-46, F.3.2-54, F.3.2-55, F.3.2-58, F.3.2-61, F.3.2-63, F.3.2-64, F.3.2-65, F.3.2-66, F.3.2-67, F.3.2-71, F.3.2-72, F.3.2-73, F.3.2-74, F.3.2-75, F.3.2-76, F.3.2-81, F.3.2-83, F.3.2-84, F.3.2-85, F.3.2-87, F.3.2-88, F.3.2-89, F.3.2-91, F.3.2-92, F.3.3-43, F.3.3-47, F.3.3-48, F.3.3-49, F.3.3-50, F.3.3-58, F.3.3-59, F.3.3-75, F.3.3-79, F.3.3-81, F.3.3-82, F.3.3-83, F.3.3-1, F.3.3-5, F.3.3-6, F.3.3-7, F.3.3-15, F.3.3-16, F.3.3-33, F.3.3-37, F.3.3-39, F.3.3-41, H-2, H-7, J-3, J-7

U.S. Department of Energy (DOE), xv, xxxvii, 5-54, 5-80, 6-5, 6-10, 6-13, 6-16, 6-22, 6-24, 6-25, 6-26, 6-29, 6-31, 6-32, 6-34, 6-44, 8-2, 8-7, 8-9, 8-13, 9-8, 9-9, 9-11, 9-12, 9-13, 9-15, 9-16, 9-17, 9-18, 9-19, 9-20, 9-30, 9-36, 9-37, 10-20, A-2, E-34, E-163, E-169, E-184, E-228

U.S. Environmental Protection Agency (EPA), iii, xxxviii, 1-1, 1-7, 2-37, 2-49, 2-50, 2-140, 2-141, 2-176, 2-177, 2-192, 3-27, 3-32, 4-1, 4-12, 4-80, 4-87, 4-89, 4-92, 4-101, 5-31, 5-35, 5-62, 5-63, 5-69, 5-71, 5-128, 6-9, 6-12, 6-14, 7-2, 7-3, 7-4, 7-16, 7-36, 7-37, 7-38, 7-39, 7-43, 7-44, 9-1, 9-17, 9-22, 9-23, 9-24, 9-25, 9-26, 9-31, 9-32, 9-33, 9-38, 9-42, 9-55, 9-59, 9-66, 9-68, 9-80, 9-85, 9-102, 9-108, 9-133, 9-143, 9-149, 9-172, 9-182, 9-187, 9-188, 9-212, 9-223, 9-233, 9-236, 9-238, 9-240, 10-11, 10-16, 10-17, B-2, D-31, D-39, D-53, D-55, D-60, D-82, D-92, D-106, E-1, E-6, E-26, E-28, E-30, E-80, E-85, E-107, E-135, E-144, E-145, E-154, F-29, F.3.1-4, F.3.1-6, F.3.1-15, F.3.1-16, F.3.1-20, F.3.1-60, F.3.1-61, F.3.1-83, F.3.2-15, F.3.2-19, F.3.2-65, F.3.2-87, F.3.3-46, F.3.3-69, F.3.3-80, F.3.3-83, F.3.3-4, F.3.3-26, F.3.3-38, F.3.3-41, H-2, H-3, J-7, K-1, K-2, K-5

U.S. Fish and Wildlife Service (FWS), xxiii, xxxvii, xxxviii, 2-63, 2-66, 2-68, 2-69, 2-70, 2-97, 2-113, 2-114, 2-192, 4-35, 5-24, 5-26, 5-28, 7-4, 9-74, 9-82, 9-83, 9-108, 9-121, 9-129, 9-130, 9-149, 9-161, 9-168, 9-169, 9-188, 9-201, 9-209, 9-210, B-2, C-11, E-28, E-29, E-30, E-39, E-69, E-80, E-192, E-227, F-1, F-3, F.3.1-4, F.3.1-26, F.3.1-27, F.3.1-28, F.3.1-29, F.3.1-30, F.3.1-31, F.3.1-32, F.3.1-45, F.3.1-46, F.3.1-47, F.3.1-48, F.3.1-49, F.3.1-84, F.3.2-55, F.3.2-88, F.3.3-43, F.3.3-46, F.3.3-48, F.3.3-49, F.3.3-70, F.3.3-71, F.3.3-77, F.3.3-81, F.3.3-82, F.3.3-1, F.3.3-4, F.3.3-6, F.3.3-27, F.3.3-28, F.3.3-30, F.3.3-35, F.3.3-37, F.3.3-38, F.3.3-39, H-3

Unirradiated fuel, 6-17, 6-19, 6-20, 6-21, 6-22, 6-23, 6-24, 6-25, 6-26, 6-27, 6-35, 6-38, 6-41, 7-47, E-169, J-12

Uranium, xv, xx, xxiv, xli, xlvi, 3-12, 6-1, 6-2, 6-3, 6-4, 6-5, 6-6, 6-7, 6-8, 6-9, 6-10, 6-15, 6-17, 6-18, 6-19, 6-21, 6-36, 6-37, 6-45, 7-5, 7-39, 7-46, 9-25, 9-42, 10-17, 10-21, 10-25, 10-30, 10-31, A-1, A-2, D-10, D-11, D-90, D-91, E-20, E-21, E-33, E-136, E-148, E-163, E-164, E-167, E-168, E-170, E-190, E-191, K-2, K-3, K-4

V

Vegetation, xlv, 2-6, 2-10, 2-52, 2-53, 2-54, 2-55, 2-56, 2-62, 2-68, 2-69, 2-70, 2-73, 2-74, 2-77, 2-78, 2-79, 2-80, 2-83, 2-91, 2-110, 2-111, 2-159, 2-180, 2-181, 2-182, 2-190, 3-19, 3-32, 4-21, 4-32, 4-33, 4-37,

4-40, 4-42, 4-102, 4-103, 4-108, 5-3, 5-17, 5-18, 5-24, 5-29, 5-30, 5-74, 5-119, 5-121, 7-20, 7-21, 7-25, 7-33, 7-44, 9-80, 9-127, 9-166, 9-205, 9-207, 10-5, 10-10, 10-12, 10-13, 10-28, D-53, D-74, E-81, E-84, E-85, E-86, E-87, E-88, E-108, E-111, E-116, E-144, F.3.1-13, F.3.1-25, F.3.1-28, F.3.1-68, F.3.2-12, F.3.2-84, F.3.3-44, F.3.3-45, F.3.3-54, F.3.3-56, F.3.3-57, F.3.3-64, F.3.3-65, F.3.3-68, F.3.3-69, F.3.3-70, F.3.3-71, F.3.3-73, F.3.3-74, F.3.3-76, F.3.3-77, F.3.3-78, F.3.3-2, F.3.3-3, F.3.3-11, F.3.3-13, F.3.3-14, F.3.3-21, F.3.3-22, F.3.3-25, F.3.3-26, F.3.3-27, F.3.3-29, F.3.3-30, F.3.3-31, F.3.3-34, F.3.3-35, F.3.3-36, F.3.3-37, G-15, J-6

Visual impact, 2-157, 2-163, 2-164, 2-165, 4-84, 4-85, 5-66, 7-34, 7-35, 9-29, 9-35, 9-40, 9-100, 9-141, 9-142, 9-180, 9-221, D-85, E-137, E-138, F-29, F-30

W

Waste management, 2-127, 3-25, 3-28, 4-100, 4-102, 4-103, 5-118, 6-1, 6-4, 6-5, 7-44, 7-48, 9-5, 10-31, 10-32, J-13

Wastewater, xviii, xix, 2-138, 2-140, 2-141, 2-142, 3-14, 3-20, 3-26, 3-28, 3-31, 4-75, 4-76, 4-101, 4-104, 5-4, 5-5, 5-6, 5-15, 5-58, 5-59, 5-60, 5-78, 5-94, 5-95, 5-96, 5-127, 7-5, 7-6, 7-14, 9-18, 9-57, 9-60, 9-67, 9-69, 9-70, 9-71, 9-93, 9-107, 9-109, 9-110, 9-115, 9-117, 9-137, 9-148, 9-150, 9-151, 9-155, 9-157, 9-176, 9-186, 9-189, 9-195, 9-196, 9-217, 9-238, 9-239, 10-29, E-49, E-51, F.3.1-75, H-5, J-8

Water quality, 1-6, 1-7, 2-42, 2-43, 2-45, 2-47, 2-48, 2-50, 2-51, 2-83, 3-7, 3-27, 3-31, 4-2, 4-12, 4-21, 4-22, 4-23, 4-24, 4-42, 4-44, 4-45, 4-54, 4-81, 4-101, 4-102, 4-104, 4-109, 4-112, 5-3, 5-4, 5-5, 5-6, 5-10, 5-14, 5-15, 5-17, 5-39, 5-41, 5-64, 5-95, 5-96, 5-121, 5-125, 6-45, 7-9, 7-10, 7-14, 7-15, 7-16, 7-20, 7-26, 7-28, 7-29, 7-30, 7-48, 7-49, 9-18, 9-26, 9-33, 9-67, 9-69, 9-71, 9-72, 9-73, 9-76, 9-84, 9-85, 9-86, 9-115, 9-116, 9-117, 9-118, 9-119, 9-120, 9-129, 9-132, 9-133, 9-155, 9-156, 9-157, 9-158, 9-159, 9-160, 9-169, 9-171, 9-172, 9-173, 9-195, 9-196, 9-197, 9-198, 9-199, 9-200, 9-209, 9-212, 9-213, 9-235, 9-238, 9-239, 10-6, 10-11, D-26, D-28, D-29, D-30, D-40, D-42, D-47, D-53, D-56, D-57, D-63, D-66, D-68, D-69, D-70, D-72, D-73, E-49, E-50, E-51, E-53, E-60, E-63, E-75, E-80, E-89, E-102, E-104, E-108, E-110, E-111, E-116, E-118, E-119, E-121, E-123, E-131, E-204, E-209, E-224, F.3.1-13, F.3.1-15, F.3.1-24, F.3.1-36, F.3.1-37, F.3.1-41, F.3.1-42, F.3.1-43, F.3.1-68, F.3.1-75, F.3.1-76, F.3.1-80, F.3.1-81, F.3.2-13, F.3.2-14, F.3.2-24, F.3.2-44, F.3.2-46, F.3.2-47, F.3.2-72, F.3.2-75, F.3.2-84, H-4, J-5, J-7

Watersheds, xiv, xxxv, 2-20, 2-26, 2-66, 2-72, 2-73, 2-75, 2-76, 2-90, 3-31, 4-10, 4-35, 4-42, 4-43, 4-101, 4-107, 5-3, 5-26, 5-40, 7-25, 7-28, 9-67, D-52, E-6, E-75, E-79, E-81, E-83, E-84, E-87, E-100, E-154, E-176, E-204, E-232, F.3.1-8, F.3.1-12, F.3.1-36, F.3.1-41, F.3.1-64, F.3.1-80, F.3.2-11, F.3.2-43, F.3.2-46, F.3.2-71, F.3.2-72, F.3.2-84, F.3.3-28

Wetlands, vi, vii, viii, x, xxiv, xxvii, xxviii, xxxv, xliii, 1-1, 1-3, 1-6, 1-7, 1-9, 1-12, 1-13, 2-5, 2-6, 2-9, 2-10, 2-12, 2-14, 2-15, 2-18, 2-20, 2-21, 2-25, 2-52, 2-53, 2-54, 2-55, 2-56, 2-60, 2-61, 2-62, 2-63, 2-66, 2-68, 2-69, 2-72, 2-73, 2-77, 2-78, 2-79, 2-80, 2-81, 2-82, 2-83, 2-157, 3-16, 3-21, 3-23, 3-24, 4-1, 4-2, 4-4, 4-5, 4-7, 4-8, 4-9, 4-10, 4-11, 4-13, 4-14, 4-15, 4-16, 4-17, 4-18, 4-19, 4-20, 4-22, 4-25, 4-27, 4-28, 4-29, 4-30, 4-31, 4-32, 4-33, 4-34, 4-36, 4-37, 4-38, 4-39, 4-40, 4-41, 4-42, 4-43, 4-44, 4-45, 4-53, 4-89, 4-91, 4-103, 4-104, 4-107, 4-109, 5-3, 5-17, 5-18, 5-22, 5-23, 5-24, 5-25, 5-26, 5-28, 5-29, 5-30, 5-74, 5-118, 5-126, 6-15, 7-6, 7-8, 7-9, 7-18, 7-19, 7-20, 7-21, 7-23, 7-24, 7-25, 7-28, 7-29, 7-35, 7-50, 9-11, 9-27, 9-29, 9-34, 9-35, 9-47, 9-50, 9-53, 9-61, 9-66, 9-74, 9-76, 9-78, 9-79, 9-80, 9-81, 9-112, 9-115, 9-116, 9-121, 9-124, 9-125, 9-126, 9-127, 9-128, 9-152, 9-153, 9-154, 9-156, 9-161, 9-164, 9-165, 9-166, 9-167, 9-168, 9-179, 9-190, 9-192, 9-194, 9-196, 9-200, 9-201, 9-204, 9-205, 9-206, 9-207, 9-208, 9-229, 10-1, 10-6, 10-10, 10-11, 10-12, 10-13, 10-19, 10-20, 10-28, 10-32,

C-6, C-8, C-13, C-14, D-15, D-17, D-18, D-22, D-23, D-28, D-30, D-31, D-32, D-33, D-37, D-38, D-39, D-40, D-41, D-42, D-43, D-44, D-45, D-46, D-47, D-48, D-49, D-50, D-51, D-52, D-53, D-54, D-55, D-56, D-57, D-58, D-59, D-61, D-62, D-63, D-64, D-65, D-66, D-68, D-70, D-71, D-92, D-104, D-106, D-107, E-11, E-21, E-22, E-26, E-27, E-28, E-31, E-32, E-35, E-38, E-39, E-40, E-41, E-43, E-44, E-45, E-49, E-50, E-65, E-66, E-67, E-68, E-69, E-70, E-71, E-72, E-73, E-75, E-76, E-77, E-78, E-79, E-80, E-81, E-82, E-83, E-84, E-85, E-86, E-87, E-88, E-89, E-90, E-91, E-92, E-93, E-95, E-96, E-97, E-98, E-99, E-100, E-101, E-102, E-103, E-104, E-105, E-110, E-111, E-112, E-113, E-115, E-116, E-121, E-127, E-131, E-188, E-189, E-196, E-201, E-202, E-203, E-204, E-205, E-206, E-207, E-208, E-209, E-210, E-216, E-224, E-231, F-29, F-30, F.3.1-6, F.3.1-13, F.3.1-42, F.3.1-68, F.3.1-80, F.3.2-7, F.3.2-13, F.3.2-46, F.3.2-47, F.3.2-62, F.3.2-63, F.3.2-67, F.3.2-71, F.3.2-72, F.3.2-74, F.3.2-75, F.3.2-81, F.3.2-82, F.3.2-83, F.3.2-84, F.3.2-85, F.3.2-86, F.3.2-88, F.3.2-91, F.3.3-44, F.3.3-49, F.3.3-50, F.3.3-54, F.3.3-55, F.3.3-56, F.3.3-57, F.3.3-58, F.3.3-59, F.3.3-61, F.3.3-62, F.3.3-65, F.3.3-68, F.3.3-69, F.3.3-74, F.3.3-75, F.3.3-76, F.3.3-77, F.3.3-78, F.3.3-79, F.3.3-83, F.3.3-2, F.3.3-7, F.3.3-11, F.3.3-12, F.3.3-14, F.3.3-15, F.3.3-16, F.3.3-18, F.3.3-19, F.3.3-22, F.3.3-25, F.3.3-26, F.3.3-28, F.3.3-29, F.3.3-30, F.3.3-31, F.3.3-32, F.3.3-33, F.3.3-34, F.3.3-35, F.3.3-36, F.3.3-37, F.3.3-40, H-2, H-5, H-6, J-6, J-7

Wildlife, xv, xvi, xxxvii, xxxviii, xliii, xlvi, 1-6, 2-14, 2-47, 2-52, 2-53, 2-56, 2-57, 2-60, 2-61, 2-62, 2-63, 2-67, 2-77, 2-79, 2-81, 2-82, 2-97, 2-116, 2-136, 2-137, 2-165, 2-177, 4-2, 4-7, 4-26, 4-28, 4-29, 4-30, 4-40, 4-41, 4-55, 4-103, 4-107, 5-2, 5-20, 5-22, 5-23, 5-30, 5-43, 5-70, 5-126, 7-4, 7-6, 7-7, 7-9, 7-18, 7-20, 7-21, 7-23, 7-25, 7-29, 7-31, 9-11, 9-14, 9-17, 9-24, 9-31, 9-40, 9-75, 9-76, 9-77, 9-78, 9-79, 9-80, 9-81, 9-108, 9-114, 9-121, 9-123, 9-124, 9-125, 9-126, 9-127, 9-128, 9-131, 9-135, 9-149, 9-150, 9-162, 9-163, 9-164, 9-165, 9-166, 9-167, 9-168, 9-171, 9-188, 9-201, 9-202, 9-203, 9-204, 9-205, 9-206, 9-207, 9-208, 9-211, 9-214, 10-12, 10-13, 10-27, 10-28, C-3, D-5, D-39, D-40, D-41, D-44, D-48, D-49, D-53, D-56, D-57, D-61, D-63, D-64, D-67, D-72, D-97, E-8, E-35, E-38, E-40, E-65, E-66, E-68, E-71, E-72, E-75, E-76, E-77, E-78, E-79, E-80, E-84, E-85, E-89, E-90, E-91, E-94, E-97, E-98, E-99, E-100, E-102, E-103, E-115, E-125, E-127, E-167, E-177, E-205, E-206, E-208, E-227, F-1, F.3.1-4, F.3.1-5, F.3.1-6, F.3.1-8, F.3.1-26, F.3.1-27, F.3.1-30, F.3.1-31, F.3.1-32, F.3.1-44, F.3.1-45, F.3.1-49, F.3.1-60, F.3.1-64, F.3.1-83, F.3.2-5, F.3.2-7, F.3.2-11, F.3.2-53, F.3.2-54, F.3.2-64, F.3.2-65, F.3.2-67, F.3.2-72, F.3.2-87, F.3.3-44, F.3.3-45, F.3.3-46, F.3.3-47, F.3.3-48, F.3.3-50, F.3.3-54, F.3.3-60, F.3.3-61, F.3.3-62, F.3.3-63, F.3.3-64, F.3.3-67, F.3.3-68, F.3.3-69, F.3.3-70, F.3.3-74, F.3.3-76, F.3.3-77, F.3.3-78, F.3.3-80, F.3.3-81, F.3.3-2, F.3.3-3, F.3.3-4, F.3.3-5, F.3.3-6, F.3.3-7, F.3.3-11, F.3.3-17, F.3.3-18, F.3.3-19, F.3.3-20, F.3.3-21, F.3.3-24, F.3.3-25, F.3.3-26, F.3.3-27, F.3.3-28, F.3.3-31, F.3.3-34, F.3.3-36, F.3.3-37, F.3.3-38, F.3.3-39, G-7, J-6

Wind, xviii, xxix, 2-45, 2-82, 2-172, 2-173, 2-174, 2-175, 2-176, 2-178, 2-179, 2-180, 2-181, 2-182, 2-184, 2-185, 4-30, 5-20, 5-21, 5-48, 5-70, 5-73, 7-22, 8-10, 9-7, 9-9, 9-10, 9-11, 9-12, 9-37, 9-38, 9-39, 9-40, 9-41, 9-43, 9-44, D-41, D-44, D-46, D-47, D-77, D-91, D-93, D-94, D-95, D-96, D-97, D-98, D-99, D-100, D-101, D-102, D-103, D-104, D-107, E-74, E-75, E-98, E-117, E-142, E-171, E-172, E-176, E-177, E-178, E-179, E-180, E-181, E-182, E-183, E-184, E-185, E-190, E-191, E-198, E-199, E-200, E-216, E-223, E-224, E-232, F.3.3-63, F.3.3-64, F.3.3-80, F.3.3-20, F.3.3-21, F.3.3-38, G-11, G-12, I-4, I-5, I-8

Workforce, vii, xviii, xix, xxii, xlii, 2-118, 2-126, 2-129, 2-134, 2-137, 2-189, 3-24, 3-25, 3-30, 4-54, 4-56, 4-60, 4-61, 4-62,

4-63, 4-64, 4-66, 4-67, 4-68, 4-69, 4-70, 4-71, 4-73, 4-74, 4-75, 4-76, 4-77, 4-78, 4-80, 4-83, 4-88, 4-89, 4-91, 4-92, 4-93, 4-96, 4-99, 4-105, 5-22, 5-42, 5-48, 5-49, 5-50, 5-52, 5-53, 5-56, 5-57, 5-58, 5-60, 5-61, 5-63, 5-66, 5-70, 5-71, 5-81, 5-82, 5-122, 5-123, 6-44, 7-32, 7-40, 9-12, 9-26, 9-27, 9-34, 9-42, 9-43, 9-44, 9-86, 9-87, 9-88, 9-89, 9-90, 9-92, 9-93, 9-94, 9-134, 9-135, 9-136, 9-137, 9-138, 9-173, 9-174, 9-175, 9-176, 9-177, 9-214, 9-215, 9-216, 9-218, 10-26, D-17, D-88, E-128, E-129, E-145, E-203, E-212, F.3.3-47, F.3.3-67, F.3.3-81, F.3.3-5, F.3.3-24, F.3.3-39, J-8, K-1, K-2, K-3, K-4

Y

Yucca Mountain, xx, xxi, 6-17, 6-25, 6-29, 6-30, 6-31, 6-33, 6-34, 6-35, 6-37, 6-38, 6-40, 6-44, 10-29, D-90, E-163, E-164, J-12

Z

Zoning, 4-7, 4-10, 5-2, 5-3, 5-121, 5-122, 5-124, 9-50, 9-60, 9-61, 9-190, 10-5, H-4

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11. ABSTRACT (200 words or less)

This environmental impact statement (EIS) has been prepared in response to an application to the U.S. Nuclear Regulatory Commission (NRC) by PSEG Power, LLC, and PSEG Nuclear, LLC (PSEG), for an early site permit (ESP). The proposed action requested in the PSEG application is the NRC issuance of an ESP for the PSEG Site located adjacent to the existing Hope Creek and Salem Generating Stations.

This final environmental impact statement includes the preliminary analysis that evaluates the environmental impacts of the proposed action and alternatives to the proposed action .

After considering the environmental aspects of the proposed NRC action, the NRC staff's preliminary recommendation to the Commission is that the ESP be issued as requested. The recommendation is based on (1) the application submitted by PSEG, including Revision 4 of the Environmental Report (ER), and the PSEG responses to requests for additional information from the NRC and USACE staffs; (2) consultation with Federal, State Tribal , and local agencies; (3) the staff's independent review; (4) the staff's consideration of comments related to the environmental review that were received during the public scoping process and the public comment period following the publication of the draft EIS; and (5) the assessments summarized in the EIS, including the potential mitigation measures identified in the ER and this EIS.

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