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

November 3, 2010

Mr. Stanley W. Gorski
Field Offices Supervisor
Habitat Conservation Division
National Marine Fisheries Service
James J. Howard Marine Sciences Laboratory
74 Magruder Road
Highlands, NJ 07732

SUBJECT: NOTICE OF AVAILABILITY OF THE DRAFT PLANT-SPECIFIC SUPPLEMENT 45 TO THE GENERIC ENVIRONMENTAL IMPACT STATEMENT FOR LICENSE RENEWAL OF NUCLEAR PLANTS REGARDING HOPE CREEK GENERATING STATION AND SALEM NUCLEAR GENERATING STATION, UNITS 1 AND 2

Dear Mr. Gorski:

The U.S. Nuclear Regulatory Commission (NRC) has prepared the enclosed draft plant-specific Supplement 45 to NUREG-1437, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (GEIS), regarding the license renewal of Hope Creek Generating Station (HCGS) and Salem Nuclear Generating Station (Salem), Units 1 and 2, located in Salem County. We are requesting your comments on this draft supplement.

In a letter dated December 23, 2009, the NRC requested that the National Marine Fisheries Service (NMFS) provide a list of essential fish habitat that have been designated in the vicinity of the HCGS and Salem sites and their associated transmission line corridors. The NMFS replied to this request on February 23, 2010, and indicated that the estuarine portions of the Delaware River and its tributaries including the estuarine areas crossed by the transmission lines have been designated as essential fish habitat for a wide variety of species. The NRC staff's Essential Fish Habitat Assessment will be forthcoming and submitted separately as part of our consultation under the Magnuson-Stevens Act.

Please note that the period for public comment on the enclosure expires December 17, 2010. If you have any questions regarding this issue, please contact Leslie Perkins at 301-415-2375 or by e-mail at Leslie.Perkins@nrc.gov.

Sincerely,

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

Docket Nos. 50-272, 50-311 and 50-354

Enclosure:
As stated

cc w/encl: Distribution via Listserv

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ADAMS Accession Nos.:
1. Letter: **ML103000462**
2. "Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Supplement 45" Volume 1: **ML102940169**
3. "Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Supplement 45" Volume 2: **ML102940267**
4. Package: **ML103070391**

*concurrence via e-mail

OFFICE	PM:RPB1:DLR	LA:RPOB:DLR	BC:RPB1:DLR
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United States Nuclear Regulatory Commission
Protecting People and the Environment

NUREG-1437, Vol. 1
Supplement 45

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

Draft Report for Comment
Main Report

Office of Nuclear Reactor Regulation

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NUREG-1437, Vol. 1
Supplement 45

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

Draft Report for Comment
Main Report

Manuscript Completed: October 2010
Date Published: October 2010

Office of Nuclear Reactor Regulation

Proposed Action	Issuance of renewed operating license NPF-57 for Hope Creek Generating Station and operating licenses DPR-70 and DPR-75 for Salem Nuclear Generating Station, Units 1 and 2 in Lower Alloway Creek Township, Salem County, New Jersey.
Type of Statement	Draft Supplemental Environmental Impact Statement
Agency Contact	Leslie Perkins U.S. Nuclear Regulatory Commission Office of Nuclear Reactor Regulation Mail Stop O-11F1 Washington, D.C. 20555-0001 Phone: 301-415-2375 Email: Leslie.Perkins@nrc.gov
Comments	Any interested party may submit comments on this supplemental environmental impact statement. Please specify NUREG-1437, Supplement 45, draft, in your comments. Comments must be received by December 17, 2010. Comments received after the expiration of the comment period will be considered if it is practical to do so, but assurance of consideration of late comments will not be given. Comments may be emailed to HopeCreekEIS@nrc.gov, SalemEIS@nrc.gov, or mailed to: Chief, Rulemaking, Directives, and Editing Branch U.S. Nuclear Regulatory Commission Mail Stop T6-D59 Washington, D.C. 20555-0001 Please be aware that any comments that you submit to the NRC will be considered a public record and entered into the Agencywide Documents Access and Management System (ADAMS). Do not provide information you would not want to be publicly available.

ABSTRACT

This draft supplemental environmental impact statement (SEIS) has been prepared in response to an application submitted by PSEG Nuclear, LLC (PSEG) to renew the operating licenses for Hope Creek Generating Station (HCGS) and Salem Nuclear Generating Station, Units 1 and 2 (Salem) for an additional 20 years.

This draft SEIS provides a preliminary analysis that evaluates the environmental impacts of the proposed action and alternatives to the proposed action. Alternatives considered include replacement power from a new supercritical coal-fired generation and natural gas combined-cycle generation plant; a combination of alternatives that includes natural gas combined-cycle generation, energy conservation/energy efficiency, and wind power; and not renewing the operating licenses (the no-action alternative).

The preliminary recommendation is that the Commission determined that the adverse environmental impacts of license renewal for Salem and HCGS are not so great that preserving the option of license renewal for energy-planning decision makers would be unreasonable.

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EXECUTIVE SUMMARY

BACKGROUND

By a letter dated August 18, 2009, PSEG Nuclear, LLC (PSEG) submitted an application to the U.S. Nuclear Regulatory Commission (NRC) to issue renewed operating licenses for Salem Nuclear Generating Station, Units 1 and 2 (Salem) and Hope Creek Generating Station (HCGS) for an additional 20-year period.

The following document and the review it encompasses are requirements of NRC regulations implementing Section 102 of the National Environmental Policy Act (NEPA) of 1969, of the *United States Code* (42 U .S.C. 4321), in Title 10 of the *Code* of *Federal Regulations* (CFR), Part 51 (10 CFR Part 51). In 10 CFR 51.20(b)(2), the Commission indicates that issuing a renewed power reactor operating license requires preparation of an environmental impact statement (EIS) or a supplement to an existing EIS. In addition, 10 CFR 51.95(c) states that the EIS prepared at the operating license renewal stage will be a supplement to the *Generic Environmental Impact Statement (GEIS) for License Renewal* of *Nuclear Plants,* N U R EG-1437, Volumes 1 and 2 (NRC 1996, 1999).

Upon acceptance of the PSEG application, the Staff began the environmental review process described in 10 CFR Part 51 by publishing a Notice of Intent to prepare an EIS and conduct a public scoping process. The Staff held public scoping meetings on November 5, 2009 at the Salem County Emergency Services Building in Woodstown, New Jersey, and conducted a site regulatory audit of both facilities in March 2010.

In preparing this supplemental environmental impact statement (SEIS) for Salem and HCGS, the Staff performed the following:

- Reviewed PSEG's environmental reports (ERs) and compared them to the GEIS
- Consulted with other agencies
- Conducted a review of the issues following the guidance set forth in NUREG-1555, Supplement 1, *Standard Review Plans for Environmental Reviews for Nuclear Power Plants, Supplement 1: Operating License Renewal*
- Considered the public comments received during the scoping process.

PROPOSED ACTION

PSEG initiated the proposed Federal action-issuance of a renewed power reactor operating license-by submitting applications for license renewal of Salem for which the existing licenses DPR-70 (Unit 1) and DPR-75 (Unit 2) expire August 13, 2016, and April 18, 2020, respectively; and HCGS for which the existing license NPF-57 expires April 11, 2026. NRC's Federal action is the decision of whether or not to renew each license for an additional 20 years.

PURPOSE AND NEED FOR ACTION

The purpose and need for the proposed action (issuance of renewed licenses) is to provide an option that allows for power generation capability beyond the term of a current nuclear power plant operating license to meet future system generating needs, as such needs may be determined by State, utility, and, where authorized, Federal (other than NRC) decision-makers. This definition of purpose and need reflects the Commission's recognition that, unless there are findings in the safety review required by the Atomic Energy Act of 1954 (AEA) or findings in the NEPA environmental analysis that would lead the NRC to not grant a license renewal, the NRC does not have a role in the energy-planning decisions of State regulators and utility officials as to whether a particular nuclear power plant should continue to operate.

If the renewed licenses are issued, State regulatory agencies and PSEG will ultimately decide whether or not the plant will continue to operate based on factors such as the need for power or other matters within the State's jurisdiction or the purview of the owners. If the operating licenses are not renewed, then the facilities must be shut down on or before the expiration date of the current operating licenses: August 13, 2016 and April 18, 2020 for Salem Unit 1 and Unit 2, respectively; and April 11, 2026 for HCGS.

ENVIRONMENTAL IMPACTS OF LICENSE RENEWAL

The SEIS evaluates the potential environmental impacts of the proposed action. The environmental impacts of the proposed action can be assigned values of SMALL, MODERATE, or LARGE. The Staff established a process for identifying and evaluating the significance of any new and significant information on the environmental impacts of license renewal of Salem and HCGS. The NRC did not identify information that is both new and significant related to Category 1 issues that would call into question the conclusions in the GEIS. Similarly, neither the scoping process nor the Staff's review has identified any new issue applicable to Salem or HCGS that has a significant environmental impact. The Staff, therefore, relies upon the conclusions of the GEIS for all the Category 1 issues applicable to Salem and HCGS.

LAND USE

SMALL. The Staff did not identify any Category 2 impact issues for land use, nor did the staff identify any new and significant information during the environmental review; therefore, there would be no impacts beyond those discussed in the GEIS.

AIR QUALITY

SMALL. The Staff did not identify any Category 2 issues for the impact on air quality, nor did the staff identify any new or significant information during the environmental review; therefore, for plant operation during the license renewal term, there are no impacts beyond those discussed in the GEIS.

GROUNDWATER USE AND QUALITY

SMALL. Groundwater use conflicts: potable and service water-plants using greater than 100 gallons per minute (gpm) is a Category 2 issue related to license renewal at Salem and HCGS. Groundwater use conflicts were enough of a regional concern to cause designation of two Critical Areas, but the Salem and HCGS facility location was not included within either of the areas. Also, the success in allowing groundwater levels to recover suggests that groundwater use conflicts in western Salem County are likely to become less of a concern, rather than greater. Therefore, although groundwater production at Salem and HCGS may be contributing to a gradual reduction in groundwater availability, this reduction is not likely to impact any potential groundwater users.

SURFACE WATER USE AND QUALITY

SMALL. The Staff did not identify any Category 2 issues for the impact on surface water use and quality, nor did the staff identify any new or significant information during the environmental review; therefore, for plant operation during the license renewal term, there are no impacts beyond those discussed in the GEIS.

AQUATIC RESOURCES

SMALL to MODERATE. The Staff reviewed studies conducted by PSEG on the impacts of entrainment, impingement, and heat shock on the aquatic environment. The results of the studies indicate that the processes of entrainment, impingement, and thermal discharge collectively have not had a noticeable adverse effect on the aquatic resources. The Staff considered these results and reviewed the available information, including that provided by the applicant, the staff's site visit, the States of New Jersey and Delaware, the NJPDES permits and applications, and other public sources. The Staff concludes that impacts to fish and shellfish from the collective effects of entrainment, impingement, and heat shock at Salem during the renewal term would be SMALL. However, future anthropogenic and natural environmental stressors would cumulatively affect the aquatic community of the Delaware Estuary sufficiently that they would noticeably alter important attributes, such as species ranges, populations, diversity, habitats, and ecosystem processes. Based on this assessment, the Staff concludes that cumulative impacts during the relicensing period from past, present, and future stressors affecting aquatic resources in the Delaware Estuary would range from SMALL to MODERATE.

TERRESTRIAL RESOURCES

SMALL to MODERATE. With regard to operation of Salem and HCGS during the license renewal term, the NRC did not identify any Category 2 issues for terrestrial resources, nor did the staff identify any new or significant information during the environmental review; therefore, there are no impacts beyond those discussed in the GEIS. However, while the level of impact due to direct and indirect impacts of Salem and HCGS on terrestrial communities is SMALL, the cumulative impact when combined with all other sources, even if Salem and HCGS were excluded, would be MODERATE.

THREATENED AND ENDANGERED SPECIES

SMALL. The Staff reviewed information from the site audit, Environmental Reports for Salem and HCGS, other reports, and coordination with FWS and State regulatory agencies in New Jersey and Delaware regarding listed species. The Staff concludes that the impacts on federally listed terrestrial and freshwater aquatic species from an additional 20 years of operation and maintenance of the Salem and HCGS facilities and associated transmission line ROWs would be SMALL.

HUMAN HEALTH

SMALL. With regard to Category 1 human health issues during the license renewal term-microbiological organisms (occupational health), noise, radiation exposures to public, occupational radiation exposures, and electromagnetic fields (chronic effects), the Staff did not identify any new or significant information during the environmental review. Therefore, there are no impacts beyond those discussed in the GEIS.

The applicant has no plans to conduct refurbishment activities during the license renewal term, thus, no change to radiological conditions is expected to occur. Continued compliance with regulatory requirements is expected during the license renewal term; therefore, the impacts from radioactive effluents are not expected to change during the license renewal term.

The chronic effects of electromagnetic fields from power lines were not designated as Category 1 issues, and will not be until a scientific consensus is reached on the health implications of these fields. The Staff considers the GEIS finding of "uncertain" for electromagnetic fields-chronic effects still appropriate and will continue to follow developments on this issue.

Microbiological organisms (public health) and electromagnetic fields-acute effects (electric shock) are Category 2 human health issues which are discussed below.

The Staff concludes that thermophilic microbiological organisms are not likely to present a public health hazard as a result of discharges to the Delaware Estuary. The Staff concludes that impacts on public health from thermophilic microbiological organisms from continued operation of Salem and HCGS in the license renewal period would be SMALL.

The Staff reviewed PSEG's analysis of electromagnetic fields-acute shock resulting from induced charges in metallic structures, and verified that there are no locations under the transmission lines that have the capacity to induce more than 5 milliamps (mA) in a vehicle parked beneath the line. No induced shock hazard to the public should occur, since the lines are operating within original design specifications and meet current National Electric Safety Code (NESC) clearance standards. The Staff has reviewed the available information, including the applicant's evaluation and computational results. Based on this information, the staff concludes that the potential impacts from electric shock during the renewal period would be SMALL.

SOCIOECONOMICS

SMALL to LARGE. The Staff identified no Category 1 public services and aesthetic impacts, or new and significant information during the environmental review; therefore, there would be no impacts beyond those discussed in the GEIS. Category 2 socioeconomic impacts include housing impacts, public services (public utilities), offsite land use, public services (public transportation), and historic and archaeological resources.

Salem and HCGS are located in a high population area, and Cumberland, Gloucester, Salem, and New Castle Counties are not subject to growth control measures that would limit housing development. Any changes in employment at Salem and HCGS would have little noticeable effect on housing availability in these counties. Since PSEG has indicated that they have no plans to add non-outage employees during the license renewal period, there would be no impact on housing during the license renewal term beyond what has already been experienced. Also, there would be no transportation impacts during the license renewal term beyond those already being experienced.

PSEG operations during the license renewal term would also not increase plant-related population growth demand for public water and sewer services. Since there are no planned refurbishment activities at PSEG, there would be no land use impacts related to population or tax revenues, and no transportation impacts. As previously stated, PSEG has no plans to add non-outage employees during the license renewal period, employment levels at Salem and HCGS would remain relatively unchanged. Therefore, there would be no increase in the assessed value of Salem and HCGS, and annual property tax payments to Lower Alloways Creek Township would be expected to remain relatively constant throughout the license renewal period. Based on this information, there would be no tax revenue-related land-use impacts during the license renewal term beyond those already being experienced.

Based on the Staff's review of the New Jersey State Museum (NJSM) files, there are no previously recorded archaeological or above ground historic architectural resources identified on the Salem/Hope Creek property. There is little potential for historic and archaeological resources to be present on most of the Salem/Hope Creek property. No new facilities, service roads, or transmission lines are proposed for the Salem/Hope Creek site as a part of this operating license renewal, nor are refurbishment activities proposed. Therefore, there is little potential for National Register eligible historic or archaeological resources to be impacted by renewal of this operating license.

With respect to environmental justice, an analysis of minority and low-income populations residing within a 50-mile (80-km) radius of Salem and HCGS indicated there would be no disproportionately high and adverse impacts to these populations from the continued operation of Salem and HCGS during the license renewal period. Monitoring results have demonstrated that concentrations of contaminants in native vegetation, crops, soils and sediments, surface water, fish, and game animals in areas surrounding Salem and HCGS have been quite low (at or near the threshold of detection) and seldom above background levels. Consequently, no disproportionately high and adverse human health impacts would be expected in special pathway receptor populations in the region as a result of subsistence consumption of fish and wildlife.

Based on this information, the Staff concludes that the potential direct and indirect impacts to socioeconomics from continued operation of the Salem and HCGS would be SMALL. However, if PSEG decides to proceed with the construction of a new nuclear plant at the Salem and HCGS site, the cumulative impacts to socioeconomics could be SMALL to LARGE. This specific impact would depend on the actual design, characteristics and construction practices proposed by the applicant for the new nuclear plant. If a combined license application is submitted to the NRC, the detailed socioeconomic impacts would be analyzed and addressed in a separate NEPA document that would be prepared by the NRC.

SEVERE ACCIDENT MITIGATION ALTERNATIVES

Since Salem and HCGS had not previously considered alternatives to reduce the likelihood or potential consequences of a variety of highly uncommon but potentially serious accidents, NRC regulation 10 CFR 51.53(c)(3)(ii)(L) requires that Salem and HCGS evaluate Severe Accident Mitigation Alternatives (SAMAs) in the course of license renewal review. SAMAs are potential ways to reduce the risk or potential impacts of uncommon but potentially severe accidents, and may include changes to plant components, systems, procedures, and training. Based on the review of potential SAMAs, the staff concludes that Salem and HCGS made a reasonable, comprehensive effort to identify and evaluate SAMAs. Based on the review of the SAMAs for Salem and HCGS, and the plant improvements already made, the staff concludes that none of the potentially cost-beneficial SAMAs relate to adequately managing the effects of aging during the period of extended operation; therefore, they need not be implemented as part of the license renewal pursuant to 10 CFR Part 54.

ALTERNATIVES

The Staff considered the environmental impacts associated with alternatives to license renewal. These alternatives include other methods of power generation and not renewing the Salem and HCGS operating licenses (the No-Action alternative). Replacement power options considered were supercritical coal-fired generation, natural gas combined-cycle generation, and, as part of the combination alternative, wind power generation combined with energy conservation/energy efficiency. Each alternative was evaluated using the same impact areas that were used in evaluating impacts from license renewal. The results of this evaluation are summarized in the Table 1.

COMPARISON OF ALTERNATIVES

A comparison of the impacts of Salem and HCGS license renewal with its three reasonable alternatives is provided in Table 1. In the Staff's best professional opinion, the coal-fired alternative is the least environmentally favorable alternative due to impacts to air quality from nitrogen oxides (NO_X), sulfur oxides (SO_X), particulate matter (PM), polycyclic aromatic hydrocarbons (PAHs), carbon monoxide (CO), carbon dioxide (CO_2), and mercury, and also due to the corresponding human health impacts. Construction impacts to transportation, aquatic, and terrestrial resources are also factors that added to this conclusion. The gas-fired alternative would have lower air emissions, but construction-related impacts to transportation, aquatic, and terrestrial resources would be similar to those from the coal-fired alternative. The combination alternative would have lower air emissions and waste management impacts than both the gas-fired and coal-fired alternatives; however, it would have relatively higher construction impacts from aquatic and terrestrial resources and potential impacts on historic and archaeological resources, primarily as a result of the wind turbine component

Under the No-Action alternative, plant shutdown would begin to eliminate most of the approximately 1,614 jobs at Salem and HCGS and would reduce general tax revenue in the region. Depending on the jurisdiction, the economic loss could have a significant impact.

Renewal of the Salem and HCGS licenses would have a small impact on environmentally-related issues; therefore, in the Staff's professional opinion, renewal of the licenses is the environmentally preferred action. All other alternatives capable of meeting the needs currently served by Salem and HCGS entail potentially greater impacts than the proposed action involving license renewal. The No-Action alternative does not meet the purpose and need of this draft SEIS.

Table 1. Summary of Environmental Impacts of Proposed Action and Alternatives

Alternative	Impact Area						
	Air Quality	**Groundwater**	**Surface Water**	**Aquatic and Terrestrial Resources**	**Human Health**	**Socio-economics**	**Waste Management**
License Renewal	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL to LARGE	SMALL[(a)]
Supercritical Coal-fired Alternative	MODERATE	SMALL	SMALL	SMALL to MODERATE	MODERATE	SMALL to MODERATE	MODERATE
Gas-fired Alternative	SMALL to MODERATE	SMALL	SMALL	SMALL	SMALL	SMALL to MODERATE	SMALL
Combination Alternative	SMALL	SMALL	SMALL	SMALL to MODERATE	SMALL	SMALL to LARGE	SMALL
No Action Alternative	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL to LARGE	SMALL

(a) For the Salem and HCGS license renewal alternative, waste management was evaluated in Chapter 6. Consistent with the findings in the GEIS, these impacts were determined to be SMALL with the exception of collective offsite radiological impacts from the fuel cycle and from high-level waste and spent fuel disposal.

RECOMMENDATION

The Staff's preliminary recommendation is that the Commission determines that the adverse environmental impacts of license renewals for Salem and HCGS are not so great that preserving the option of license renewal for energy planning decision makers would be unreasonable. This recommendation is based on:

(1) Analysis and findings in the GEIS,

(2) Information submitted in the Salem and HCGS ERs,

(3) Consultation with other Federal, State, and local agencies,

(4) Review of other pertinent studies and reports, and

(5) Consideration of public comments received during the scoping process

REFERENCES

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

National Environmental Policy Act of 1969, as amended, 42 U.S.C. 4321 et seq.

PSEG Nuclear, LLC (PSEG). 2009a. Salem Nuclear Generating Station, Units 1 and 2, License Renewal Application, Appendix E - Applicant's Environmental Report – Operating License Renewal Stage. Lower Alloways Creek Township, New Jersey. August, 2009. ADAMS Nos. ML092400532, ML092400531, ML092430231

PSEG. 2009b. Hope Creek Generating Station, License Renewal Application, Appendix E - Applicant's Environmental Report – Operating License Renewal Stage. Lower Alloways Creek Township, New Jersey. August, 2009. ADAMs No. ML092430389

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

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

ABBREVIATIONS AND ACRONYMS

‘	Minute(s)
°C	Degree(s) Celsius
°F	Degree(s) Fahrenheit
ΔT	Difference in Temperature
ac	Acre(s)
ADAMS	Agency Document Access and Management System
AEA	Atomic Energy Act of 1954
AEC	U.S. Atomic Energy Commission
AEO	Annual Energy Outlook
AFCM	Aggregated Food Chain Model
AIT	Alternative Intake Technology
ALARA	as low as is reasonably achievable
AQCR	Air Quality Control Region
ASMFC	Atlantic States Marine Fisheries Council
AWEA	American Wind Energy Association
BA	Biological Assessment
Barnwell	Barnwell LLW Facility
bgs	Below Ground Surface
BMWP	Biological Monitoring Work Plan
BNE	Bureau of Nuclear Engineering
BP	Before Present
BPJ	Best Professional Judgment
BPU	Board of Public Utilities
BTA	Best Technology Available
BTU	British Thermal Unit(s)
BWR	Boiling Water Reactor
CAA	Clean Air Act
CAFRA	Coastal Areas Facility Review Act
CAIR	Clean Air Interstate Rule
CAMR	Clean Air Mercury Rule

CDS	Comprehensive Demonstration Study
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CH_4	Methane
cm	Centimeter(s)
cm/s	Centimeter(s) per Second
CO	Carbon Monoxide
CO_2	Carbon Dioxide
COLA	Combined Operating License Application
CPC	Center for Plant Conservation
CR	County Route
CSS	Colonial Swedish Society
CST	Condensate Storage Tank
CVCS	Chemical and Volume Controlled System
CWA	Clean Water Act
CWIS	Cooling Water Intake Structure
CWS	Circulating Water System
DAW	Dry Active Waste
dBA	Decibels
DCE	Dichloroethylene
DCR	Discharge Cleanup and Removal
DDL	Delaware Department of Labor
DDT	dichlorodiphenyltrichloroethane
DMR	Discharge Monitoring Reports
DNREC	Delaware Department of Natural Resources and Environmental Control
DOE	U.S. Department of Energy
DOT	Department of Transportation
DPC	Delaware Population Consortium
DPCC	Discharge Prevention, Containment, and Countermeasure
DPR	Demonstration Power Reactor
DRBC	Delaware River Basin Commission
DSC	Discover Salem County

DSM	Demand-Side Management
DSN	Discharge Serial Number
DVRPC	Delaware Valley Regional Planning Commission
ECHO	Enforcement and Compliance History Online
EEP	Estuary Enhancement Program
EFH	Essential Fish Habitat
EIA	Energy Information Administration (of DOE)
EIS	Environmental Impact Statement
ELF-EMF	extremely low frequency-electromagnetic field
EO	Executive Order
EPCRA	Emergency Planning and Community Right-to-know
ER	environmental report
EPA	U.S. Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
ER	Environmental Report
ESA	Endangered Species Act of 1973
ESMP	Environmental Surveillance and Monitoring Program
ESP	Early Site Permit
FEMA	Federal Emergency Management Act
FHB	Fuel Handling Building
FMP	Fishery Management Plan
fpm	Foot (Feet) per Minute
fps	Foot (Feet) per Second
FR	Federal Register
ft	Foot (feet)
ft^3	cubic foot
FWS	U.S. Fish and Wildlife Service
FWW	Freshwater Wetland
Gal	gallon(s)
GCPD	Gloucester County Planning Division
GE	GE Power Systems

GEIS	Generic Environmental Impact Statement for License Renewal of Nuclear Plants, NUREG-1437
GHC	Geo-Heat Center
GHG	Greenhouse Gas
gpm	Gallon(s) per Minute
GRS	Groundwater Recovery System
H_2O	Light Water
^2H_2O	Heavy Water
ha	Hectare(s)
HAP	Hazardous Air Pollutants
HCGS	Hope Creek Generating Station
HDA	Heat Dissipation Area(s)
HEPA	High Energy Particulate Air
HFC	Hydrofluorocarbons
HFE	Hydrofluorinated ethers
HLW	High-Level Waste
hr	Hour(s)
HUD	Housing and Urban Development
Hz	Hertz
IBA	Important Bird Area
IBMWP	Improved Biological Monitoring Work Program
IEEE	Institute of Electrical and Electronics Engineers, Inc.
INEEL	Idaho National Energy and Environmental Laboratory
IPA	Integrated Plant Assessment
IPCC	Intergovernmental Panel on Climate Change
ISFSI	Independent Spent Fuel Storage Installation
ITS	Incidental Take Statement
J	Joule
kg	Kilogram(s)
km	Kilometer(s)
km^2	Square Kilometer(s)
kwh	Kilowatt(s) Hour

kv	Kilovolt(s)
LACT	Lower Alloways Creek Township
lb	Pound(s)
LLRSF	Low Level Radwaste Storage Facility
LLW	Low Level Waste
LUR	Land Use Regulation
LWMS	Liquid Waste Management System
m	Meter(s)
m^2	Square Meter(s)
m^3	Cubic Meter(s)
mA	Milliampere(s)
MAFMC	Mid Atlantic Fishery Management Council
MANE-VU	Mid-Atlantic/Northeast Visibility Union
MBTU/hr	Million British Thermal Units per Hour
MDNR	Maryland Department of Natural Resources
mg/l	Milligrams per Liter
MGD	Million Gallons per Day
mi	Mile(s)
mi^2	Square Mile(s)
min	Minute(s)
mm	Millimeter(s)
MMS	Minerals Management Service
mps	Meter(s) per Second
MSA	Magnuson-Stevens Fishery Conservation and Management Act
MSL	Mean Sea Level
MSX	Multinucleated Sphere Unknown
MT	Metric Ton(s)
MW	megawatt
MW(d)	megawatt days
MW(e)	Megawatt-Electric
MW(h)	Megawatt Hour
MW(t)	Megawatt-Thermal
NAAQS	National Ambient Air Quality Standards

NAS	National Academy of Sciences
NCES	National Center for Educational Statistics
NEFMC	New England Fisheries Management Council
NEFSC	North East Fisheries Science Center
NEI	Nuclear Energy Institute
NEPA	National Environmental Policy Act of 1969
NERC	North American Electric Reliability Council
NESC	National Electric Safety Code NESC
NF_3	Nitrogen Trifluoride
ng	Nanograms
NHP	National Heritage Program
NHPA	National Historic Preservation Act
NIEHS	National Institute of Environmental Health Sciences
NJAC	New Jersey Administrative Code
NJAW	New Jersey American Water
NJDEP	New Jersey Department of Environmental Protection
NJDFW	New Jersey Division of Fish and Wildlife
NJDLWD	New Jersey Department of Labor and Workforce Development
NJGS	New Jersey Geological Survey
NJPDES	New Jersey Pollutant Discharge Elimination System
NJSA	New Jersey State Atlas
NJSM	New Jersey State Museum
NJWSA	New Jersey Water Science Center
NMFS	National Marine Fisheries Service
N_2O	Nitrous Oxide
NO_2	Nitrogen Dioxide
NO_x	Nitrogen Oxide(s)
NOAA	National Oceanic and Atmospheric Administration
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
NRLWDS	Non-Radioactive Liquid Waste Disposal System
NUREG	NRC Regulatory Guide
NWFMC	New England Fisheries Management Council
NWI	National Wetlands Inventory
NWR	National Wildlife Refuge
NYNHP	New York Natural Heritage Program
OMB	Office of Management and Budget
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
PCE	Perchloroethene or Tetrachloroethene
pCi/L	Picocuries per Liter
PFC	Perfluorocarbons
PHI	Pepco Holding, Inc.
PM	Particulate Matter
$PM_{2.5}$	Particulate Matter, 2.5 Microns or Less in Diameter
PM_{10}	Particulate Matter, 10 Microns or Less in Diameter
PNR	Pinelands National Reserve
ppm	Parts per Million
ppt	Parts per Thousand
PRM	Potomac-Rantan-Magothy
PSD	Prevention of Significant Deterioration
PSEG	PSEG Nuclear, LLC
PSE&G	Public Service Electric and Gas Company
Psia	Pound(s) per Square Inch
PTE	Potential to Emit
PWR	Pressurized Water Reactor
RAWP	Remedial Action Work Plan
RCS	Reactor Coolant System
RCRA	Resource Conservation and Recovery Act
RGGI	Regional Greenhouse Gas Initiative
REMP	Radiological Environmental Monitoring Program

RGPP	Radiological Groundwater Protection Program
RIS	Representative Impact Species
RK	River Kilometer
RLWS	Radioactive Liquid Waste System
RM	river mile
ROI	Region of Influence
ROW(s)	Right-of-Way(s)
RPO	Regional Planning Organization
RPS	Renewable Portfolio Standard
RS	Representative Species
SADC	State Agriculture Development Committee
SAFMC	South Atlantic Fishery Management Council
Salem	Salem Nuclear Generating Station, Units 1 & 2
SAMA	Severe Accident Mitigation Alternative
SAR	Safety Analysis Report
SARA	Superfund Amendments and Reauthorization Act
SCR	Selective Catalytic Reduction
SEIS	Supplemental Environmental Impact Statement
SER	Safety Evaluation Report
SF_6	Hexafluoride
SFP	Spent Fuel Pool
SHPO	State Historic Preservation Office
Site	Combined Site
SO_2	Sulfur Dioxide
SO_x	Sulfur Oxides
SPCC	Spill Prevention, Control, and Countermeasure
SSB	Spawning Stock Biomass
SSBPR	Spawning Stock Biomass per Recruit
Staff	NRC staff
STP	Sewage Treatment Plant
SWPPP	Stormwater Pollution Prevention Plan
SWS	Service Water System

TCPA	Toxic Catastrophe Prevention Act
TLD	Thermo Luminescent Dosimeter
TSP	Total Suspended Particles
UO_2	Uranium Dioxide
UNESCO	United Nations Educational, Scientific, and Cultural Organization
U.S.	United States
USACE	United States Army Corps of Engineers
U.S.C.	United States Code
USCB	United Stated Census Bureau
USDA	United States Department of Agriculture
USGS	U.S. Geological Survey
VOC	Volatile Organic Compound
WMA	Wildlife Management Areas
WQM	Water Quality Management

1.0 PURPOSE AND NEED FOR ACTION

Pursuant to the U.S. Nuclear Regulatory Commission's (NRC's) environmental protection regulations in Title 10, Part 51, of the U.S. *Code of Federal Regulations* (10 CFR 51), which implement the U.S. National Environmental Policy Act of 1969 (NEPA), an environmental impact statement (EIS) is required to be prepared for issuance of a new nuclear power plant operating license.

The Atomic Energy Act of 1954 (AEA) originally specified that licenses for commercial power reactors be granted for up to 40 years with an option to renew for up to another 20 years. The 40-year licensing period is based on economic and antitrust considerations rather than on technical limitations of the nuclear facility.

The decision to seek a license renewal rests entirely with nuclear power facility owners and typically is based on the facility's economic viability and the investment necessary to continue to meet NRC safety and environmental requirements. The NRC staff (Staff) makes the decision to grant or deny a license renewal, based on whether or not the applicant has demonstrated that the environmental and safety requirements in the NRC's regulations can be met during the period of extended operation.

1.1 Proposed Federal Action

PSEG Nuclear, LLC (PSEG) initiated the proposed Federal action by submitting applications for license renewal of Salem Nuclear Generating Station, Units 1 and 2 (Salem) for which the existing licenses DPR-70 (Unit 1) and DPR-75 (Unit 2) expire on August 13, 2016, and April 18, 2020, respectively and Hope Creek Generating Station (HCGS), for which the existing license NPF-57 expires April 11, 2026. NRC's Federal action is the decision whether or not to renew these licenses for an additional 20 years.

1.2 Purpose and Need for the Proposed Federal Action

The purpose and need for the proposed action (issuance of a renewed license) is to provide an option that allows for power generation capability beyond the term of a current nuclear power plant operating license to meet future system generating needs, which may be determined by applicable energy-policy decision-makers. This definition of purpose and need reflects the Commission's recognition that, unless there are findings in the safety review required by the AEA or findings in the NEPA environmental analysis that would lead the NRC to not grant a license renewal, the NRC does not have a role in the energy-planning decisions as to whether or not a particular nuclear power plant should continue to operate.

If the renewed license is issued, the appropriate regulatory agencies (other than NRC) and PSEG will ultimately decide whether the plant will continue to operate based on additional factors such as the need for power, other matters within the regulator's jurisdiction, or the purview of the owners. If the operating license is not renewed, the appropriate facility must be shut down on or before the expiration date of the current operating licenses, August 13, 2016 for Unit 1 at Salem, April 18, 2020 for Unit 2 at Salem, and April 11, 2026 at HCGS.

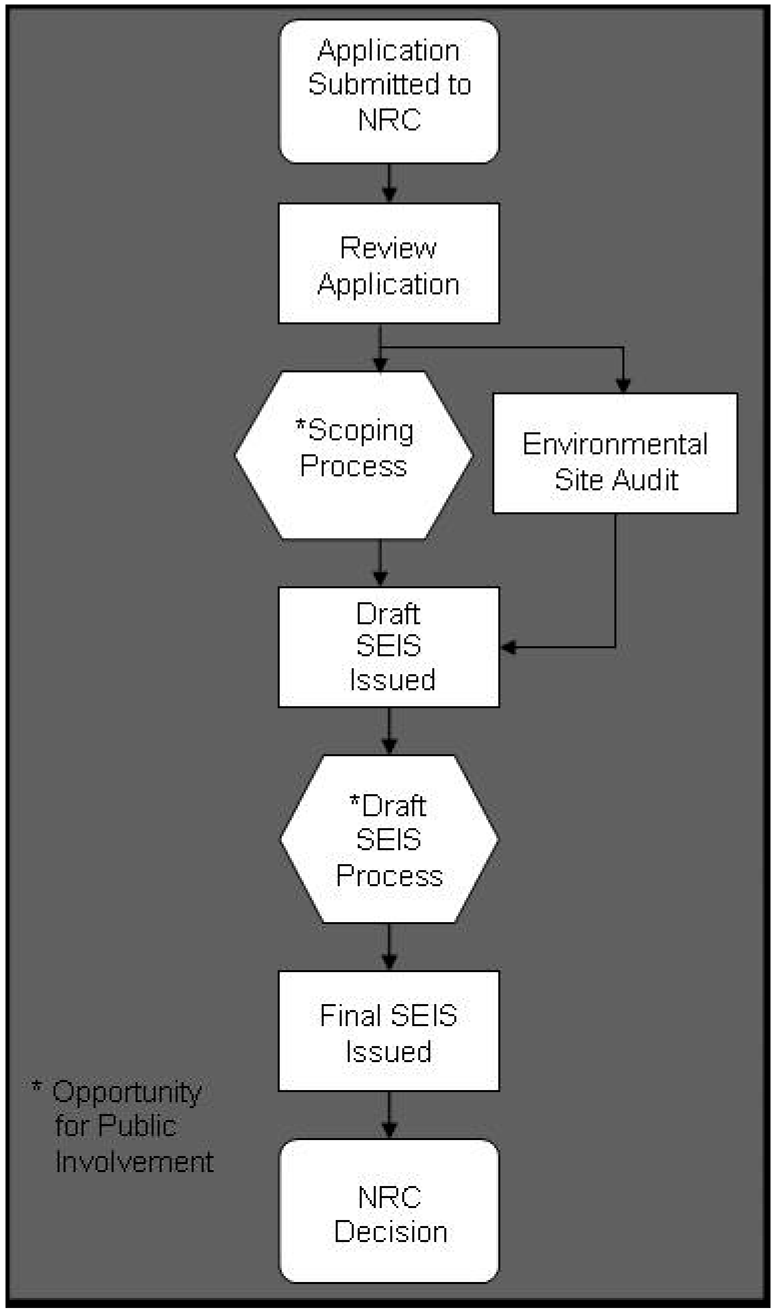
1.3 Major Environmental Review Milestones

As part of the license renewal application, PSEG submitted an environmental report (ER), dated August 18, 2009, for each Salem unit (PSEG, 2009a) and the HCGS (PSEG, 2009b). After reviewing the application and the ERs for sufficiency, the Staff published a notice of acceptance for docketing of the application on October 23, 2009, in the *Federal Register* (FR) (Volume 74, p. 54854, (74 FR 54854) for Salem; and Volume 74, p. 54856, (74 FR 54856) for HCGS). Also, on October 23, 2009, the NRC published another notice in the FR (74 FR 54859) on its intent to conduct scoping, thereby beginning the 60-day scoping period for the supplemental environmental impact statement (SEIS).

The NRC conducted two public scoping meetings on November 5, 2009 in Woodstown, New Jersey. The Staff prepared an SEIS scoping process summary report dated September 2010, which presents the comments received during the scoping process (NRC, 2010). Appendix A to this SEIS presents comments considered to be within the scope of the environmental license renewal review and the NRC's consideration of those comments.

To independently verify information provided in the ER, the Staff conducted a site audit at the Salem and HCGS site in March 2010. During the site audit, the Staff met with plant personnel,

Figure 1-1. Environmental Review Process.
The environmental review provides opportunities for public involvement.



reviewed specific documentation, toured the facility, and met with interested Federal, State, and local agencies.

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

Upon completion of the scoping period and site audit, the Staff compiled its findings in this draft SEIS. An illustration of this process is provided in Figure 1-1. This SEIS is made publicly available for a period of 45 days during which the Staff will host public meetings and collect public comments. Based on the information gathered, the Staff will amend the draft SEIS findings as necessary, and then publish the final SEIS.

The Staff has established a license renewal process that can be completed in a reasonable period of time with clear requirements to assure safe plant operation for up to an additional 20 years. The safety review, which documents its finding in a Safety Evaluation Report (SER), is conducted simultaneously with the environmental review process. Both the findings in the SEIS and the SER are factors considered in the Commission's decision to either grant or deny the issuance of a new license.

1.4 Generic Environmental Impact Statement

To improve the efficiency of the license renewal process, the Staff prepared a generic assessment of the environmental impacts associated with license renewal. Specifically, the agency prepared NUREG-1437, *Generic Environmental Impact Statement (GEIS) for License Renewal of Nuclear Power Plants,* which evaluates the environmental consequences of renewing the licenses of individual nuclear power plants and operating them for an additional 20 years (NRC, 1996; NRC, 1999).[1] The Staff analyzed those environmental issues that could be resolved generically in the GEIS.

The GEIS establishes 92 separate issues for the Staff to consider. Of these, the staff determined that 69 are generic to all plants (Category 1), while 21 issues do not lend themselves to generic consideration (Category 2). Two other issues, which must be evaluated on a site-specific basis, are environmental justice and the chronic effects of electromagnetic fields. Appendix B to this report lists all 92 issues.

For each environmental issue, the GEIS: (1) describes the activity that affects the environment, (2) identifies the population or resource that is affected, (3) assesses the nature and magnitude of the impact on the affected population or resource, (4) characterizes the significance of the effect for both beneficial and adverse effects, (5) determines whether the results of the analysis apply to all plants or not, and (6) considers whether additional mitigation measures are warranted or not for impacts that would have the same significance level for all plants.

[1] The NRC originally issued the GEIS in 1996 and issued Addendum 1 to the GEIS in 1999. Hereafter, all references to the "GEIS" include the GEIS and Addendum 1.

The GEIS assesses the significance of these issues, using the Council on Environmental Quality (CEQ) terminology for “significant.” The GEIS established three levels of significance for potential impacts—SMALL, MODERATE, and LARGE. The three levels of significance are defined below:

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

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

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

The GEIS includes a determination of whether or not the analysis of the environmental issue could be applied to all plants and whether or not additional mitigation measures are warranted (Figure 1-2). Issues are assigned a Category 1 or a Category 2 designation. As set forth in the GEIS, Category 1 issues are those that meet all of the following criteria:

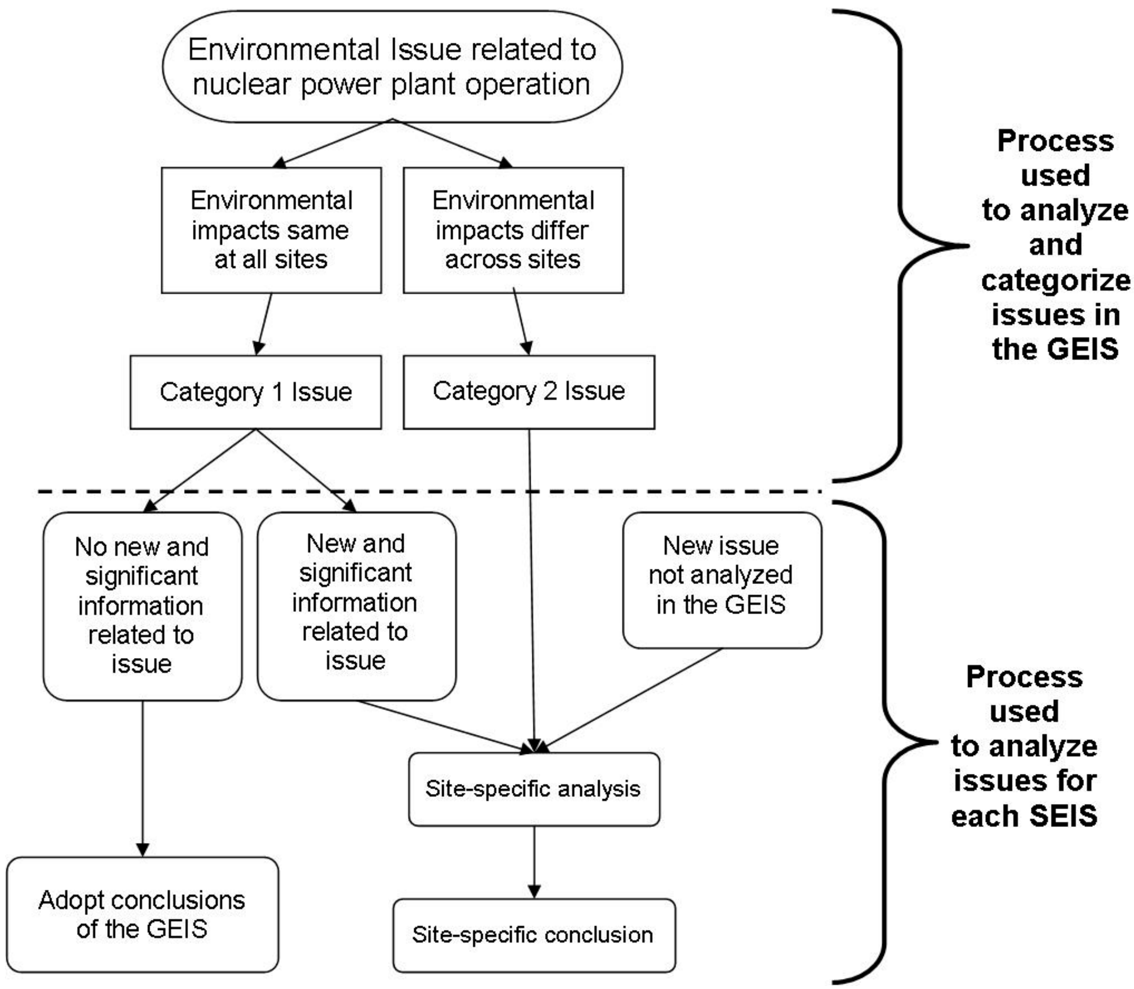
(1) The environmental impacts associated with the issue have been determined to apply either to all plants or, for some issues, to plants having a specific type of cooling system or other specified plant or site characteristics.

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

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

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

Figure 1-2. Environmental Issues Evaluated During License Renewal. *92 issues were initially evaluated in the GEIS. A site-specific analysis is required for 23 of those 92 issues.*



1.5 Supplemental Environmental Impact Statement

The SEIS presents an analysis that considers the environmental effects of the continued operation of Salem and HCGS, potential alternatives to license renewal, and potential mitigation measures for minimizing adverse environmental impacts. Chapter 8 contains analysis and comparisons of the environmental impacts of alternatives. Chapter 9 presents the preliminary recommendation to the Commission as to whether or not the environmental impacts of license renewal are so great that preserving the option of license renewal would be unreasonable. The recommendation will be made after consideration of comments received during the public scoping period for the draft SEIS.

During the preparation of this SEIS, the Staff:

- reviewed the information provided in the PSEG ERs;
- consulted with other Federal, State, and local agencies;
- conducted an independent review of the issues during the site audit; and
- considered public comments received during the scoping process and on the draft SEIS.

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

New and significant information either:
(1) identifies a significant environmental issue not covered in the GEIS, or
(2) was not considered in the analysis in the GEIS and leads to an impact finding that is different from the finding presented in the GEIS.

1.6 Cooperating Agencies

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

1.7 Consultations

Pursuant to the following acts, Federal agencies are required to consult with applicable State and Federal agencies and groups before taking action that may affect endangered species, fisheries, or historic and archaeological resources, respectively:

- Endangered Species Act of 1973, as amended;
- Magnuson-Stevens Fisheries Conservation and Management Act of 1996, as amended; and
- National Historic Preservation Act of 1966, as amended.

Listed below are the agencies and groups that have been consulted; Appendix D of this report includes copies of consultation documents:

Delaware Division of Historical and Cultural Affairs, Dover, New Jersey

Maryland Historical Trust, Crownsville, Maryland

New Jersey Historic Preservation Office, Trenton, New Jersey

Pennsylvania Bureau for Historic Preservation, Harrisburg, PA

Delaware Division of Historical and Cultural Affairs, Dover, Delaware

U.S. Fish and Wildlife Services, Pleasantville, New Jersey

National Oceanographic and Atmospheric Administration, National Marine Fisheries Service, Gloucester, Massachusetts

National Oceanographic and Atmospheric Administration, National Marine Fisheries Service, Highlands, New Jersey

New Jersey Department of Environmental Protection, Division of Land Use Regulation, Trenton, New Jersey

Pocomoke Indian Nation, Mount Airy, Maryland

1.8 Correspondence

Table 1-1 lists persons and organizations to which a copy of this draft SEIS is sent. Appendix E to this report contains a chronological list of documents sent and received during the environmental review. During the course of the environmental review, the Staff contacted the following Federal, State, regional, local, or tribal agencies:

Accohannock Indian Tribe, Salisbury, Maryland

Delaware Nation, Andarko, Oklahoma

Delaware Tribe of Indians, Bartlesville, Oklahoma

Eastern Lenape Nation of PA, Mountville, Pennslyvania

Echota Chickamauga Cherokee Tribe of New Jersey, Irvington, New Jersey

Lenape Tribe of Delaware, Cheshold, Delaware

Nanticoke Indians Association, Inc., Millsboro, Delaware

Nanticoke Lenni-Lenape Indians of New Jersey, Brigeton, New Jersey

Nause-Waiwash Tribe, Cambridge, Maryland

Osprey Band of Free Cherokees, Mays Landing, New Jersey

Piscataway-Conoy Confederacy and Sub-Tribes, Inc., LaPlata, Maryland

Piscataway Indian Nation, Accokeek, Maryland

Pocomoke Indian Nation, Mount Airy, Maryland

Powhatan Renape Nation, Rancocas, New Jersey

Ramapough Mountain Lenape, Mahway, New Jersey

Unalachtigo Band of the Nanticoke-Lenni Lenape Nation, Bridgeton, New Jersey

Younghiogheny Shawnee Band, Bethesda Maryland

Table 1-1. List of persons who are sent a copy of this draft SEIS

State Historic Preservation Officer, Delaware Division of Historical and Cultural Affairs, Dover, New Jersey	Director and State Historic Preservation Officer, Maryland Historical Trust, Crownsville, Maryland	Historic Preservation Officer, New Jersey Historic Preservation Office, Trenton, New Jersey
Historic Preservation Officer, Pennsylvania Bureau for Historic Preservation, Harrisburg, PA	Delaware Division of Historical and Cultural Affairs, Dover, Delaware	U.S. Fish and Wildlife Services, Pleasantville, New Jersey
National Oceanographic and Atmospheric Administration, National Marine Fisheries Service, Gloucester, Massachusetts	National Oceanographic and Atmospheric Administration, National Marine Fisheries Service, Highlands, New Jersey	Joseph Sindoni, PSEG Nuclear LLC
New Jersey Department of Environmental Protection, Division of Land Use Regulation, Trenton, New Jersey	Nanticoke Lenni-Lenape Indians of New Jersey, Brigeton, New Jersey	Jerry Humphreys, NJ Bureau of Nuclear Engineering
Jamie Turner, Delaware Emergency Management Agency	Cheryl Reardon, ANJEC	Tanya Baker, Office of Senator Kaufman
Jane Nogaki, NJ Environmental Federation	Kate Roher, Kent/Sussex County Director	Garth Spencer, Office of Senator Tome Carper (DE)
Julie Acton, Salem County Freeholder	Karen Tuccillo, NJDEP	Kathryn Sutton, Morgan Lewis
Tom Figlio	Michael Tuosto, PSEG Nuclear LLC	Al Fulvio, Exelon
Rich Pinney, State of New Jersey	James Stavely, PSEG Nuclear LLC	Nancy Ranek, Excelon

1.9 Status of Compliance

PSEG is responsible for complying with all NRC regulations and other applicable Federal, State, and local requirements; Appendix C describes some of the principal Federal statutes for which PSEG must comply. Table 1-2 lists the numerous permits and licenses issued by Federal, State, and local authorities for activities at Salem and HCGS, respectively.

Table 1-2. Licenses and Permits. *Existing environmental authorizations for Salem and HCGS*

Salem Nuclear Generating Station, Units 1 and 2

Permit	Number	Dates	Responsible Agency
Operating Licenses	DPR-70 and DPR-75	Issued: 8/13/1976 and 4/18/1980 Expires: 8/13/2016 and 4/18/2020	U.S. Nuclear Regulatory Commission
Groundwater Allocation Permit	D-90-71	Issued: 11/15/2000 Expires: 11/15/2010 Renewal request submitted 8/5/2010	Delaware River Basin Commission
Surface Water Permit	DRBC Docket No. D-68-20-CP (revision 2)	Issued: 09/13/2001 Expires: 09/13/2026	Delaware River Basin Commission
Water Use Contract	76-EP-482	Issued: 01/13/1977 Expires: None	Delaware River Basin Commission
Industrial Waste Treatment Facility	D-83-36	Issued: 01/25/1984 Expires: None	Delaware River Basin Commission
Approval of wells and installation/allocation of ground water	D75-94	Issued: 08/27/1975 Expires: None	Delaware River Basin Commission
Conditional Use Approval/Variance for temporary storage of spent nuclear fuel	SP-1-09; VR-1-09	Issued: 08/26/2009 Expires: 08/26/2014	Lower Alloways Creek Township
Preliminary and Final Site Plan Approval – Operating a Shooting Range	SP-1-05	Issued: 05/25/2005 Expires: None	Lower Alloways Creek Township
Preliminary and Final Site Plan Approval – Improvements to Employee Parking Lots B & C	SP-2-05	Issued: 08/24/2005 Expires: None	Lower Alloways Creek Township

Permit	Number	Dates	Responsible Agency
Minor Site Plan Approval – Salem HCGS Dimineralized water (DM) Plant Upgrades	SP-3-04	Issued: 10/27/2004 Expires: None	Lower Alloways Creek Township
Renewal of Conditional Use Permit – Continued Storage of Radioactive Material (Spent Fuel Storage Pools)	CU-07-1	Issued: 12/19/2007 Expires: 12/19/2012	Lower Alloways Creek Township
New Jersey Pollutant Discharge Elimination System Permit	NJ0005622	Issued: 06/29/2001 Effective: 08/01/2001 Expires: 07/31/2006 (Administratively continued while renewal application is being reviewed.)	New Jersey Department of Environmental Protection
Discharge Prevention, Containment, and Countermeasure (DPCC) Plan; Discharge Cleanup and removal (DCR) Plan	170400041000	Issued: 03/04/2009 Expires: 07/27/2011	New Jersey Department of Environmental Protection
Waterfront Development Permit	170-02-001.4 WFD 050001	Issued: 08/16/2005 Expires: 08/16/2010 Activity-based permit; No renewal required	New Jersey Department of Environmental Protection
Coastal Areas Facility Review Act (CAFRA) Permit (DM Plant)	1704-02-001.3 CAF 040001	Issued: 09/23/2004 Expires: 09/23/2009 Activity-based permit; No renewal required	New Jersey Department of Environmental Protection
Coastal Areas Facility Review Act (CAFRA) Permit (Maintenance and Project Support Building)	1704-02-001.3 CAF 040002	Issued: 03/24/2005 Expires: 03/24/2010 Activity-based permit; No renewal required	New Jersey Department of Environmental Protection
Coastal Areas Facility Review Act (CAFRA) Permit (Security Vehicle Barrier System)	1704-02-001.4 CAF 050002	Issued: 08/16/2005 Expires: 08/16/2010 Activity-based permit; No renewal required	New Jersey Department of Environmental Protection

Permit	Number	Dates	Responsible Agency
Coastal Areas Facility Review Act (CAFRA) Permit (Nuclear Administration Building (NAB) Parking Lot)	1704-02-001.4 CAF 050003	Issued: 12/01/2005 Expires: 12/01/2010 Activity-based permit; No renewal required	New Jersey Department of Environmental Protection
Freshwater Wetland (FWW) Permit (Security Vehicle Barrier System)	1704-02-001.4 FWW 050001	Issued: 08/16/2005 Expires: 08/16/2010 Activity-based permit; No renewal required	New Jersey Department of Environmental Protection
Freshwater Wetland (FWW) Permit (NAB Parking Lot)	1704-02-001.4 FWW 050002	Issued: 12/01/2005 Expires: 12/01/2010 Activity-based permit; No renewal required	New Jersey Department of Environmental Protection
Water Allocation Permit for Salem and HCGS	Activity No: WAP04001 Program Interest ID: 2216P	Issued: 01/01/2005 Expires: 01/31/2011	New Jersey Department of Environmental Protection
Public Water Supply Identification Number	1704300	Issued: 09/04/1980 Expires: None	New Jersey Department of Environmental Protection
Air Pollution Control Operating Permit (Title V Operating Permit)	BOP080001	Issued: 02/02/2005 Modified: 03/27/2009 Expires: 02/01/2011	New Jersey Department of Environmental Protection
Grant of Permanent Right-of-Way	None	Issued: 11/04/1971 Expires: None	New Jersey Department of Environmental Protection
Medical Waste Generator Certificate	34571	Issued: 08/14/1992 Expires: Renewed annually	New Jersey Department of Environmental Protection
Riparian Easement Grant	68-12	Issued: 01/10/1974 Expires: None	The State of New Jersey
Riparian License	69-80	Issued: 08/29/1972	The State of New

Permit	Number	Dates	Responsible Agency
		Expires: None	Jersey
South Carolina Radioactive Waste Transport Permit	0018-29-10-X	Issued: 12/29/2009 Renewed Annually	South Carolina Department of Health and Environmental Control – Division of Waste Management
Tennessee Radioactive Waste Transport Permit	T-NJ002-L10	Issued: 12/29/2009 Renewed Annually	State of Tennessee Department of Environmental and Conservation Division of Radiological Health
Maintenance Dredging	CENAP-OP-R-2006-6232-45	Issued: 07/14/2008 Expires: 07/27/2020	U.S. Army Corps of Engineers
Deed of Easement	None	Issued: 04/24/1968 Expires: None	U.S. Department of the Army
Incidental Take Statement – sea turtles and shortnose sturgeon	N/A	Issued: 05/15/1993 Expires: None	U.S. Department of Commerce, National Oceanic and Atmospheric Administration, and National Marine Fisheries Service
Hazardous Material Shipments Registration	US DOT ID 997370 061908 002 018QS	Issued: 07/01/2008 Expires: 06/30/2011	U.S. Department of Transportation
Spill Prevention, Control, and Countermeasure (SPCC) Plan Approval	None	Pending	U.S. Environmental Protection Agency
Facility Response Plan Approval	0200087	Submitted: 02/15/2008 Status: Pending	U.S. Environmental Protection Agency
Hazardous Waste Generator	NJD07707811	Acknowledged: 09/13/1989 Expires: None	U.S. Environmental Protection Agency

Hope Creek Generating Station

Permit	Number	Dates	Responsible Agency
Operating Licenses	NPF-57	Issued: 4/11/1986 Expires: 4/11/2026	NRC
Conditional Use and Variance for temporary storage of spent nuclear fuel	SP-1-09 and VR-1-09	Issued: 08/26/2009 Expires: 06/24/2014	Lower Alloways Creek Township
Preliminary and Final Site Plan Approval – Operating a Shooting Range	SP-1-05	Issued: 05/25/2005 Expires: None	Lower Alloways Creek Township
Preliminary and Final Site Plan Approval – Improvements to Employee Parking Lots B & C	SP-2-05	Issued: 08/24/2005 Expires: None	Lower Alloways Creek Township
Discharge Prevention, Containment, and Countermeasure (DPCC) Plan; Discharge Cleanup and removal (DCR) Plan	170400041000	Issued: 03/04/2009 Expires: 07/27/2011	New Jersey Department of Environmental Protection
Waterfront Development Permit	170-02-001.4 WFD 050001	Issued: 08/16/2005 Expires: 08/16/2010 Activity-based permit; No renewal required	New Jersey Department of Environmental Protection
Coastal Areas Facility Review Act (CAFRA) Permit (Land use associated with HCGS)	74-014	Issued: 09/03/1975 Expires: None	New Jersey Department of Environmental Protection
Coastal Areas Facility Review Act (CAFRA) Permit (Land use associated with Sandblast Facility Modifications)	1704-90-004-5-CAM	Issued: 04/25/1995 Expires: None	New Jersey Department of Environmental Protection
Coastal Areas Facility Review Act (CAFRA) Permit (DM Plant)	1704-02-001.3 CAF 040001	Issued: 09/23/2004 Expires: 09/23/2009 Activity-based permit; No renewal required	New Jersey Department of Environmental Protection

Permit	Number	Dates	Responsible Agency
Coastal Areas Facility Review Act (CAFRA) Permit (NAB Parking Lot)	1704-02-001.4 CAF 050003	Issued: 12/01/2005 Expires: 12/01/2010 Activity-based permit; No renewal required	New Jersey Department of Environmental Protection
Freshwater Wetland (FWW) Permit (NAB Parking Lot)	1704-02-001.4 FWW 050002	Issued: 12/01/2005 Expires: 12/01/2010 Activity-based permit; No renewal required	New Jersey Department of Environmental Protection
Water Allocation Permit for Salem and HCGS	Activity No: WAP09001 Program Interest ID: 2216P	Issued: 01/01/2005 Expires: 06/30/2020	New Jersey Department of Environmental Protection
Public Water Supply Identification Number	1704300	Issued: 09/04/1980 Expires: None	New Jersey Department of Environmental Protection
Type “B” Wetlands Permit	W74-02	Issued: 02/28/1975 Expires: None	New Jersey Department of Environmental Protection
Medical Waste Generator Certificate	34571	Issued: 08/14/1992 Renewed annually	New Jersey Department of Environmental Protection
South Carolina Radioactive Waste Transport Permit	0018-29-10-X	Issued: 12/29/2009 Renewed Annually	South Carolina Department of Health and Environmental Control – Division of Waste Management

Permit	Number	Dates	Responsible Agency
Tennessee Radioactive Waste Transport Permit	T-NJ002-L10	Issued: 12/29/2009 Renewed Annually	State of Tennessee Department of Environmental and Conservation Division of Radiological Health
Spill Prevention, Control, and Countermeasure (SPCC) Plan	None	Last Reviewed: 02/29/2008 Next Scheduled Review: 02/28/2013	U.S. Environmental Protection Agency
Facility Response Plan Approval	0200087	Submitted: 02/15/2008 Pending	U.S. Environmental Protection Agency
Notification of Hazardous Waste Activity	NJD07707811	Acknowledged: 09/13/1989 Expires: None	U.S. Environmental Protection Agency

1.10 References

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

74 FR 54854. U.S. Nuclear Regulatory Commission. Washington D.C. "Notice of Acceptance for Docketing of the Application and Notice of Opportunity for Hearing Regarding Renewal of Facility Operating License Nos. DPR-70 and DPR-75 for an Additional 20-Year Period; PSEG Nuclear LLC, Salem Nuclear Generating Stations, Units 1 and 2." Federal Register: Vol 74, No. 204, pp 54854- 54856. October 23, 2009.

74 FR 54856. U.S. Nuclear Regulatory Commission. Washington D.C. "Notice of Acceptance for Docketing of the Application and Notice of Opportunity for Hearing Regarding Renewal of Facility Operating License No. DPR-57 for an Additional 20-Year Period; PSEG Nuclear LLC Hope Creek Generating Station, Unit 1." Federal Register: Vol 74, No. 204, pp 54856- 54858. October 23, 2009.

74 FR 54859. U.S. Nuclear Regulatory Commission. Washington D.C. "PSEG Nuclear, LLC; Notice of Intent to Prepare an Environmental Impact Statement and Conduct the Scoping Process for Salem Nuclear Generating Station, Units 1 and 2, and Hope Creek Generating Station." Federal Register: Vol 74, No. 204. pp 54859-54860. October 23, 2009.

Atomic Energy Act of 1954. 42 U.S.C. 2011, et seq.

Endangered Species Act of 1973. 16 U.S.C. 1531, et seq.

Magnuson-Stevens Fishery Conservation and Management Act, as amended by the *Sustainable Fisheries Act of 1996*. 16 U.S.C. 1855, et seq.

National Environmental Policy Act of 1969. 42 U.S.C. 4321, et seq.

National Historic Preservation Act. 16 U.S.C. 470, et seq.

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NRC (U.S. Nuclear Regulatory Commission). 1999. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Main Report*, "Section 6.3 – Transportation, Table 9.1, Summary of Findings on NEPA Issues for License Renewal of Nuclear Power Plants, Final Report." NUREG-1437, Volume 1, Addendum 1, Washington, D.C. August 1999. ADAMS No. ML04069720.

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PSEG (PSEG Nuclear, LLC). 2009a. Salem Nuclear Generating Station, Units 1 and 2, License Renewal Application, Appendix E - Applicant's Environmental Report – Operating License Renewal Stage. Lower Alloways Creek Township, New Jersey. August, 2009. ADAMS Nos. ML092400532, ML092400531, ML092430231

PSEG (PSEG Nuclear, LLC). 2009b. Hope Creek Generating Station, License Renewal Application, Appendix E - Applicant's Environmental Report – Operating License Renewal Stage. Lower Alloways Creek Township, New Jersey. August, 2009. ADAMs No. ML092430389

2.0 AFFECTED ENVIRONMENT

Salem Nuclear Generating Station (Salem) and Hope Creek Generating Station (HCGS) are located at the southern end of Artificial Island in Lower Alloways Creek Township, Salem County, New Jersey. The facilities are located at River Mile 50 (RM 50; River Kilometer 80 [RK 80]) and RM 51 (RK 82) on the Delaware River, respectively, approximately 17 miles (mi; 27 kilometers [km]) south of the Delaware Memorial Bridge. Philadelphia is about 35 mi (56 km) northeast and the city of Salem, New Jersey is 8 mi (13 km) northeast of the site (AEC, 1973). Figure 2-1 shows the location of Salem and HCGS within a 6-mi (10 km) radius, and Figure 2-2 is an aerial photograph of the site.

Because existing conditions are partially the result of past construction and operation at the plants, the impacts of these past and ongoing actions and how they have shaped the environment are presented in this chapter. Section 2.1 of this report describes Salem and HCGS as a combined site (site), the individual facilities, and their operations; Section 2.2 discusses the affected environment; and Section 2.3 describes related Federal and State activities near the site.

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

Artificial Island is a 1,500-acre (ac; 600 hectare [ha]) island that was created by the U.S. Army Corps of Engineers (USACE) beginning in the early 20th century. The island began as buildup of hydraulic dredge spoils within a progressively enlarged diked area established around a natural sandbar that projected into the river. The island is characterized by low and flat tidal marsh and grassland with an average elevation of about 9 feet (ft; 3 meters [m]) above mean sea level (MSL) and a maximum elevation of about 18 ft (5.5 m) above MSL (AEC, 1973).

Public Service Enterprise Group Incorporated Nuclear, LLC (PSEG) owns approximately 740 ac (300 ha) on the southern end of Artificial Island. The Salem and HCGS facilities occupy 373 ac (150 ha; 220 ac [89 ha] for Salem and 153 ac [62 ha] for HCGS) in the southwestern corner of the island. The remainder of Artificial Island is undeveloped.

The remainder of the island is owned by the U.S. Government and the State of New Jersey. The northern portion of Artificial Island, a very small portion of which is within the State of Delaware boundary, and a 1-mi (1.6-km) wide inland strip of land abutting the island are owned by the U.S. Government (AEC, 1973). The State of New Jersey owns the remainder of Artificial Island, as well as much of the nearby inland property. The distance to the PSEG property boundary from the two Salem reactor buildings is approximately 4,200 ft (1,300 m). Distance to the PSEG property boundary from the HCGS reactor building is 2,960 ft (902 m).

There are no major highways or railroads within about 7 mi (11 km) of the site. Land access is provided via Alloway Creek Neck Road to Bottomwood Avenue. The site is located at the end of Bottomwood Avenue and there is no traffic that bypasses the site. Barge traffic has access to the site by way of the Intracoastal Waterway channel maintained in the Delaware River (AEC, 1973).

Figures 2-3 and 2-4 show the property boundaries and facility layouts for the Salem and HCGS facilities, respectively.

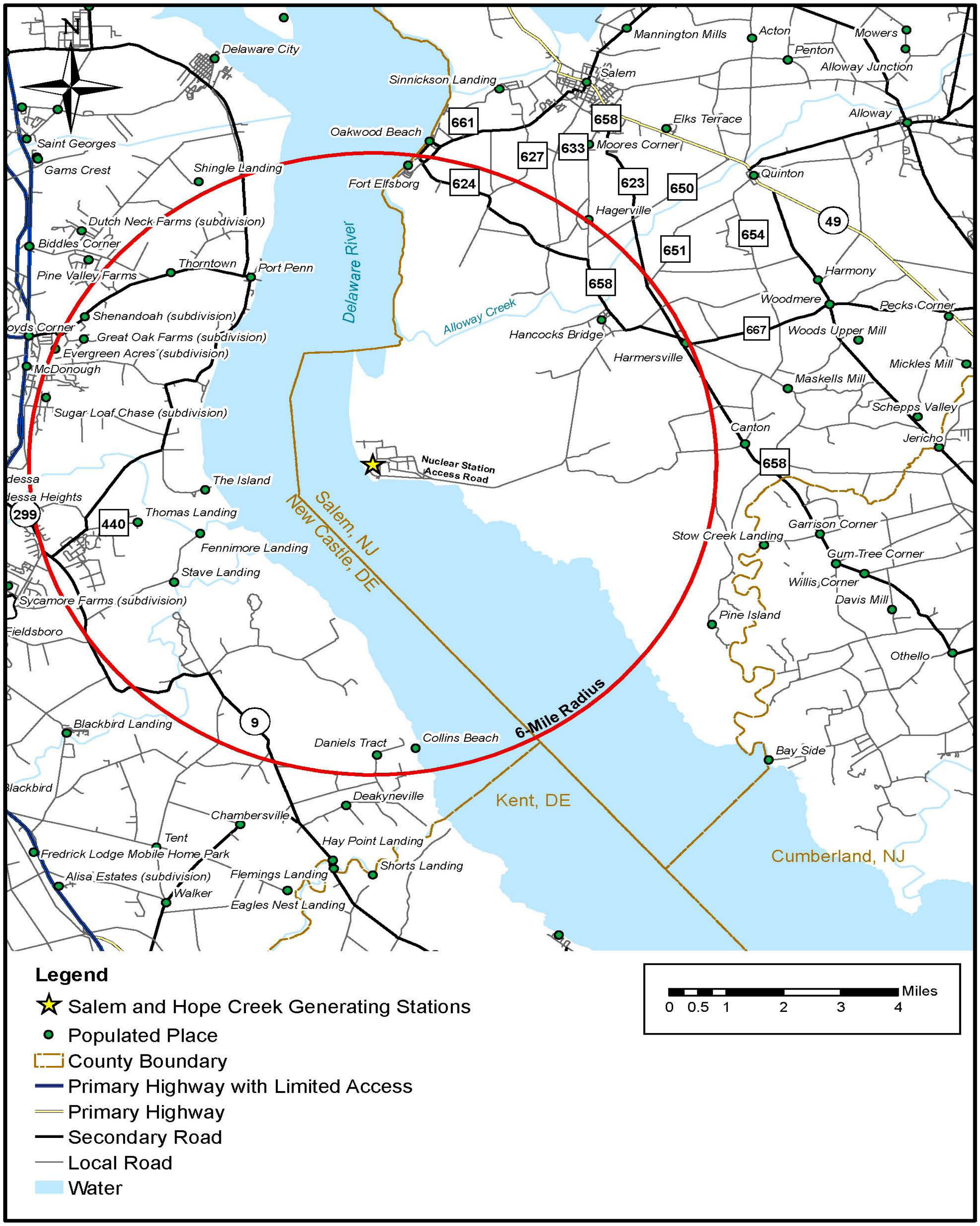
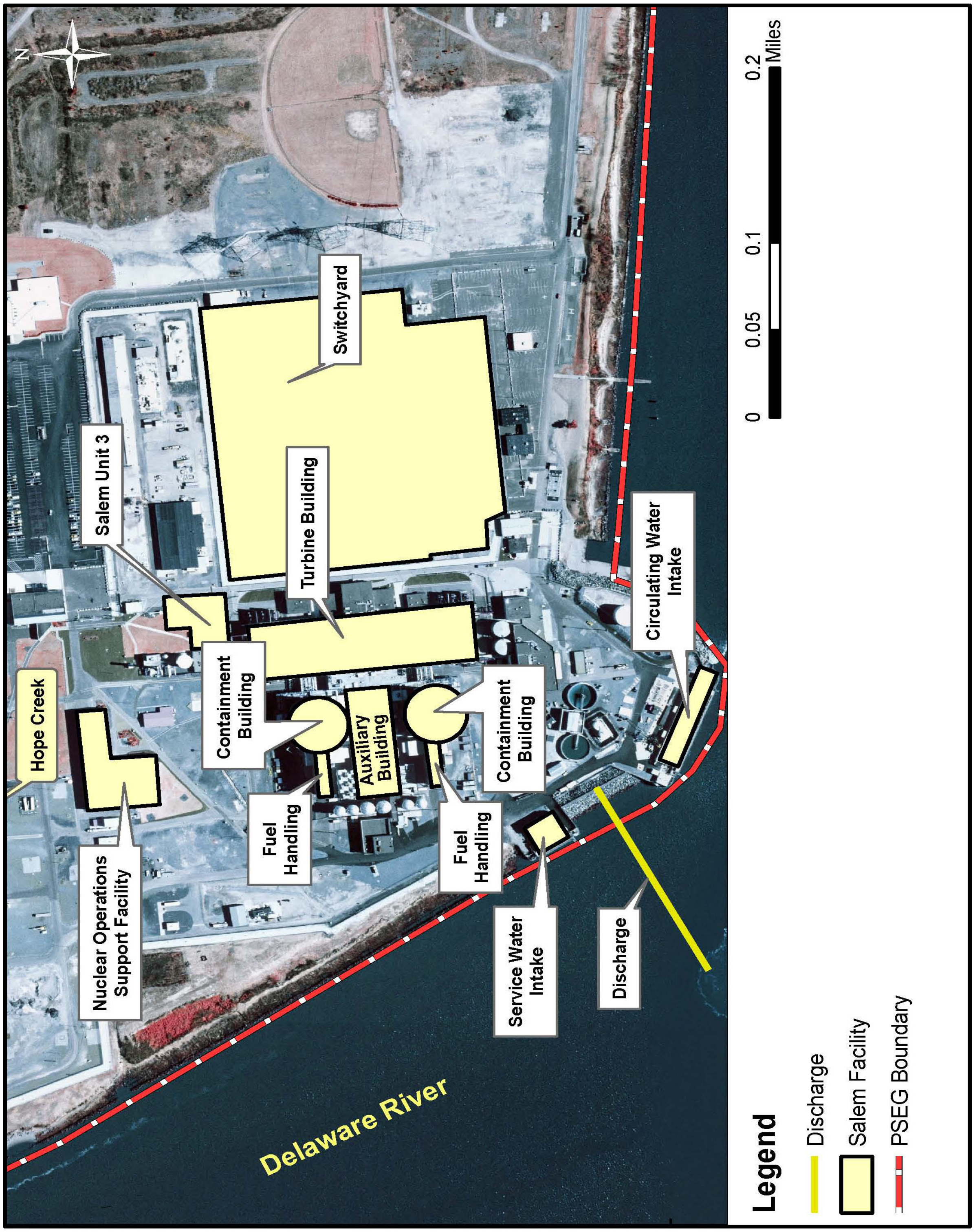


Figure 2-1. Location of the Salem Nuclear Generating Station and Hope Creek Generating Station Site, within a 6-Mile Radius (Source: PSEG, 2009a; 2009b)

Figure 2-2. Aerial Photo (Source: PSEG, 2009a; 2009b)



1 **Figure 2-3. Salem Nuclear Generating Station Facility Layout (Source: PSEG, 2009a)**

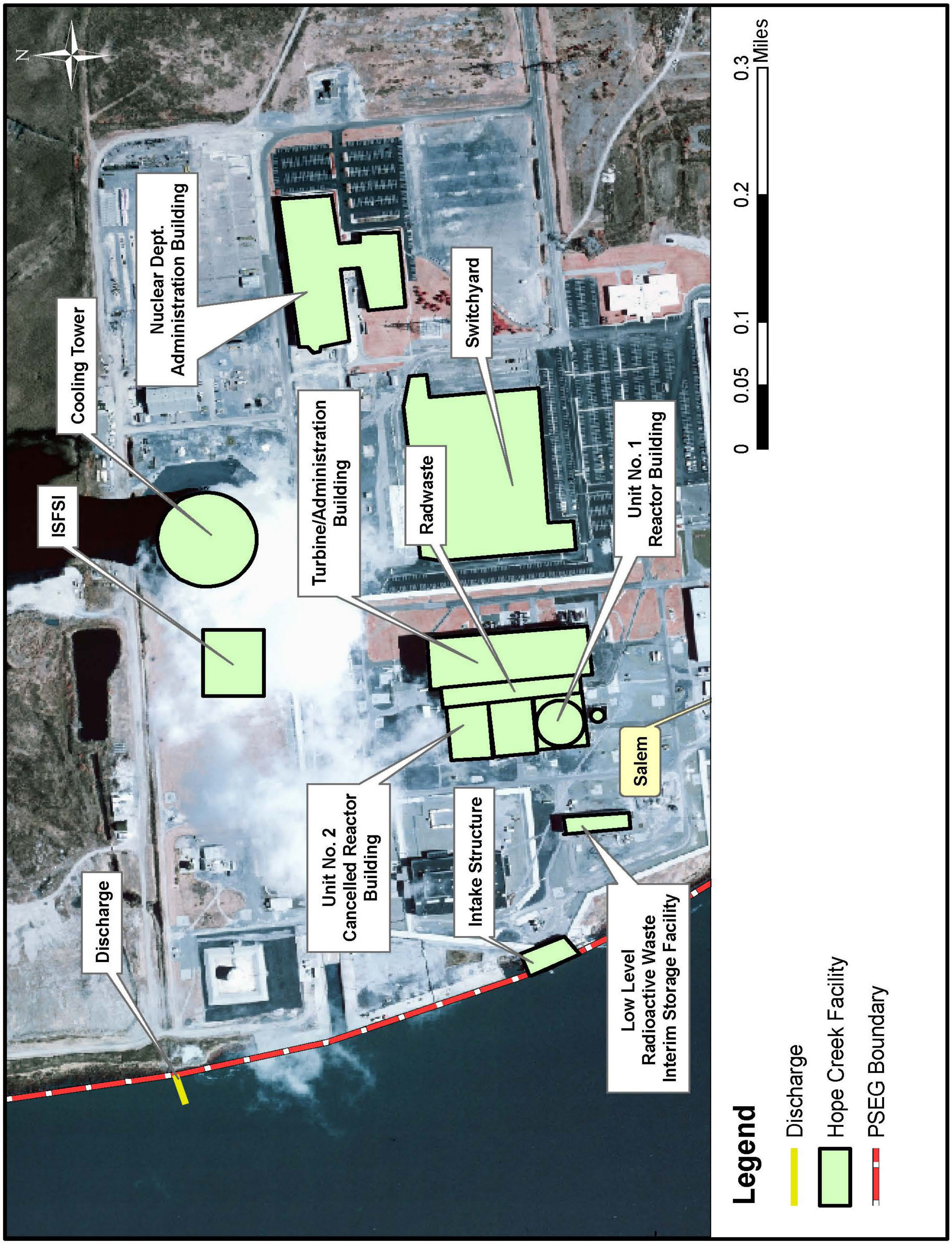


Figure 2-4. Hope Creek Generating Station Facility Layout (Source: PSEG, 2009b)

Three metropolitan areas lie within 50 mi (80 km) of the PSEG site: Wilmington, DE, the closest city, approximately 15 mi (24 km) to the northwest; Philadelphia, PA, approximately 35 mi (56 km) to the northeast; and Baltimore, MD, approximately 45 mi (72 mi) to the southwest (Figure 2-5 shows a map of the site within a 50-mi [80 km] radius).

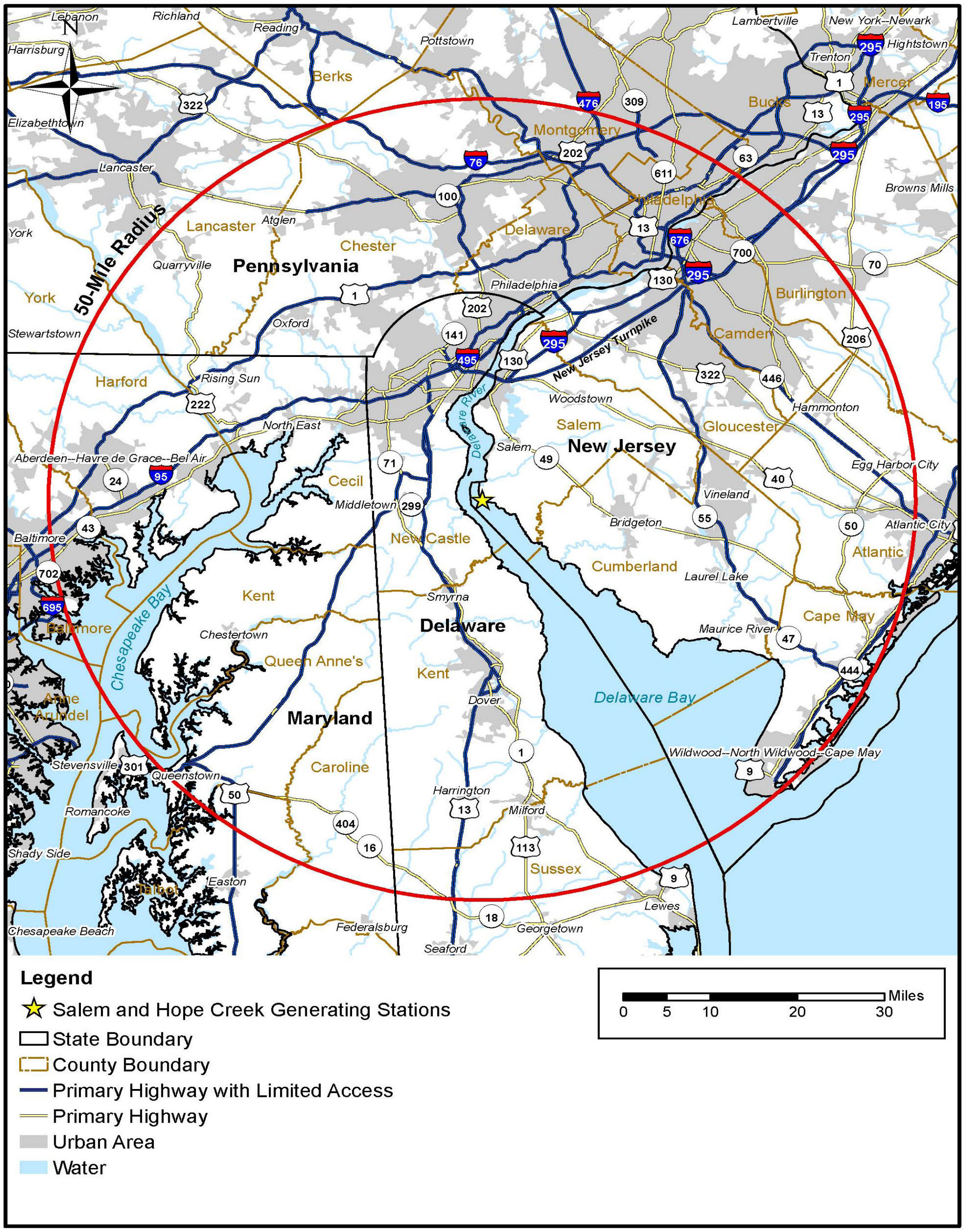


Figure 2-5. Location of the Salem Nuclear Generating Station and Hope Creek Generating Station Site, within a 50-Mile Radius (Source: PSEG, 2009a; 2009b)

Industrial activities within 10 mi (16 km) of the site are confined principally to the west bank of the Delaware River, north of Artificial Island, in the cities of Delaware City, New Castle, and Wilmington. There is no significant industrial activity near the site. With little industry in the region, construction and retail trade account for nearly 40 percent of the revenues generated in the Salem County economy (USCB, 2006). Smaller communities in the vicinity of the site (Haddock's Bridge, NJ; Salem, NJ; Quinton, NJ; and Shenandoah, DE) consist primarily of small retail businesses. Much of the surrounding marshland is owned by the U.S. Government and the State of New Jersey and is further described in section 2.2.1.

Located about 2 mi (3 km) west of the site on the western shore of the Delaware River is the Augustine State Wildlife Management Area, a 2,667-ac (1,079 ha) wildlife management area managed by the Delaware Division of Fish and Wildlife (Delaware Division of Fish and Wildlife, 2010a). Southwest of the site, also on the Delaware side of the Delaware River, is the Appoquinimink Wildlife Area. Located less than a mile (less than one km) northeast of the site is the upper section of the Mad Horse Creek Fish and Wildlife Management Area. This is a noncontiguous, 9,500-ac (3,800 ha) wildlife area managed by the New Jersey Division of Fish and Wildlife (NJDFW) with sections northeast, east, and southeast of the site (NJDFW, 2009a). Recreational activities at these wildlife areas within 10 mi (16 km) of the site consist of boating, fishing, hunting, camping, hiking, picnicking, and swimming.

2.1.1 Reactor and Containment Systems

2.1.1.1 Salem Nuclear Generating Station

Salem is a two-unit plant, which uses pressurized water reactors (PWR) designed by Westinghouse Electric. Each unit has a current licensed thermal power at 100 percent power of 3,459 megawatt-thermal (MW[t]). Salem Units 1 and 2 entered commercial service June 1977 and October 1981, respectively. At 100 percent reactor power, the currently anticipated net electrical output is approximately 1,169 megawatt-electric (MW[e]) for Unit 1 and 1,181 MW(e) for Unit 2. The Salem units have once-through circulating water systems for condenser cooling that withdraws brackish water from the Delaware Estuary through one intake structure located at the shoreline on the south end of the site. An air-cooled combustion turbine peaking unit rated at approximately 40 MW(e) (referred to as "Salem Unit 3") is also present (PSEG, 2009a; 2009b).

In the PWR power generation system (Figure 2-6); reactor heat is transferred from the primary coolant to a lower pressure secondary coolant loop, allowing steam to be generated in the steam supply system. The primary coolant loops each contain one steam generator, two centrifugal coolant pumps, and the interconnected piping. Within the reactor coolant system (RCS), the reactor coolant is pumped from the reactor through the steam generators and back to the reactor inlet by two centrifugal coolant pumps located at the outlet of each steam generator. Each steam generator is a vertical, U- tube-and-shell heat exchanger that produces superheated steam at a constant pressure over the reactor operating power range. The steam is directed to a turbine, causing it to spin. The spinning turbine is connected to a generator, which generates electricity. The steam is directed to a condenser, where the steam is cooled and condensed back in liquid water. This cooled water is then cycled back to the steam generator, completing the loop.

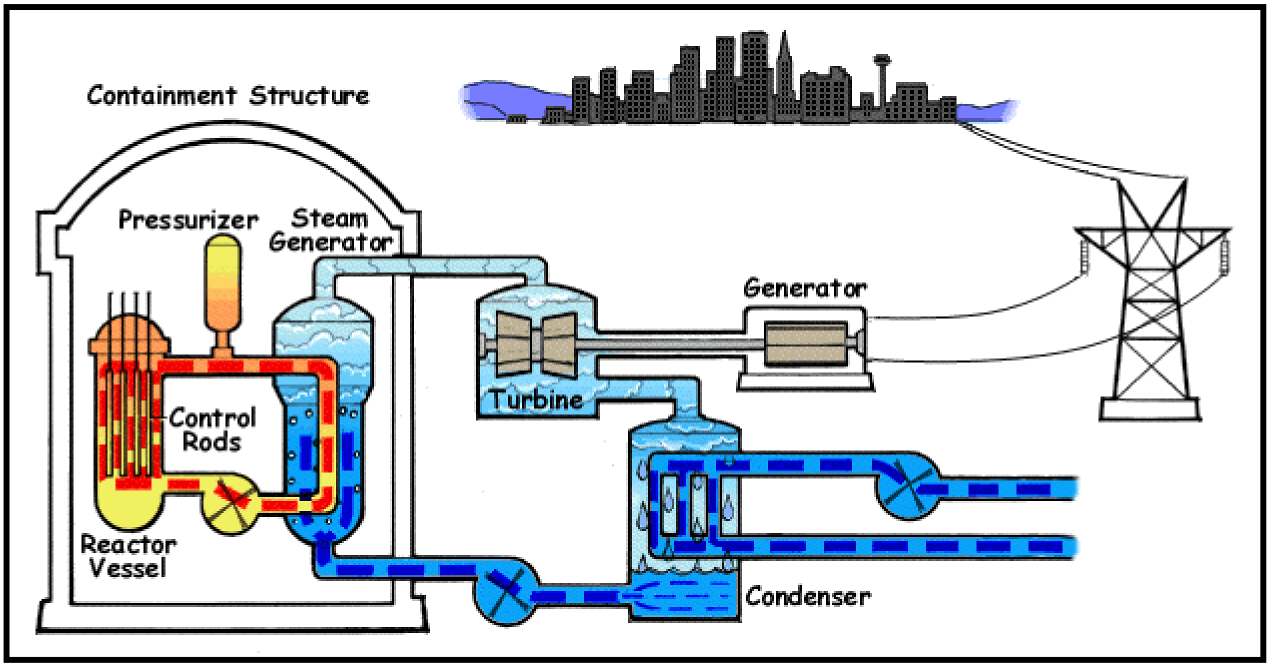


Figure 2-6. Simplified Design of a Pressurized Water Reactor

The containment building serves as a biological radiation and a pressure container for the entire RCS. The reactor containment structures are a vertical cylinders with 16-ft (4.9-m) thick flat foundation mats and 2- to 5-ft (0.6- to 1.5-m) thick reinforced concrete slab floors topped with hemispherical dome roofs. The side walls of each containment building are 142 ft (43.3 m) high and the inside diameter is 140 ft (43 m). The concrete walls are 4.5 ft (1.4 m) thick and the containment building dome roofs are 3.5 ft (1.1 m) thick. The inside surface of the reactor building is lined with a carbon steel liner with varying thickness ranging from 0.25 inch (0.64 centimeter [cm]) to 0.5 inch (1.3 cm) (PSEG, 2007a).

The nuclear fueled cores of the Salem reactors are moderated and cooled by a moderator, which slows the speed of neutrons thereby increasing the likelihood of fission of an uranium-235 atom in the fuel. The cooling water is circulated by the reactor coolant pumps. These pumps are vertical, single-stage centrifugal pumps equipped with controlled-leakage shaft seals (PSEG, 2007b).

Both Salem units use slightly enriched uranium dioxide (UO_2) ceramic fuel pellets in zircaloy cladding (PSEG, 2007b). Fuel pellets are loaded into fuel rods, and fuel rods are joined together in fuel assemblies. The fuel assemblies consist of 264 fuel rods arranged in a square array. Salem uses fuel that is nominal enriched to 5.0 percent (percent uranium-235 by weight). The combined fuel characteristics and power loading result in a fuel burn-up of about 60,000 megawatt-days (MW [d]) per metric ton uranium (PSEG, 2009a).

The original Salem steam generators have been replaced. In 1997, the Unit 1 steam generators were replaced and in 2008 the Unit 2 steam generators were replaced (PSEG, 2009a).

2.1.1.2 Hope Creek Generating Station

HCGS is a one-unit station, which uses a boiling water reactor (BWR) designed by General Electric. The power plant has a current licensed thermal power output of 3,840 MW(t) with an electrical output estimated to be approximately 1,083 MW(e) (73 FR 13032). HCGS has a closed-cycle circulating water system for condenser cooling that consists of a natural draft cooling tower and associated withdrawal, circulation, and discharge facilities. HCGS withdraws brackish water with the service water system (SWS) from the Delaware Estuary (PSEG, 2009b).

In the BWR power generation system (Figure 2-7), heat from the reactor causes the cooling water which passes vertically through the reactor core to boil, producing steam. The steam is directed to a turbine, causing it to spin. The spinning turbine is connected to a generator, which generates electricity. The steam is directed to a condenser, where the steam is cooled and is condesned back in liquid water. This water is then cycled back to the reactor core, completing the loop.

The containment is the reactor building. The structure serves as a biological radiation shield and a pressure container for the entire RCS. The reactor building is a vertical cylinder with 14-ft (4.3-m) thick flat foundation mats and 2- to 5-ft (0.6- to 1.5-m) thick reinforced concrete slab floors. The side walls of the cylinder are approximately 250 ft (76 m) high, topped with a torispherical dome roof, and surrounded by a rectangular structure that is 132 ft (40 m) tall (PSEG, 2006a).

The HCGS reactor uses slightly enriched UO_2 ceramic fuel pellets in zircaloy cladding (PSEG, 2007b). Fuel pellets are loaded into fuel rods and fuel rods are joined together in fuel assemblies. HCGS uses fuel that is nominal enriched to 5.0 percent (percent uranium-235 by weight) and the combined fuel characteristics and power loading result in a fuel burn-up of about 60,000 MW(d) per metric ton uranium.

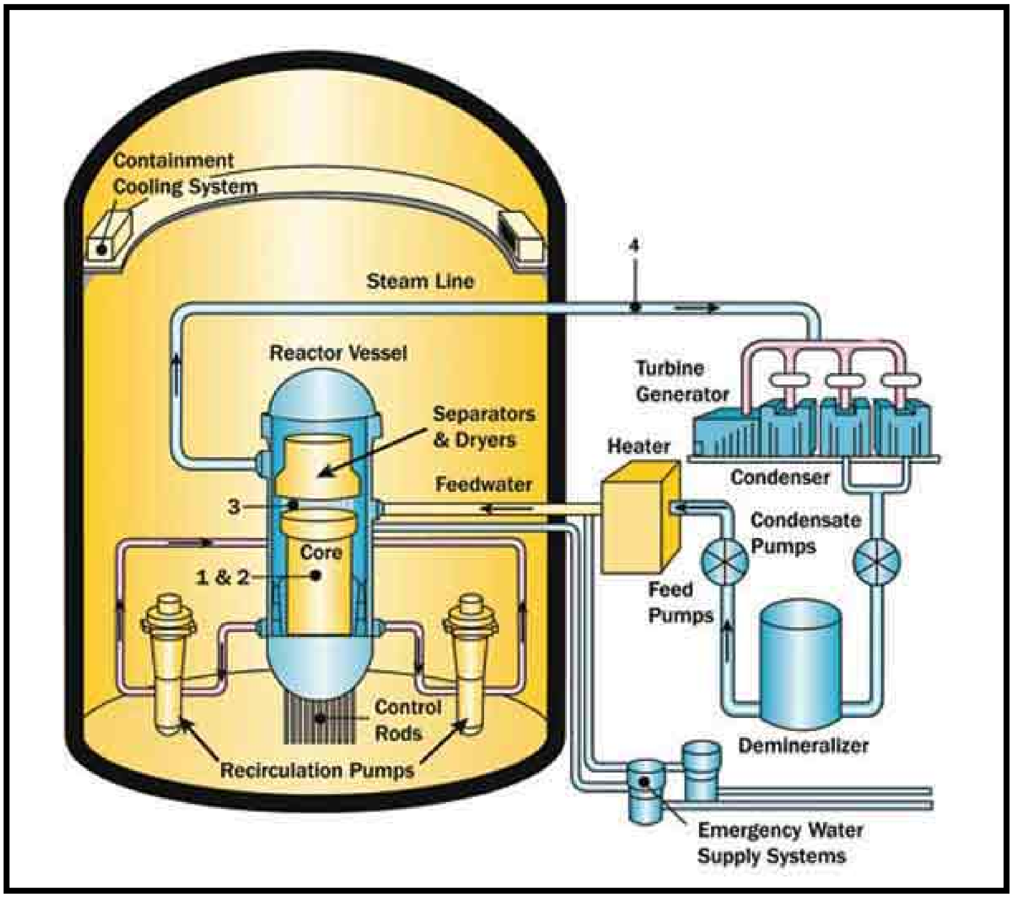


Figure 2-7. Simplified Design of a Boiling Water Reactor

2.1.2 Radioactive Waste Management

Radioactive wastes resulting from plant operations are classified as liquid, gaseous, or solid. Liquid radioactive wastes are generated from liquids received directly from portions of the RCS or were contaminated by contact with liquids from the RCS. Gaseous radioactive wastes are generated from gases or airborne particulates vented from reactor and turbine equipment containing radioactive material. Solid radioactive wastes are solids from the RCS, solids that came into contact with RCS liquids or gases, or solids used in the RCS or steam and power conversion system operation or maintenance.

The Salem and HCGS facilities include radioactive waste systems which collect, treat, and provide for the disposal of radioactive and potentially radioactive wastes that are byproducts of plant operations. Radioactive wastes include activation products resulting from the irradiation of reactor water and impurities therein (principally metallic corrosion products) and fission products resulting from defective fuel cladding or uranium contamination within the RCS. Radioactive waste system operating procedures ensure that radioactive wastes are safely processed and discharged from the plant within the limits set forth in Title 10 of the *Code of Federal*

Regulations (CFR) Part 20, "Standards for Protection against Radiation," and 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities."

When reactor fuel has exhausted a certain percentage of its fissile uranium content, it is referred to as spent fuel. Spent fuel assemblies are removed from the reactor core and replaced with fresh fuel assemblies during routine refueling outages, typically every 18 months. Spent fuel assemblies are stored in the spent fuel pool (SFP). Salem's SFP storage capacity for each unit is 1,632 fuel assemblies, which will allow sufficient storage up to the year 2011 for Unit 1 and 2015 for Unit 2 (PSEG, 2009a). The HCGS SFP facility is designed to store up to 3,976 fuel assemblies (PSEG, 2009b).

In 2005, the NRC issued a 10 CFR Part 72 general license to PSEG, which authorized that spent nuclear fuel could be stored at an independent spent fuel storage installation (ISFSI) at the PSEG site. The general license allows PSEG, as a reactor licensee under 10 CFR Part 50, to store spent fuel from both HCGS and Salem at the ISFSI, provided that such storage occurs in approved casks in accordance with the requirements of 10 CFR Part 72, subpart K (General License for Storage of Spent Fuel at Power Reactor Sites) (NRC, 2005). At this time, only HCGS spent fuel is stored at the ISFSI. However, transfers of spent fuel from the Salem SFP to the ISFSI are expected to begin approximately one year before the remaining capacity of the pool is less than the capacity needed for a complete offload to spent fuel pool (PSEG, 2009b).

2.1.2.1 Radioactive Liquid Waste

Both the Salem and HCGS facilities operate systems to provide controlled handling and disposal of small quantities of low-activity, liquid radioactive wastes generated during station operation. However, because the Salem units are cooled by a once-through RCS and the HCGS unit is cooled by a closed-cycle RCS, the management of potentially radioactive liquids is different. Potentially radioactive liquid waste streams at the Salem facility are managed by the radioactive liquid waste system (RLWS) and the chemical and volume controlled system (CVCS). At HCGS, potentially radioactive liquid waste streams are managed under the liquid waste management system (LWMS).

The bulk of the radioactive liquids discharged from the Salem RCS are processed and retained inside the plant by the CVCS recycle train. This minimizes liquid input to the RLWS. Liquid radioactive waste entering the RLWS is released in accordance with NRC regulations. Prior to release, liquids are collected in tanks, sampled, and analyzed. Based on the results of the analysis, the waste is processed to remove radioactivity before releasing it to the Delaware Estuary via the circulating water system and a permitted outfall. Discharge streams are monitored, and safety features are incorporated to preclude releases in excess of the limits prescribed in 10 CFR Part 20, "Standards for Protection Against Radiation" (PSEG, 2009a).

In 2003, PSEG identified tritium in groundwater from onsite sampling wells near the Salem Unit 1 fuel handling building (FHB). The source of tritium was identified as the Salem Unit 1 SFP. In November 2004, the New Jersey Department of Environmental Protection (NJDEP), Bureau of Nuclear Engineering (BNE) approved a groundwater remediation strategy and by September 2005, a full-scale groundwater recovery system (GRS) had been installed (PSEG, 2009a). The GRS pulls groundwater toward the recovery system and away from the site boundary.

Since 2005, tritium-contaminated groundwater from the GRS is transferred to the LWMS where it mixes with other liquid plant effluent before being discharged into the Salem once-through, condenser cooling water system discharge line. The recovered groundwater is sampled prior to entering the discharge line to demonstrate compliance with offsite dose requirements. The water is subsequently released to the Delaware Estuary via a permitted outfall in accordance with plant procedures and NRC requirements for the effluent release of radioactive liquids. Surface water sampling as part of the radiological environmental monitoring program (REMP) does not show an increase in measurable tritium levels since the GRS was initiated.

Potentially radioactive liquid wastes entering the HCGS LWMS are collected in tanks in the auxiliary building. Radioactive contaminants are removed from the wastewater either by demineralization or filtration. This ensures that the water quality is restored before being returned to the condensate storage tank (CST) or discharged via the cooling tower blowdown line to the Delaware Estuary via a permitted outfall. If the liquid is recycled to the plant, it meets the purity requirements for CST makeup. Liquid discharges to the Delaware Estuary are maintained in compliance with 10 CFR Part 20, “Standards for Protection Against Radiation” (PSEG, 2009b).

Radioactivity removed from the liquid wastes is concentrated in the filter media and ion exchange resins, which are managed as solid radioactive wastes.

2.1.2.2 Radioactive Gaseous Waste

The Salem and HCGS radioactive gaseous waste disposal systems process and dispose of routine radioactive gases removed from the gaseous effluent and released to the atmosphere. Gaseous wastes are processed to reduce radioactive materials in gaseous effluents before discharge to meet the dose limits in 10 CFR Part 20 and the dose design objectives in Appendix I to 10 CFR Part 50.

At both facilities, radioactive gases are collected so that the short-lived gaseous isotopes (principally air with traces of krypton and xenon) are allowed to decay. At Salem, these gases are collected in tanks in the auxiliary building and released intermittently in a controlled manner.

At HCGS, gases are held up in holdup pipes prior to entering a treatment section where adsorption of gases on charcoal provides additional time for decay. At HCGS, gases are then filtered using high-efficiency particulate air (HEPA) filters before being released to the atmosphere from the north plant vent.

2.1.2.3 Radioactive Solid Waste

Solid radioactive waste generated at the Salem and HCGS facilities are managed by a single solid radioactive waste system. This system manages radioactive solid waste, including packaging and storage, until the waste is shipped offsite. Offsite wastes are processed by volume reduction and/or shipped for disposal at a licensed disposal facility. PSEG provides a quarterly waste storage report to the Township of Haddock’s Bridge.

The State of South Carolina’s licensed low level waste (LLW) disposal facility, located in Barnwell, has limited the access from radioactive waste generators located in States that are not part of the Atlantic Interstate Low-Level Radioactive Waste Compact. New Jersey is a member of the Atlantic Interstate Low-Level Radioactive Waste Compact. To control releases to the environment, these wastes are packaged in the Salem and HCGS auxiliary buildings.

The PSEG low-level radwaste storage facility (LLRSF) supports normal dry active waste (DAW) handling activities for HCGS and Salem. DAW consists of compactable trash, such as contaminated or potentially contaminated rags, clothing, and paper. This waste is generally bagged, placed in Sea-van containers, and stored prior to being shipped to a licensed offsite vendor for volume reduction. The volume-reduced DAW is repackaged at the vendor and shipped for disposal at a licensed LLW disposal facility (PSEG, 2009a; 2009b). DAW and other non-compactable contaminated wastes are typically shipped to the Energy Solutions' disposal facility in Clive, UT.

The LLRSF also maintains an NRC-approved process control program. The process control program helps to ensure that waste is properly characterized, profiled, labeled, and shipped in accordance with the waste disposal facility's waste acceptance criteria and U.S. Department of Transportation (DOT) and NRC requirements. The LLRSF is a large facility that was designed to store and manage large volumes of waste. However, the facility is operated well below its designed capacity. The facility is also designed to ensure that worker radiation exposures are controlled in accordance with facility and regulatory criteria.

2.1.2.4 Mixed Waste

The term "mixed waste" refers to waste that contains both radioactive and hazardous constituents. Neither Salem nor HCGS have processes that generate mixed wastes and there are no mixed wastes stored at either facility.

2.1.3 Nonradioactive Waste Management

The Resource Conservation and Recovery Act (RCRA) governs the disposal of solid and hazardous waste. RCRA regulations are contained in Title 40, "Protection of the Environment," Parts 239 through 299 (40 CFR 239, et seq.). Parts 239 through 259 of these regulations cover solid (nonhazardous) waste, and Parts 260 through 279 regulate hazardous waste. RCRA Subtitle C establishes a system for controlling hazardous waste from "cradle to grave," and RCRA Subtitle D encourages States to develop comprehensive plans to manage nonhazardous solid waste and mandates minimum technological standards for municipal solid waste landfills.

RCRA regulations are administered by the NJDEP and address the identification, generation, minimization, transportation, and final treatment, storage, or disposal of hazardous and nonhazardous wastes. Salem and HCGS generate nonradiological waste, including oils, hazardous and nonhazardous solvents and degreasers, laboratory wastes, expired shelf-life chemicals and reagents, asbestos wastes, paints and paint thinners, antifreeze, project-specific wastes, point-source discharges regulated under the National Pollutant Discharge Elimination System (NPDES), sanitary waste (including sewage), and routine and daily refuse (PSEG, 2009a; 2009b).

2.1.3.1 Hazardous Waste

The U.S. Environmental Protection Agency (EPA) classifies certain nonradioactive wastes as "hazardous" based on characteristics, including ignitability, corrosivity, reactivity, or toxicity (identification and listing of hazardous wastes is available in 40 CFR 261). State-level regulators may add wastes to the EPA's list of hazardous wastes. RCRA provides standards for the treatment, storage, and disposal of hazardous waste for hazardous waste generators (40 CFR 262). The Salem and HCGS facilities generate small amounts of hazardous wastes, including spent and expired chemicals, laboratory chemical wastes, and occasional project-specific wastes.

PSEG is currently a small-quantity hazardous waste generator (PSEG, 2010b), generating less than 220 pounds (lb)/month (100 kilograms (kg)/month). Hazardous waste storage (180-day) areas include the hazardous waste storage facility, the combo shop, and two laydown areas east of the combo shop.

Hazardous waste generated at the facility include: F003, F005 (spent non-halogenated solvents), F001, F002 (spent halogenated solvents), D001 (ignitable waste), D002 (corrosive wastes), D003 (reactive wastes), and D004-D011 (toxic [heavy metal] waste) (PSEG, 2008b).

The EPA authorized the State of New Jersey to regulate and oversee most of the solid waste disposal programs, as recognized by Subtitle D of the RCRA. Compliance is assured through State-issued permits. The EPA's Enforcement and Compliance History Online (ECHO) database showed no violations for PSEG (EPA, 2010b).

Proper facility identification numbers for hazardous waste operations include:

- DOT Hazardous Materials Registration No. 061908002018QS
- EPA Hazardous Waste Identification No. NJD 077070811
- NJDEP Hazardous Waste Program ID No. NJD 077070811

Under the Emergency Planning and Community Right-to-Know Act (EPCRA), applicable facilities are required to provide information on hazardous and toxic chemicals to local emergency planning authorities and the EPA (Title 42, Section 11001, of the United States Code [U.S.C.] [42 U.S.C. 11001]). PSEG is subject to Federal EPCRA reporting requirements, and thus submits an annual Section 312 (TIER II) report on hazardous substances to local emergency agencies.

2.1.3.2 Solid Waste

A solid waste is defined by New Jersey Administrative Code (N.J.A.C.) 7:26-1.6 as, "any garbage, refuse, sludge, or any other waste material except it shall not include the following: 1. Source separated food waste collected by livestock producers, approved by the State Department of Agriculture, who collect, prepare and feed such wastes to livestock on their own farms; 2. Recyclable materials that are exempted from regulation pursuant to N.J.A.C. 7:26A; [and] 3. Materials approved for beneficial use or categorically approved for beneficial use pursuant to N.J.A.C. 7:26-1.7(g)." The definition of solid waste in N.J.A.C. 7:26-1.6 applies only to wastes that are not also defined as hazardous in accordance with N.J.A.C. 7:26G.

During the site audit, the Staff observed an active solid waste recycling program. Solid waste ("trash") is segregated and about 55 percent is transferred to recycling vendors (PSEG, 2009a). The remaining volume of solid waste is disposed at a local landfill.

A common sewage treatment system treats domestic wastewater from both facilities. Following treatment, solids (i.e., sludge) are either returned to the system's oxidation ditch or removed to a sludge-holding tank, based upon process requirements. Sludge directed to the sludge-holding tank is aerated and dewatered before being trucked offsite for disposal. During the site audit, the Staff viewed the PSEG sewage sludge waste volumes from 2005 through 2009. The average annual volume for these years was about 50,000 lbs (22,700 kg). Site officials stated that the disposal volume is generally driven by the facilities' budgets.

2.1.3.3 Universal Waste

In accordance with N.J.A.C. 7:26G-4.2, "Universal waste" means any of the following hazardous wastes that are managed under the universal waste requirements of N.J.A.C. 7:26A-7, whether incorporated prospectively by reference from 40 CFR Part 273, "Standards for Universal Waste Management," or listed additionally by the NJDEP: paint waste, batteries, pesticides, thermostats, fluorescent lamps, mercury-containing devices, oil-based finishes, and consumer electronics.

PSEG is a small quantity handler of universal waste (meaning the facility cannot accumulate more than 11,000 lbs (5,000 kg) of universal waste at any one time), generating common operational wastes, such as lighting ballasts containing polychlorinated biphenyls (PCBs), lamps, and batteries. Universal waste is segregated and disposed of through a licensed broker. Routine building space renovations and computer equipment upgrades can lead to substantial short-term increases in universal waste volumes.

2.1.3.4 Permitted Discharges

The Salem facility maintains a New Jersey Pollutant Discharge Elimination System (NJPDES) permit, NJ0005622, which authorizes the discharge of wastewater to the Delaware Estuary and stipulates the conditions of the permit. HCGS maintains a separate NJPDES permit, NJ0025411 for discharges to the Delaware Estuary. All monitoring is conducted in accordance with the NJDEP's "Field Sampling Procedures Manual" applicable at the time of sampling (N.J.A.C. 7:14A-6.5 (b)4), and/or the method approved by the NJDEP in Part IV of the site permits (NJDEP, 2002a).

As discussed previously, a common sewage treatment system treats domestic wastewater from both HCGS and Salem. The sewage treatment system liquid effluent discharges through the HCGS cooling tower blowdown outfall to the Delaware Estuary. The residual cooling tower blowdown dechlorination chemical, ammonium bisulfite, dechlorinates the sewage treatment effluent (PSEG, 2009a; 2009b).

Salem and HCGS share the nonradioactive liquid waste disposal system (NRLWDS) chemical waste treatment system. The NRLWDS is located at the Salem facility and operated by Salem staff. The NRLWDS collects and processes nonradioactive secondary plant wastewater prior to discharge into the Delaware Estuary. The waste water originates during plant processes, such as demineralizer regenerations, steam generator blowdown, chemical handling operations, and reverse osmosis reject waste. The outfall is monitored in accordance with the current HCGS NJPDES Permit No. NJ0025411 (PSEG, 2009a; 2009b).

Oily waste waters are treated at HCGS using an oil water separator. Treated effluent is then discharged through the internal monitoring point, which is combined with cooling tower blowdown before discharge to the Delaware Estuary. The outfall is monitored in accordance with the current HCGS NJPDES Permit No. NJ0025411.

Section 2.1.7 of this report provides more information on the site's NPDES permits and effluent limitations.

2.1.3.5 Pollution Prevention and Waste Minimization

As described in Section 2.1.3.2, PSEG operates an active solid waste recycling program that results in about 55 percent of its "trash" being recycled. PSEG also maintains a discharge prevention and response program. This program incorporates the requirements of the NJDEP, EPA Facility Response Plan, and National Oceanic and Atmospheric Administration (NOAA) Natural Resource Damage Assessment Protocol. Specific documents making up the program include:

- Spill/Discharge Prevention Plan
- Hazardous Waste Contingency Plan
- Spill/Discharge Response Plan
- Environmentally Sensitive Areas Protection Plan

PSEG also maintains the following plans to support pollution prevention and waste minimization:

- Discharge Prevention, Containment, and Countermeasure Plan
- Discharge Cleanup and Removal Plan
- Facility Response Plan
- Spill Prevention, Control, and Countermeasure Plan
- Stormwater Pollution Prevention Plan
- Pollution Minimization Plan for PCBs

2.1.4 Facility Operation and Maintenance

Various types of maintenance activities are performed at the Salem and HCGS facilities, including inspection, testing, and surveillance to maintain the current licensing basis of the facility and to ensure compliance with environmental and safety requirements. Various programs and activities currently exist at Salem and HCGS to maintain, inspect, test, and monitor the performance of facility equipment. These maintenance activities include inspection requirements for reactor vessel materials, boiler and pressure vessel inservice inspection and testing, a maintenance structures monitoring program, and maintenance of water chemistry.

Additional programs include those implemented in response to NRC generic communications; those implemented to meet technical specification surveillance requirements; and various periodic maintenance, testing, and inspection procedures. Certain program activities are performed during the operation of the unit, while others are performed during scheduled refueling outages. Nuclear power plants must periodically discontinue the production of electricity for refueling, periodic inservice inspection, and scheduled maintenance. Salem and HCGS are on an 18-month refueling cycle (PSEG, 2009a; 2009b).

Aging effects at Salem and HCGS are managed by integrated plant assessments required by 10 CFR 54.21. These programs are described in Section 2 of the facilities' Nuclear Generating Station License Renewal Applications – Scoping and Screening Methodology for Identifying Structures and Components Subject to Aging Management Review, and Implementation Results (PSEG, 2009a; 2009b).

2.1.5 Power Transmission System

Three right-of-way (ROW) corridors and five 500-kilovolt (kV) transmission lines connect Salem and HCGS to the regional electric grid, all of which are owned and maintained by Public Service Electric and Gas Company (PSE&G) and Pepco Holdings Inc. (PHI). Each corridor is 350 ft (107 m) wide, with the exception of two-thirds of both the Salem-Red Lion and Red Lion-Keeney lines, which narrow to 200 ft (61 m). Unless otherwise noted, the discussion of the power transmission system is adapted from the applicant's environmental reports (ERs) (PSEG, 2009a; 2009b) or information gathered at the NRC's environmental site audit.

For the operation of Salem, three transmission lines were initially built for the delivery of electricity: two lines connecting to the New Freedom substation near Williamston, NJ (Salem-New Freedom North and Salem-New Freedom South), and one line extending north across the Delaware River terminating at the Keeney substation in Delaware (Salem-Keeney). The Salem New Freedom North and South corridors pass through Salem and Gloucester Counties before terminating at the New Freedom substation in Camden County, New Jersey. The Salem-Keeney corridor originates in Salem County, New Jersey, crosses west across the Delaware River, and terminates at the Keeney substation in New Castle County, Delaware. After construction of HCGS, several changes were made to the existing Salem transmission system, including the disconnection of the Salem-Keeney line from Salem and its reconnection to HCGS, as well as the construction of a new substation (known as Red Lion) along the Salem-Keeney transmission line. The addition of this new substation divided the Salem-Keeney transmission line into two segments: one connecting HCGS to Red Lion and the other connecting Red Lion to Keeney. Consequently, these two segments are now referred to separately as Salem-Red Lion and Red Lion-Keeney. The portion of the Salem-Keeney line located entirely within Delaware, Red Lion-Keeney, is owned and maintained by Pepco (a regulated electric utility that is a subsidiary of PHI).

The construction of HCGS also resulted in the re-routing of the Salem-New Freedom North line and the construction of a new transmission line, HCGS-New Freedom. The Salem-New Freedom North line was disconnected from Salem and re-routed to HCGS, leaving Salem without a northern connection to the New Freedom transmission system. Therefore, a new transmission line was required to connect Salem and the New Freedom substation; this line is known as the HCGS-New Freedom line and it shares a corridor with the Salem-New Freedom

North line. Prior to and following the construction of HCGS, the Salem-New Freedom South line provides a southern-route connection between Salem and the New Freedom substation.

The only new transmission lines constructed as a result of HCGS were the HCGS-New Freedom line, the line connecting HCGS and Salem (tie line), and short reconnections for Salem-New Freedom North and Salem-Keeney. The HCGS-Salem tie line and the short reconnections do not pass beyond the site boundary.

Transmission lines considered in-scope for license renewal are those constructed specifically to connect the facility to the transmission system (10 CFR 51.53(c)(3)(ii)(H)); therefore, the Salem-New Freedom North, Salem-Red Lion, Red Lion-Keeney, Salem-New Freedom South, HCGS-New Freedom, and HCGS-Salem lines are considered in-scope for this supplemental environmental impact statement (SEIS) and are discussed in detail below.

Figure 2-8 illustrates the Salem and HCGS transmission system. The five transmission lines are described below within the designated ROW corridor (see Table 2-1):

2.1.5.1 New Freedom North Right-of-Way

- Salem-New Freedom North – This 500-kV line, which is operated by PSE&G, runs northeast from HCGS for 39 mi (63 km) within a 350-ft (107-m) wide corridor to the New Freedom switching station north of Williamstown, NJ. This line shares the corridor with the 500-kV HCGS-New Freedom line.
- HCGS-New Freedom – This 500-kV line, which is operated by PSE&G, extends northeast from Salem for 43 mi (69 km) within the shared Salem-New Freedom North corridor to the New Freedom switching station, 4 mi (6 km) north-northeast of Williamstown, New Jersey. In 2008, a new substation (Orchard) was constructed along this line. The Orchard substation is located approximately 4 mi (6 km) west of Elmer, a borough in Salem County, New Jersey, and serves to divide the line into two segments, one which runs southwest from Orchard to the site and is approximately 19 mi (31 km) in length, and one that runs northeast from Orchard to the New Freedom substation and is approximately 24 mi (39 km) in length.

2.1.5.2 New Freedom South Right-of-Way

- Salem-New Freedom South – This 500-kV line, which is operated by PSE&G, extends northeast from Salem for 42 mi (68 km) within a 350-ft (107-m) wide corridor from Salem to the New Freedom substation north of Williamstown, NJ. This line runs approximately 2 to 3 mi (3 to 5 km) south of and somewhat parallel to the New Freedom North corridor.

2.1.5.3 Keeney Right-of-Way

- Salem-Red Lion – This 500-kV line extends north from HCGS for 13 mi (21 km) and then crosses over the New Jersey-Delaware State line. It continues west over the Delaware River about 4 mi (6 km) to the Red Lion substation. In New Jersey, the line is operated by PSE&G, and in Delaware it is operated by PHI.

Two thirds of the 17-mi (27-km) corridor is 200 ft (61 m) wide, and the remainder is 350-ft (107-m) wide.

- Red Lion-Keeney – This 500-kV line, which is operated by PHI, extends from the Red Lion substation 8 mi (13 km) northwest to the Keeney switch station. Two thirds of the corridor is 200 ft (61 m) wide, and the remainder is 350-ft (107-m) wide.

The ROW corridors comprise approximately 149 mi (240 km) and 4,376 ac (1,771 ha). Four of the five lines cross within Camden, Gloucester, and Salem counties in New Jersey, with the Keeney line crossing only in Camden county in New Jersey and New Castle County in Delaware. All of the ROW corridors traverse the marshes and wetlands adjacent to the Salem and HCGS sites, including agricultural and forested lands.

All transmission lines were designed and built in accordance with industry standards in place at the time of construction. All transmission lines will remain a permanent part of the transmission system and will be maintained by PSEG and PHI regardless of the Salem and HCGS facilities' continued operation (PSEG, 2009a; 2009b). The HCGS-Salem line, which connects the two substations, would be de-activated if the Salem and HCGS switchyards were no longer in use and would need to be reconnected to the grid if they were to remain in service beyond the operation of Salem and HCGS.

Five 500-kV transmission lines connect electricity from Salem and HCGS to the regional electric transmission system via three ROWs outside of the property boundary. The HCGS-Salem tie-line is approximately 2,000 ft (610 m). This line does not pass beyond the site boundary and is not discussed as an offsite ROW.

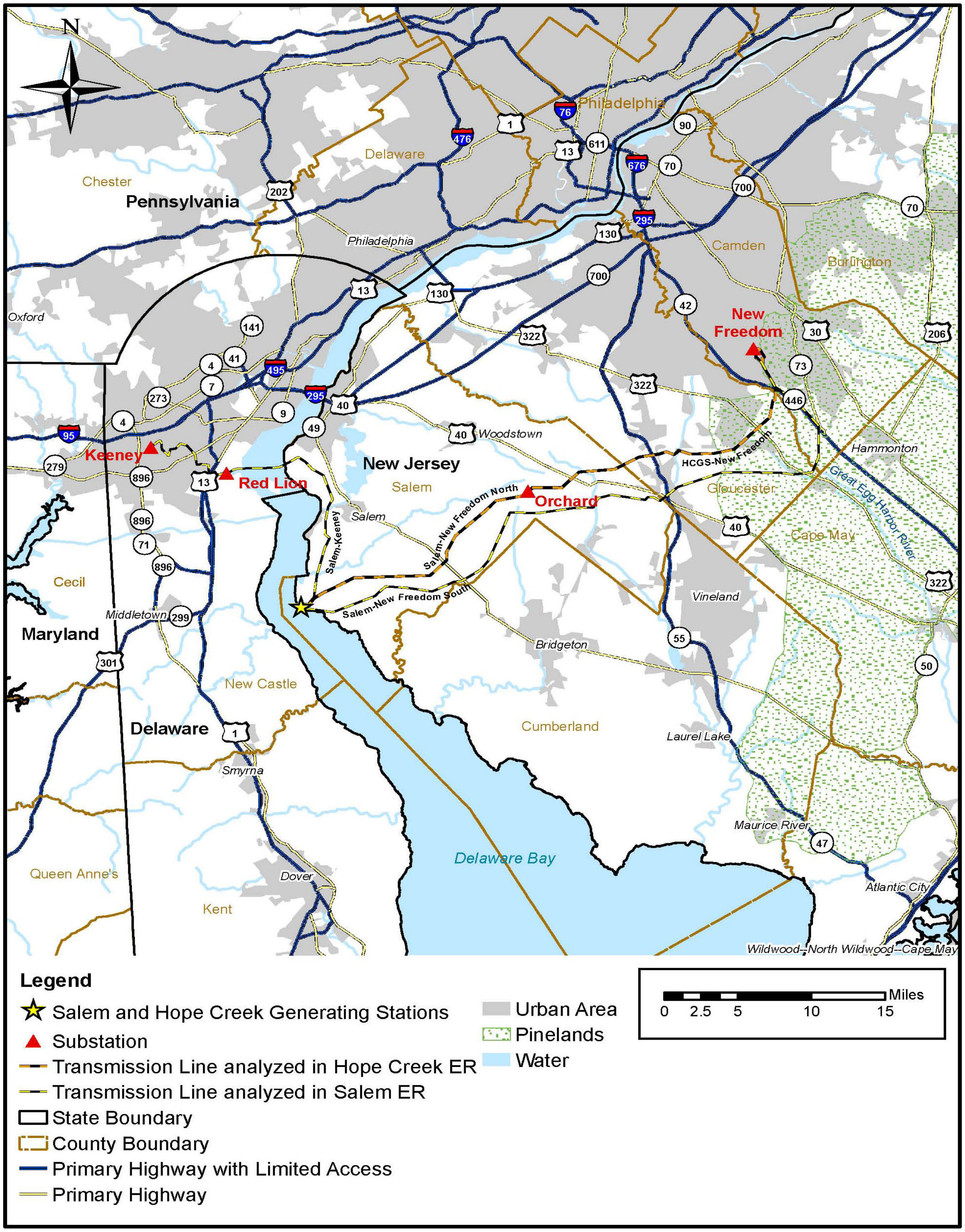


Figure 2-8. Salem Nuclear Generating Station and Hope Creek Generating Station Transmission Line System (Source: PSEG, 2009b)

Table 2-1. Salem Nuclear Generating Station and Hope Creek Generating Station Transmission System Components

	Approximate Length			ROW width	Approximate ROW area
Line	Owner	kV	mi (km)	ft (m)	ac (ha)
New Freedom North ROW					
Salem–New Freedom North	PSE&G	500	39 (63)	350 (107)	1,824 (738)
HCGS–New Freedom	PSE&G	500	43 (69)		
New Freedom South ROW					
Salem–New Freedom South	PSE&G	500	42 (68)	350 (107)	1,782 (721)
Red Lion ROW					
Salem-Red Lion	PSE&G	500	17 (27)	[(a)]200/350 (107)	521 (211)
Red-Lion Keeney	PHI	500	8 (13)	[(a)]200/350 (107)	249 (101)
Total acreage within ROW					**4,376 (1,771)**

(a) two–thirds of the corridor is 200 ft (61 m) wide
Source: PSEG, 2009a; 2009b

2.1.6 Cooling and Auxiliary Water Systems

The Delaware Estuary provides condenser cooling water and service water for both Salem and HCGS (PSEG, 2009a; 2009b). Salem and HCGS use different systems for condenser cooling, but both withdraw from and discharge water to the estuary. Salem Units 1 and 2 use once-through circulating water system (CWS). HCGS uses a closed-cycle system that employs a single natural draft cooling tower. Unless otherwise noted, the discussions below were adapted from the Salem and HCGS ERs (PSEG, 2009a; 2009b) or information gathered at the site audit.

Both sites use groundwater as the source for fresh potable water, fire protection water, industrial process makeup water, and for other sanitary water supplies. Under authorization from the NJDEP (NJDEP, 2004) and Delaware River Basin Commission (DRBC) (DRBC, 2000), PSEG can service both facilities with up to 43.2 million gallons (164,000 cubic meters [m^3]) of groundwater per month.

Discussions on surface water and groundwater use and quality are provided in Section 2.1.7.

2.1.6.1 Salem Nuclear Generating Station

The Salem facility includes two intake structures, one for the coolant water system, and the other for the service water system. Both are equipped with several features to prevent intake of debris and biota into the pumps (PSEG, 2006c):

- Ice Barriers. During the winter, removable ice barriers are installed in front of the intakes to prevent damage to the intake pumps from ice formed on the Delaware Estuary. These barriers consist of pressure-treated wood bars and underlying structural steel braces. The barriers are removed early in the spring and replaced in the late fall.

- Trash Racks. After intake water passes through the ice barriers (if installed), it flows through fixed trash racks. These racks prevent large organisms and debris from entering the pumps. The racks are made from 0.5 inch (1.3 cm) steel bars placed on 3.5-inch (8.9 cm) centers, creating a 3-inch (7.6 cm) clearance between each bar. The racks are inspected by PSEG employees, who remove any debris caught on them with mechanical, mobile, clamshell-type rakes. These trash rakes include a hopper that stores and transports removed debris to a pit at the end of each intake, where it is dewatered by gravity and disposed of off-site.

- Traveling Screens. After the course-grid trash racks, the intake water passes through finer vertical travelling screens. These are modified Ristroph screens designed to remove debris and biota small enough to have passed through the trash racks while minimizing death or injury. The travelling screens have a fine mesh with openings 0.25 inch x 0.5 inch (0.64 cm x 1.3 cm). The velocity through the Salem intake screens is approximately 1 foot per second (fps) (0.3 meters per second [m/s]) at mean low tide.

- Fish Return System. Each panel of the travelling screen has a 10-ft (3 m) long fish bucket attached across the bottom support member. As the travelling screen reaches the top of each rotation, fish and other organisms caught in the fish bucket slide along a horizontal catch screen. As the travelling screen continues to rotate, the bucket is inverted. A low-pressure water spray washes fish off the screen, and they slide through a flap into a two-way fish trough. Debris is then washed off the screen by a high-pressure water spray into a separate debris trough, and the contents of both fish and debris troughs return to the estuary. The troughs are designed so that when the fish and debris are released, the tidal flow tends to carry them away from the intake, reducing the likelihood of re-impingement. Thus, the troughs empty on either the north or south side of the intake structure depending on the direction of tidal flow.

The CWS withdraws brackish water from the Delaware Estuary using 12 circulating water pumps through a 12-bay intake structure located on the shoreline at the south end of the site. Water is discharged north of the CWS intake structure via a pipe that extends 500 ft (152 m) from the shoreline. No biocides are required in the CWS.

PSEG has an NDPDES permit for Salem from the New Jersey Department of Environmental Protection. The permit sets the maximum water usage from the Delaware Estuary to a 30-day average of 3,024 million gallons per day (MGD; 11.4 million m^3/day) of circulating water. The CWS provides approximately 1,050,000 gallons per minute (gpm; 4,000 m^3/min) to each of Salem's two reactor units.

The total design flow is 1,110,000 gpm (4,200 m^3/min) through each unit. The intake velocity is approximately 1 foot per second (fps; 0.3 meters per second [m/s]) (at mean low tide, a rate that is compatible with the protection of aquatic wildlife (EPA 2001). The CWS provides water to the main condenser to condense steam from the turbine and the heated water is returned back to estuary.

The service water system (SWS) intake is located approximately 400 ft (122 m) north of the CWS intake. The SWS intake has four bays, each containing three pumps. The 12 service-water pumps have a total design rating of 130,500 gpm (494 m^3/min). The average velocity throughout the SWS intake is less than 1 fps (0.3 m/s) at the design flow rate. The SWS intake structure is equipped with trash racks, traveling screens, and filters to remove debris and biota from the intake water stream, but do not have a modified Ristroph type travelling screen or fish return system. Backwash water is returned to the estuary.

To prevent organic buildup and biofouling in the heat exchangers and piping of the SWS, sodium hypochlorite was originally injected into the system. However, operational experience indicated that use of sodium hypochlorite was not needed, so it is no longer injected. SWS water is discharged via the discharge pipe shared with the CWS. Residual chlorine levels are maintained in accordance with the site's NJPDES Permit.

Both the Salem CWS and SWS discharge water back to the Delaware Estuary through a single return that serves both systems and is located between the Salem CWS and SWS intakes. The plan view of the Salem discharge structures is included as Figure 2-10. Cooling water from Salem is discharged through six adjacent pipes 7 ft (2 m) in diameter and spaced 15 ft (4.6 m) apart on center that merge into three pipes 10 ft (3 m) in diameter (PSEG, 2006c). The discharge piping extends approximately 500 ft (150 m) from the shore (PSEG, 1999). The discharge pipes are buried for most of their length until they discharge horizontally into the water of the estuary at a depth at mean tidal level of about 31 ft (9.5 m). The discharge is approximately perpendicular to the prevailing currents. At full power, Salem is designed to discharge approximately 3,200 MGD (12 million m^3/day) at a velocity of about 10 fps (3 m/s) (PSEG, 1999). To prevent biofouling in the heat exchangers and piping of the SWS, sodium hypochlorite is injected into the system. SWS water is discharged via the discharge pipe shared with the CWS.

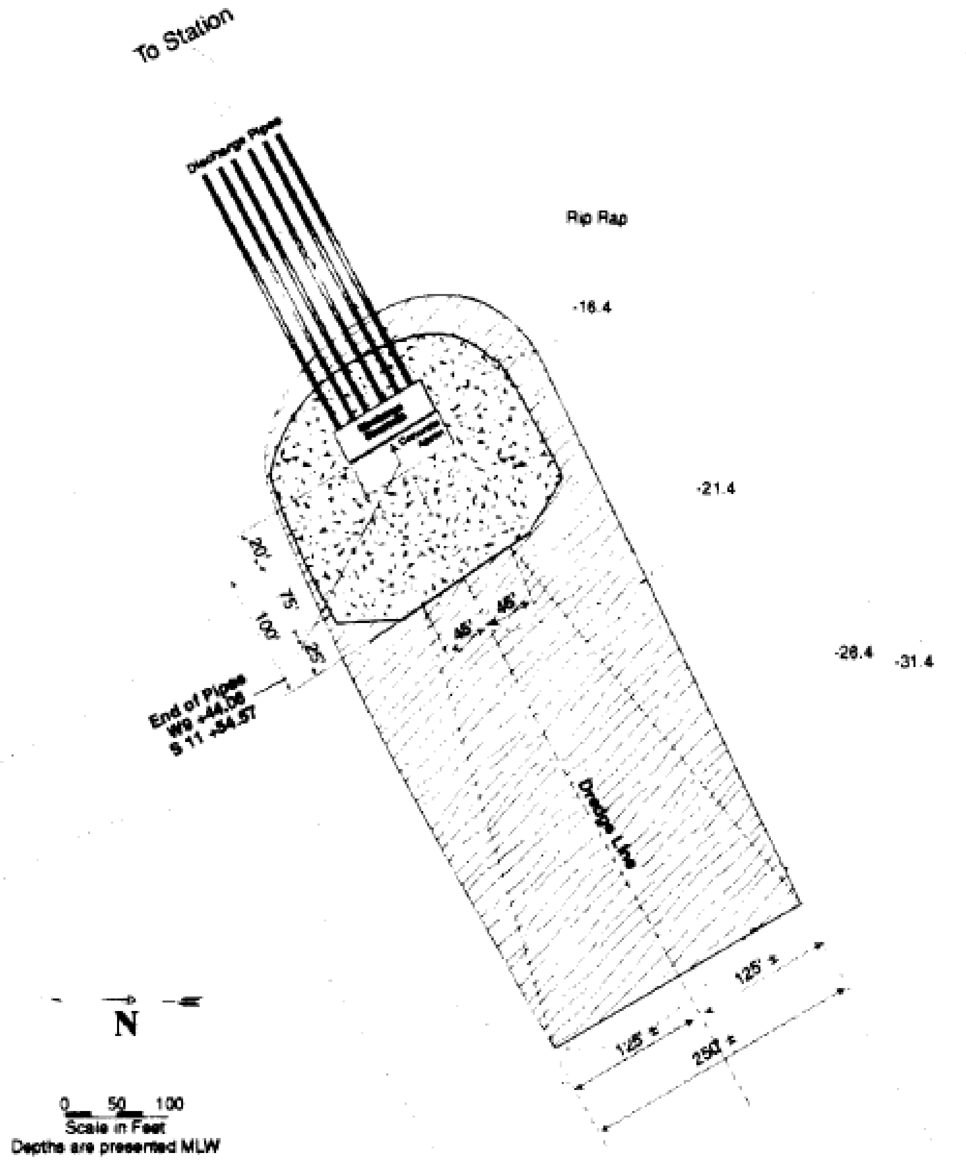


Figure 2-10. Plan View of Salem discharge pipes (Source: PSEG, 1999).

2.1.6.2 Hope Creek Generating Station

HCGS uses a single intake structure to supply water from the Delaware Estuary to the SWS. The intake structure consists of four active bays that are equipped with pumps and associated equipment (trash racks, traveling screens, and a fish-return system) and four empty bays that were originally intended to service a second reactor which was never built. Water is drawn into the SWS through trash racks and passes through the traveling screens at a maximum velocity of 0.35 fps (0.11 m/s). The openings in the wire mesh of the screens are 0.375 inches (0.95

cm) square. After passing through the traveling screens, the estuary water enters the service water pumps. Depending on the temperature of the Delaware Estuary water, two or three pumps are normally needed to supply service water. Each pump is rated at 16,500 gpm (62 m^3/min). To prevent organic buildup and biofouling in the heat exchangers and piping of the SWS, sodium hypochlorite is continuously injected into the system.

Water is them pumped into the stilling basin in the pump house. The stilling basin supplies water to the general SWS and the fire protection system. The stilling basin also supplies water for back-up residual heat removal service water and for emergency service water.

The SWS also provides makeup water for the CWS by supplying water to the cooling tower basin. The cooling tower basin contains approximately 9 million gallons (34,000 m^3) of water and provides approximately 612,000 gpm (2,300 m^3/min) of water to the CWS via four pumps. The CWS provides water to the main condenser to condense steam from the turbine and the heated water is returned back to Estuary (Figure 2-4).

The cooling tower blowdown and other facility effluents are discharged to the estuary through an underwater conduit located 1,500 ft (460 m) upstream of the HCGS SWS intake. The HCGS discharge pipe extends 10 ft (3.0 m) offshore and is situated at mean tide level. The discharge from HCGS is regulated under the terms of NJPDES permit number NJ0025411 (NJDEP, 2001a).

The HCGS cooling tower is a 512-foot (156-meter) high single counterflow, hyperbolic, natural draft cooling tower (PSEG, 2008a). While the CWS is a closed-cycle system, water is lost due to evaporation. Monthly losses average from 9,600 gpm (36 m^3/min) in January to 13,000 gpm (49 m^3/min) in July. Makeup water is provided by the SWS.

2.1.7 Facility Water Use and Quality

The Salem and HCGS facilities rely on the Delaware River as their source of makeup water for its cooling system, and they discharge various waste flows to the river. An onsite well system provides groundwater for other site needs. A description of groundwater resources at the facility location is provided in Section 2.2.8, and a description of the surface water resources is presented in Section 2.2.9. The following sections describe the water use from these resources.

2.1.7.1 Groundwater Use

The Salem and HCGS facilities access groundwater through production wells to supply fresh water for potable, industrial process makeup, fire protection, and sanitary purposes (PSEG, 2009a; 2009b). Facility groundwater withdrawal is authorized by the NJDEP and the Delaware River Basin Comission (DRBC). The total authorized withdrawal volume is 43.2 million gallons (164,000 m^3) per month for both the Salem and HCGS sites combined (NJDEP, 2004; DRBC, 2000). Although each facility has its own wells and individual pumping limits, the systems are interconnected so that water can be transferred between the facilities, if necessary (PSEG, 2009a; 2009b). The NJDEP permit is a single permit which establishes a combined permitted limit for both facilities of 43.2 million gallons (164,000 m^3) per month (NJDEP, 2004).

The groundwater for Salem is produced primarily from two wells, PW-5 and PW-6. PW-5 is installed at a depth of 840 ft (256 m) below ground surface (bgs) in the Upper Raritan Formation, and PW-6 is installed at a depth of 1,140 ft (347 m) in the Middle Raritan Formation. PW-5 has a capacity of 800 gpm (3 m^3/min), and PW-6 has a capacity of 600 gpm (2.3 m^3/min) (DRBC, 2000). The average water withdrawal from these two wells between 2002 and 2008 was 11.4 million gallons (432,000 m^3) per year (TetraTech, 2009). These wells are used to maintain water volume within two 350,000 gallon (1,300 m^3) storage tanks, of which 600,000 gallons (2,300 m^3) is reserved for fire protection (PSEG, 2009a). In addition to these two primary wells, two additional wells, PW-2 and PW-3, exist at Salem. These wells are installed within the Mount Laurel-Wenonah aquifer at depths of about 290 ft (88 m) bgs (DRBC, 2000). These wells are classified as standby wells by NJDEP (NJDEP, 2004), and had only minor usage in the period from 2002 to 2008 (TetraTech, 2009).

The groundwater for HCGS is produced from two production wells, HC-1 and HC-2, which are installed at depths of 816 ft (249 m) bgs in the Upper Potomac-Raritan-Magothy aquifer (DRBC, 2000). Each well has a pumping capacity of 750 gpm (2.8 m^3/min), and the average water withdrawal from the two wells between 2002 and 2008 was 96 million gallons (363,000 m^3) per year (TetraTech, 2009). The wells are used to maintain water supply within two 350,000 gallon (1,300 m^3) storage tanks. The bulk of the water in the storage tanks (656,000 gallons [2,500 m^3]) is reserved for fire protection, and the remainder is used for potable, sanitary, and industrial uses (PSEG, 2009b).

Overall, the combined water usage for the two facilities has averaged 210 million gallons (795,000 m^3) per year, or 17.5 million gallons (66,000 m^3) per month (TetraTech, 2009). This usage is approximately 41 percent of the withdrawal permitted under the DRBC authorization and NJDEP permit (DRBC, 2000; NJDEP, 2004).

2.1.7.2 Surface Water Use

Salem and HCGS are located on the eastern shore of the Delaware River, approximately 18 mi (29 km) south of the Delaware Memorial Bridge. The Delaware River at the facility location is an estuary approximately 2.5 mi (4 km) wide. The Delaware River is the source of condenser cooling water and service water for both the Salem and HCGS facilities (PSEG, 2009a; 2009b).

The Salem units are both once-through circulating water systems that withdraw brackish water from the Delaware River through a single CWS intake located at the shoreline on the southern end of Artificial Island. The CWS intake structure consists of 12 bays, each outfitted with removable ice barriers, trash racks, traveling screens, circulating water pumps, and a fish return system. The pump capacity of the Salem CWS is 1,110,000 gpm (4,200 m^3/min) for each unit, or a total of 2,220,000 gpm (8,400 m^3/min) for both units combined. Although the initial design included use of sodium hypochlorite biocides, these were eliminated once enough operational experience was gained to indicate that they were not needed. Therefore, the CWS water is used without treatment (PSEG, 2009a).

In addition to the CWS intake, the Salem units withdraw water from the Delaware River for the SWS, which provides cooling for auxiliary and reactor safeguard systems. The Salem SWS is supplied through a single intake structure located approximately 400 ft (122 m) north of the CWS intake. The Salem SWS intake is also fitted with trash racks, traveling screens, and fish-return troughs. The pump capacity of the Salem SWS is 65,250 gpm (247 m^3/min) for each unit, or a total of 130,500 gpm (494 m^3/min) for both units combined (PSEG, 2009a).

The withdrawal of Delaware River water for the Salem CWS and SWS systems is regulated under the terms of Salem NJPDES Permit No. NJ005622 and is also authorized by the DRBC. The NJPDES permit limits the total withdrawal of Delaware River water to 3,024 MGD (11.4 million m^3/day), for a monthly maximum of 90,720 million gallons (342 million m^3) (NJDEP, 2001a). The DRBC authorization allows withdrawals not to exceed 97,000 million gallons (367 million m^3/day) in a single 30-day period (DRBC, 1977; 2001). The withdrawal volumes are reported to NJDEP through monthly discharge monitoring reports (DMRs), and copies of the DMRs are submitted to DRBC.

Both the CWS and SWS at Salem discharge water back to the Delaware River through a single return that serves both systems. The discharge location is situated between the CWS and Salem SWS intakes, and consists of six separate discharge pipes; each extending 500 ft (152 m) into the river and discharging water at a depth of 35 ft (11 m) below mean tide. The pipes rest on the river bottom with a concrete apron at the end to control erosion and discharge water at a velocity of 10.5 fps (3.2 m/s) (PSEG, 2006c). The discharge from Salem is regulated under the terms of NJPDES Permit No. NJ005622 (NJDEP, 2001a). The locations of the intakes and discharge for the Salem facility are shown in Figure 2-3.

The HCGS facility uses a closed-cycle circulating water system, with a natural draft cooling tower, for condenser cooling. Like Salem, HCGS withdraws water from the Delaware River to supply a SWS, which cools auxiliary and other heat exchange systems. The outflow from the HCGS SWS is directed to the cooling tower basin, and serves as makeup water to replace water lost through evaporation and blowdown from the cooling tower. The HCGS SWS intake is located on the shore of the river and consists of four separate bays with service water pumps, trash racks, traveling screens, and fish-return systems. The structure includes an additional four bays that were originally intended to serve a second HCGS unit, which was never constructed. The pump capacity of the HCGS SWS is 16,500 gpm (62 m^3/min) for each pump, or a total of 66,000 gpm (250 m^3/min) when all four pumps are operating. Under normal conditions, only two or three of the pumps are typically operated. The HCGS SWS water is treated with sodium hypochlorite to prevent biofouling (PSEG, 2009b).

The discharge from the HCGS SWS is directed to the cooling tower basin, where it acts as makeup water for the HCGS CWS. The natural draft cooling tower has a total capacity of 9 million gallons (34,000 m^3) of water, and circulates water through the CWS at a rate of 612,000 gpm (2,300 m^3/min). Water is removed from the HCGS CWS through both evaporative loss from the cooling tower and from blowdown to control deposition of solids within the system. Evaporative losses result in consumptive loss of water from the Delaware River. The volume of evaporative losses vary throughout the year depending on the climate, but range from approximately 9,600 gpm (36 m^3/min) in January to 13,000 gpm (49 m^3/min) in July. Blowdown water is returned to the Delaware River (NJDEP, 2002b).

The withdrawal of Delaware River water for the HCGS CWS and SWS systems is regulated under the terms of HCGS NJPDES Permit No. NJ0025411 and is also authorized by the DRBC. Although it requires measurement and reporting, the NJPDES permit does not specify limits on the total withdrawal volume of Delaware River water for HCGS operations (NJDEP, 2003). Actual withdrawals average 66.8 MGD (253,000 m^3/day), of which 6.7 MGD (25,000 m^3/day) are returned as screen backwash, and 13 MGD (49,000 m^3/day) is evaporated. The remainder (approximately 46 MGD [174,000 m^3/day]) is discharged back to the river (PSEG, 2009b).

The HCGS DRBC contract allows withdrawals up to 16.998 billion gallons (64 million m^3) per year, including up to 4.086 billion gallons (15 million m^3) of consumptive use (DRBC, 1984a; 1984b). To compensate for evaporative losses in the system, the DRBC authorization requires releases from storage reservoirs, or reductions in withdrawal, during periods of low-flow conditions at Trenton, NJ (DRBC, 2001). To accomplish this, PSEG is one of several utilities which owns and operates the Merrill Creek reservoir in Washington, NJ. Merrill Creek reservoir is used to release water during low-flow conditions, as required by the DRBC authorization (PSEG, 2009b).

The SWS and cooling tower blowdown water from HCGS is discharged back to the Delaware River through an underwater conduit located 1,500 ft (460 m) upstream of the HCGS SWS intake. The HCGS discharge pipe extends 10 ft (3 m) offshore, and is situated at mean tide level. The discharge from HCGS is regulated under the terms of NJPDES Permit No. NJ0025411 (NJDEP, 2001a). The locations of the intake and discharge for the HCGS facility are shown in Figure 2-4.

2.2 Affected Environment

This section provides general descriptions of the environment near Salem and HCGS as background information and to support the analysis of potential environmental impacts in Chapter 4.

2.2.1 Land Use

Salem and HCGS are located at the southern end of Artificial Island located on the east bank of the Delaware River in Lower Alloways Creek Township, Salem County, New Jersey. The river is approximately 2.5 mi (4 km) wide at this location. Artificial Island is a man-made island approximately 1500-ac (600 ha) in size consisting of tidal marsh and grassland. The island was created by the U.S. Army Corps of Engineers (USACE), beginning early in the twentieth century, by the deposition of hydraulic dredge spoil material atop a natural sand bar that projected into the river. The average elevation of the island is about 9 ft (3 m) above MSL with a maximum elevation of approximately 18 ft (5.5 m) MSL (AEC, 1973). The site is located approximately 17 mi (27 km) south of the Delaware Memorial Bridge, 35 mi (56 km) southwest of Philadelphia, Pennsylvania, and 8 mi (13 km) southwest of the City of Salem, NJ.

PSEG owns approximately 740 ac (300 ha) at the southern end of the island, with Salem located on approximately 220 ac (89 ha) and HCGS occupying about 153 ac (62 ha). The remainder of Artificial Island, north of the PSEG property, is owned by the the U.S. Government and the State of New Jersey; this portion of the island remains undeveloped. The land adjacent to the eastern boundary of Artificial Island consists of tidal marshlands of the former natural shoreline. The U.S. Government owns the land adjacent to the PSEG property and the State of New Jersey owns the land adjacent to the U.S. Government-owned portion of the island. The northernmost tip of Artificial Island (owned by the U. S. Government) is within the State of Delaware boundary, which was established based on historical land grants (LACT, 1988a; 1988b; PSEG, 2009a; 2009b).

The area within 15 mi (24 km) of the site is primarily utilized for agriculture. The area also includes numerous parks and wildlife refuges and preserves such as Mad Horse Creek Fish and Wildlife Management Area to the east; Cedar Swamp State Wildlife Management Area to the south in Delaware; Appoquinimink, Silver Run, and Augustine State Wildlife Management areas to the west in Delaware; and Supawna Meadows National Wildlife Refuge to the north. The Delaware Bay and estuary is recognized as wetlands of international importance and an international shorebird reserve (NJSA, 2008). The nearest permanent residences are located 3.4 mi (5.5 km) south-southwest and west-northwest of Salem and HCGS across the river in Delaware. The nearest permanent residence in New Jersey is located 3.6 mi (5.8 km) east-northeast of the facilities (PSEG, 2009c). The closest densely populated center (with 25,000 residents or more) is Wilmington, Delaware, located 15 mi (24 km) north of Salem and HCGS. There is no heavy industry in the area surrounding Salem and HCGS; the nearest such industrial area is located approximately 10 mi (16 km) northwest of the site near Delaware City, Delaware (PSEG, 2009d).

Section 307(c)(3)(A) of the Coastal Zone Management Act (16 USC 1456 (c)(3)(A)) requires that applicants for Federal licenses to conduct an activity in a coastal zone provide to the licensing agency a certification that the proposed activity is consistent with the enforceable policies of the State's coastal zone program. A copy of the certification is also to be provided to the State. Within six months of receipt of the certification, the State is to notify the Federal agency whether the State concurs with or objects to the applicant's certification. Salem and HCGS are within New Jersey's coastal zone for purposes of the Coastal Zone Management Act. PSEG's certifications that renewal of the Salem and HCGS licenses would be consistent with the New Jersey Coastal Management Program were submitted to the NJDEP Land Use Regulation Program concurrent with submittal of the license renewal applications for the two facilities. Salem and HCGS are not within Delaware's coastal zone for purposes of the Coastal Zone Management Act (PSEG, 2009a; 2009b). Correspondence related to the certification is in Appendix D of this SEIS. By letters dated October 8, 2009, the NJDEP Division of Land Use Regulation, Bureau of Coastal Regulation concurred with the applicant's consistency of certification for Salem and HCGS.

2.2.2 Air Quality and Meteorology

2.2.2.1 Meteorology

The climate in New Jersey is generally a function of topography and distance from the Atlantic Ocean, resulting in five distinct climatic regions within the State. Salem County is located in the Southwest Zone, which is characterized by low elevation near sea level and close proximity to the Delaware Bay. These features result in the Southwest Zone generally having higher temperatures and receiving less precipitation than the northern and coastal areas of the State. Wind direction is predominantly from the southwest, except in winter when winds are primarily from the west and northwest (NOAA, 2008).

The only NOAA weather station in Salem County with recent data is the Woodstown Pittsgrove Station, located approximately 10 mi (16 km) northeast of the Salem and NCGS facilities (NOAA, 2010a). A summary of the data collected from this station from 1971 to 2001 indicates that winter temperatures average 35.2 degrees Fahrenheit (°F) (1.8 degrees Celsius [°C]) and summer temperatures average 74.8 °F (23.8 °C). Average annual precipitation in the form of rain and snow is 45.76 inches (116 cm), with the most rain falling in July and August and the most snow falling in January (NOAA, 2004).

Queries of the National Climate Data Center database for Salem County for the period January 1, 1950 to November 30, 2009 identified the following information related to severe weather events:

- 33 flood events with the majority (24) being coastal or tidal floods
- numerous heavy precipitation and prolonged rain events which also resulted in several incidences of localized flooding, but which are not included in the flood event number
- five funnel cloud sightings and two tornados ranging in intensity from F1 to F2
- 148 thunderstorm and high wind events
- 14 incidences of hail greater than 0.75 inches (1.9 cm) (NOAA, 2010b)

In 2001, unusually dry conditions were related to two wildfires that burned a total of 54 ac (22 ha). In 2009, a series of brush fires destroyed approximately 15 ac (6.1 ha) of farmland and wooded area in Salem County (NOAA, 2010c).

Climate data are available for the Woodstown Pittsgrove Station from 1901 through 2004, at which time monitoring at this location was ended (NOAA, 2010a). The closest facility which currently monitors climate data, and has an extensive historic record, is the station located at the Wilmington New Castle County Airport, located on the opposite side of the Delaware River, approximately 9 mi (14 km) northwest of the facilities (NOAA, 2010d).

2.2.2.2 Air Quality

Salem County is included in the Metropolitan Philadelphia Interstate Air Quality Control Region (AQCR), which encompasses the area geographically located in five counties of New Jersey, including Salem and Gloucester counties; New Castle County, DE; and five counties of Pennsylvania (40 CFR 81.15). Air quality is regulated by the NJDEP through their Bureau of Air Quality Planning, Bureau of Air Quality Monitoring, and Bureau of Air Quality Permitting (NJDEP, 2009a). The Bureau of Air Quality Monitoring operates a network of monitoring stations for the collection and analysis of air samples for several parameters, including carbon monoxide (CO), nitrogen dioxide (NO_2), ozone, sulfur dioxide (SO_2), particulate matter (PM), and meteorological characteristics. The closest air quality monitoring station to the Salem and HCGS facilities is in Millville, located approximately 23 mi (37 km) to the southeast (NJDEP, 2009a).

In order to enforce air quality standards, the EPA has developed National Ambient Air Quality Standards (NAAQS) under the Federal Clean Air Act. The requirements examine the six criteria pollutants, including particle pollution (PM), ground-level ozone, CO, sulfur oxides (SOx), nitrogen oxides (NOx), and lead; permissible limits are established based on human health and/or environmental protection. When an area has air quality equal to or better than the NAAQS, they are designated as an “attainment area” as defined by the EPA; however, areas that do not meet the NAAQS standards are considered “nonattainment areas” and are required to develop an air quality maintenance plan (NJDEP, 2010a).

Salem County is designated as in attainment/unclassified with respect to the NAAQSs for particulate matter, 2.5 microns or less in diameter ($PM_{2.5}$), SOx, NOx, CO, and lead. The county, along with all of southern New Jersey, is a nonattainment area with respect to the 1-hour primary ozone standard and the 8-hour ozone standard. For the 1-hour ozone standard, Salem County is located within the multi-state Philadelphia-Wilmington-Trenton non-attainment area, and for the 8-hour ozone standard, it is located in the Philadelphia-Wilmington-Atlantic City (Pennsylvania-New Jersey-Delaware-Maryland) non-attainment area. Of the adjacent counties, Gloucester County, NJ is in non-attainment for the 1-hour and 8-hour ozone standards, as well as the annual and daily $PM_{2.5}$ standard (NJDEP, 2010a). New Castle County, DE is considered to be in moderate non-attainment for the ozone standards and non-attainment for $PM_{2.5}$ (40 CFR 81.315).

Sections 101(b)(1), 110, 169(a)(2), and 301(a) of the Clean Air Act (CAA), as amended (42 U.S.C. 7410, 7491(a)(2), 7601(a)), established 156 mandatory Class I Federal areas where visibility is an important value that cannot be compromised. There is one mandatory Class I Federal area in the State of New Jersey, which is the Brigantine National Wildlife Refuge (40 CFR 81.420), located approximately 58 mi (93 km) southeast of the Salem and HCGS facilities. There are no Class I Federal areas in Delaware, and no other areas located within 100 mi (160 km) of the facilities (40 CFR 81.400).

PSEG has a single Air Pollution Control Operating Permit (Title V Operating Permit), No. BOP080001, from the NJDEP to regulate air emissions from all sources at Salem and HCGS (PSEG, 2009a; 2009b). This permit was last issued on February 2, 2005, and expired on February 1, 2010. PSES was required to submit an application for renewal no later than February 2009. An application for a new Title V permit was submitted in October 2008 and the EPA review was scheduled to begin on May 20, 2010 (EPA, 2010a). The expired permit remains in effect until the new permit is approved and issued. The facilities qualify as a major source[1] under the Title V permit program and, therefore, are operated under a Title V permit (NJDEP, 2009b). The air emissions sources regulated by permit and located at Salem, include:

- a boiler for heating purposes
- Salem Unit 3, a 40 MW fuel-oil fired peaking unit used intermittently
- six emergency generators, tested monthly
- a boiler at the circulating water house, used for heating only in winter
- miscellaneous volatile organic compounds (VOC) emissions from fuel tanks

[1] Under the Title V Operating Permit program, the EPA defines a major source as a stationary source with the potential to emit (PTE) any criteria pollutant at a rate greater than 100 tons/year (91 metric tons [MT]/year), or any single hazardous air pollutant (HAP) at a rate of greater than 10 tons/year (9.1 MT/year)or a combination of HAPs at a rate greater than 25 tons/year (23 MT/year).

The air emissions sources located at HCGS, which are regulated under the permit, include:

- the cooling tower
- a boiler for house heating and use for startup steam for the BWR
- four emergency generators, tested monthly
- miscellaneous VOC emissions from fuel tanks
- a small boiler used to heat the service water house

Meteorological conditions at the facilities are monitored at a primary and a backup meteorological tower located at the entrance of the facilities, on the southeast side of the property. The primary tower is a 300-ft (91-m) high tower supported by guy wires, and the backup tower is a 33-ft (10-m) high telephone pole located approximately 500 ft (152 m) south of the primary tower. Measurements collected at the primary tower include temperature, wind speed, and wind direction at elevations of 300, 150, and 33 ft (91, 46, and 10 m) above ground level; dew point measured at the 33-ft (10-m) level; and rainfall, barometric pressure, and solar radiation measured at less than 10 ft (3 m) above the ground surface. Measurements collected at the backup tower include wind speed and wind direction (PSEG, 2006b).

2.2.3 Groundwater Resources

2.2.3.1 Description

Groundwater at the Salem and HCGS facilities is present in Coastal Plain sediments, an assemblage of sand, silt, and clay formations that comprise a series of aquifers beneath the facilities. Four primary aquifers underlie the facility location. The shallowest of these is the shallow water-bearing zone, which is contained within the dredge spoil and engineered fill sediments of Artificial Island. Groundwater is found within this zone at a depth of 10 to 40 ft (3 to 12 m) below ground surface (bgs) (PSEG, 2007a). The groundwater in the shallow zone is recharged through direct infiltration of precipitation on Artificial Island and is brackish. Groundwater in the shallow zone flows toward the southwest, toward the Delaware River (PSEG, 2009b).

Beneath the shallow water-bearing zone, the Vincentown Aquifer is found at a depth of 55 to 135 ft (17 to 41 m) bgs. The aquifer is confined and semi-confined beneath Miocene clays of the Kirkwood Formation. Groundwater within the Vincentown Aquifer flows toward the south. Water within the Vincentown Aquifer is potable and accessed through domestic wells in eastern Salem County, upgradient of the facility. In western Salem County, including near the facility, saltwater intrusion from the Delaware River has occurred, resulting in brackish, non-potable groundwater within this aquifer (PSEG, 2007a).

The Vincentown Aquifer is underlain by the Hornerstown and Navesink confining units, which in turn overlie the Mount Laurel-Wenonah Aquifer. The Mount Laurel-Wenonah Aquifer exists at a depth of 170 to 270 ft (52 to 82 m) bgs and is recharged through leakage from the overlying aquifers (Rosenau et al., 1969).

Beneath the Mount Laurel-Wenonah Aquifer is a series of clay and fine sand confining units and poor quality aquifers, including the Marshalltown Formation, Englishtown Formation, Woodbury Clay, and Merchantville Formation. These units overlie the Potomac-Raritan-Magothy (PRM)

Aquifer, which is found at a depth of 450 ft (137 m), with freshwater encountered to a depth of 900 ft (274 m) bgs at the facility location (PSEG, 2007a). The PRM Aquifer is a large aquifer of regional importance for municipal and domestic water supply. In order to protect groundwater resources within this aquifer, the State of New Jersey has established Critical Water-Supply Management Area 2, in which groundwater withdrawals are limited and managed through allocations (USGS, 2007). Critical Water-Supply Management Area 2 includes Ocean, Burlington, Camden, Atlantic, Gloucester, and Cumberland counties, as well as the eastern portion of Salem County. The area does not include the western portion of Salem County where the facility is located, so groundwater withdrawals at the facility location are not subject to withdrawal restrictions associated with this management area.

2.2.3.2 Affected Users

The use of groundwater by the facility is discussed in Section 2.1.7.1. Groundwater is the source of more than 75 percent of the freshwater supply within the Coastal Plain region, and wells used for public supply commonly yield 500 to more than 1,000 gpm (1.9 to 3.8 m^3/min) (EPA, 1988). The water may have localized concentrations of iron in excess of 460 miligrams per liter (mg/L) and may be contaminated locally by saltwater intrusion and waste disposal; however, water quality is considered satisfactory overall (NJWSC, 2009).

Groundwater is not accessed for public or domestic water supply within 1 mi (1.6 km) of the Salem and HCGS facilities (PSEG, 2009a; 2009b). However, groundwater is the primary source of municipal water supply within Salem and the surrounding counties. There are 18 public water supply systems in Salem County. New Jersey American Water (NJAW) is the largest of these, providing groundwater from the PRM Aquifer to more than 14,000 customers in Pennsgrove, located approximately 18 mi (29 km) north of the Salem and HCGS facilities (EPA, 2010e; NJAW, 2010). The other two major suppliers are Pennsville Township and the City of Salem (EPA, 2010e). The City of Salem is the closest public water supply system in Salem County to the facilities, but provides water from surface water sources (EPA, 2010e). The Pennsville Township water system is located approximately 15 mi (24 km) north of the Salem and HCGS facilities and supplies water to approximately 13,500 residents from the PRM Aquifer (EPA, 2010e; NJDEP, 2007).

There are 27 water systems in New Castle County, Delaware. Municipal and investor-owned utilities provide drinking water to the county. The majority of the potable water supply is provided from surface water sources (EPA, 2010e). The nearest offsite use of groundwater for potable water supply is located approximately 3.5 mi (5.6 km) west of the site, in New Castle County, Delaware (Arcadis, 2006). This water supply consists of two wells installed within the Mt. Laurel aquifer, serving 132 residents (DNREC, 2003).

2.2.3.3 Available Volume

Groundwater within the PRM Aquifer is an important resource for water supply in a region extending from Mercer and Middlesex counties in New Jersey to the north, and toward Maryland to the southwest. Groundwater withdrawal from the early part of the 20th century through the 1970s resulted in the development of large-scale cones of depression in the elevation of the piezometric surface and, therefore, the available water quantity within the aquifer (Walker, 1983). Large scale withdrawals of water from the aquifer are known to influence water availability at significant lateral distances from pumping centers (Walker, 1983). In reaction to these observations, water management measures, including limitations on pumping, were instituted by the NJDEP (although not including the Salem and HCGS facility area). As of 2003, NJDEP-mandated decreases in water withdrawals had resulted in general recovery of water level elevations in both the Upper and Middle PRM aquifers in the Salem County area (DePaul et al., 2009).

2.2.3.4 Existing Quality

Annual REMP reports document regular sampling of groundwater as required by the NRC. In support of this SEIS, the annual REMP reports for 2006, 2007, and 2008 were reviewed (PSEG, 2007b; 2008a; 2009c). The program includes the collection and analysis of groundwater at one or two locations that may be affected by station operations. Although the facility has determined that there are no groundwater wells in locations that could be affected by station operations, they routinely collect a sample from one location, well 3E1 at a nearby farm, as a management audit sample. These samples, collected on a monthly basis, are analyzed for gamma emitters, gross alpha, gross beta, and tritium. In 2006 through 2008, no results were identified which would suggest potential impacts from facility operations.

In 2003, a release of tritium to groundwater from the Salem Unit 1 SFP was identified. The release was caused from the blockage of drains by mineral deposits. Response measures, including removal of the mineral deposits and installation of additional drains, were taken and the release was stopped (Arcadis, 2006).

A site investigation was initiated in 2003, and included the installation and sampling of 29 monitoring wells in the shallow and Vincentown aquifers (PSEG, 2004a). The tritium was released into groundwater inside of the cofferdam area that surrounds the Salem containment unit. Groundwater within the cofferdam area is able to flow outside of the cofferdam through a low spot in the top surface, which allowed the tritium plume to enter the flow system outside of the cofferdam. From that location, the plume followed a preferential flow path along the high permeability sand and gravel bed beneath the circulating water discharge pipe and, thus, toward the Delaware River. Tritium was detected in shallow groundwater at concentrations up to 15,000,000 picoCuries per liter (pCi/L). The extent of the impact was limited to within the PSEG property boundaries and no tritium was detected in the Vincentown aquifer, indicating that the release was limited to the shallow water-bearing aquifer (PSEG, 2009d). The release did not include any radionuclides other than tritium.

In 2004, PSEG developed a remedial action workplan, and a GRS was approved by NJDEP and became operational by September 2005. The GRS operates by withdrawing tritium-impacted groundwater from six pumping wells within the plume, and a mobile pumping unit that can be moved between other wells as needed to maximize withdrawal efficiency. The pumping system reverses the groundwater flow gradient and stops the migration of the plume toward the property boundaries. The tritium-impacted water removed from the groundwater is processed in the facility's NRLWDS. As part of this system, the groundwater is collected in tanks, sampled, and analyzed to identify the quantity of radioactivity and the isotopic breakdown. Upon verification that the groundwater meets NRC discharge requirements, it is released under controlled conditions to the Delaware River through the circulatory water system

(PSEG, 2009a). Operation of the groundwater extraction system is monitored by a network of 36 monitoring wells (PSEG, 2009e). This monitoring indicates that maximum tritium concentrations have dropped substantially, from a maximum of 15,000,000 pCi/L to below 100,000 pCi/L. Some concentrations still exceed the New Jersey Ground Water Quality Criterion for tritium of 20,000 pCi/L (PSEG, 2009e). However, groundwater that exceeds this criterion does not extend past the property boundaries (PSEG, 2009a).

To verify the status of the groundwater remediation program, Staff interviewed NJDEP staff during the site audit in March 2010. The NJDEP staff confirmed that both NJDEP and the New Jersey Geological Survey (NJGS) had been substantially involved in assisting PSEG in developing a response to the tritium release, and that NJDEP conducts ongoing confirmation sampling. Both NJDEP and NJGS review PSEG's Quarterly Remedial Action Progress Reports, including confirmation of the analytical results and verification of plume configurations based on those results. NJDEP staff confirmed that the GRS is operating in a satisfactory manner.

In response to an industry-wide initiative sponsored by the Nuclear Energy Institute (NEI), PSEG implemented a facility-wide radiological groundwater protection program (RGPP) at the Salem and HCGS facilities in 2006. The program, which is separate from the monitoring associated with the GRS, included the identification of station systems that could be sources of radionuclide releases, installation of monitoring wells near and downgradient of those systems and installation of wells upgradient and downgradient of the facility perimeter. The monitoring program consists of 13 monitoring wells at Salem (5 pre-existing and 8 new) and 13 wells at HCGS (all new). The results of the program are reported in the facility's annual Radiological Environmental Operating Reports. The wells are sampled on a semiannual basis and have detected no plant-related gamma-emitters. In the 2008 annual program, tritium was detected in 5 of the 13 wells at Salem, and 6 of the 13 wells at HCGS. All sample results were lower than 1,000 pCi/L, which is less than the 20,000 pCi/L EPA drinking water standard and New Jersey Ground Water Quality Criterion (PSEG, 2009c). These levels of detection are not high enough to trigger voluntary reporting that would be made under the guidelines of the NEI guidance (PSEG, 2009a).

During the site audit, PSEG provided information indicating that elevated tritium concentrations had been detected in six RGPP wells at the HCGS facility in November 2009. This included detection of tritium at concentrations up to 1,200 pCi/L in four wells, and at approximately 3,500 pCi/L in two wells (wells BH and BJ). The wells were all re-sampled in December 2009, and the tritium concentrations had dropped to levels of approximately 500 to 800 pCi/L, which still exceeded their levels prior to November 2009. The wells involved are located at the HCGS facility and are not related to the tritium plume being managed at Salem. PSEG has instituted a well inspection and assessment program to identify the source of the tritium, which is thought to be from either analytical error of rain-out of gaseous emissions in precipitation. Based on the locations of the wells and identification of cracked caps on some wells, it is possible that collection of rainwater run-on entered the wells, causing the increased concentrations. In response, PSEG has replaced all well caps with screw caps and is working with NJDEP and the Staff to implement a well inspection program.

During the site audit, PSEG also provided information on a small-scale diesel pump and treat remediation system being operated near Salem Unit 1 to address a leak of diesel fuel at that location. NJDEP is also involved in the operation of that system, and NJDEP staff confirmed that the remediation system is operating in a satisfactory manner.

2.2.4 Surface Water Resources

2.2.4.1 Description

The Salem and HCGS facilities are located on Artificial Island, a man-made island constructed on the New Jersey (eastern) shore of the Delaware River (PSEG, 2009a; 2009b). All surface water in Salem County drains to the Delaware River and Bay. Some streams flow directly to the river, while others join subwatersheds before reaching their destination. The tides of the Atlantic Ocean influence the entire length of the Delaware River in Salem County. Tidal marshes are located along the lower stretches of the Delaware River and are heavily influenced by the tides, flooding twice daily. Wetland areas, such as Mannington and Supawna Meadows, make up roughly 30 percent of the county. The southwestern portion of Salem County is predominately marshland, and to the north, tidal marshes are found in the western sections of the county at the mouths of river systems, including the Salem River and Oldmans Creek (Salem County, 2008).

The Division of Land Use Regulation (LUR) is managed by the NJDEP and seeks to preserve quality of life issues that affect water quality, wildlife habitat, flood protection, open space, and the tourism industry. Coastal waters and adjacent land are protected by several laws, including the Waterfront Development Law (N.J.S.A. 12:5-3), the Wetlands Act of 1970 (N.J.S.A. 13:9A), New Jersey Coastal Permit Program Rules (N.J.A.C. 7:7), Coastal Zone Management Rules (N.J.A.C. 7:7E), and the Coastal Area Facility Review Act (N.J.S.A. 13:19), which regulates almost all coastal development and includes the Kilcohook National Wildlife Refuge that is located in Salem County (NJDEP, 2010b).

The facilities are located at River Mile (RM) 51 on the Delaware River. At this location, the river is approximately 2.5 mi (4 km) wide. The facilities are located on the Lower Region portion of the river, which is designated by the DRBC as the area of the river subject to tidal influence, and between the Delaware Bay and Trenton, NJ (DRBC, 2008a). The Lower Region and the Delaware Bay together form the Estuary Region of the river, which is included as the Partnership for the Delaware Estuary within the EPA's National Estuary Program (EPA, 2010d).

Water use from the river at the facility location is regulated by both the DRBC and the State of New Jersey. The DRBC was established in 1961, through the Delaware River Basin Compact, as a joint Federal and State body to regulate and manage water resources within the basin. The DRBC acts to manage and regulate water resources in the basin by: (1) allocating and regulating water withdrawals and discharges; (2) resolving interstate, water-related disputes; (3) establishing water quality standards; (4) managing flow; and (5) watershed planning (DRBC, 1961).

As facilities that use water resources in the basin, Salem and HCGS water withdrawals are conducted under contract to the DRBC. The Salem facility uses surface water under a DRBC contract originally signed in 1977 (DRBC, 1977), and most recently revised and approved for a 25-year term in 2001 (DRBC, 2001). Surface water withdrawals by the HCGS facility were originally approved for two units in 1975, and then revised for a single unit in 1985 following PSEG's decision to build only one unit (DRBC, 1984a). The withdrawal rates are also regulated by NJDEP, under NJPDES Permit Nos. NJ0025411 (for HCGS) and NJ005622 (for Salem).

2.2.4.2 Affected Users

The Delaware River Basin is densely populated, and surface water resources within the river are used for a variety of purposes. Freshwater from the non-tidal portion of the river is used to supply municipal water throughout New York, Pennsylvania, and New Jersey, including the large metropolitan areas of Philadelphia and New York City. Approximately 75 percent of the length of the non-tidal Delaware River is designated as part of the National Wild and Scenic Rivers System. The river is economically important for commercial shipping, as it includes port facilities for petrochemical operations, military supplies, and raw materials and consumer products (DRBC, 2010).

In the tidal portion of the river, water is accessed for use in industrial operations, including power plant cooling systems. A summary of DRBC-approved water users on the tidal portion of the river from 2005 lists 22 industrial facilities and 14 power plants in Pennsylvania, New Jersey, and Delaware (DRBC, 2005). Of these facilities, Salem is by far the highest volume water user in the basin, with a reported water withdrawal volume of 1,067,892 million gallons (4.042 billion m^3) in 2005 (DRBC, 2005). This volume exceeds the combined total withdrawal for all other industrial, power, and public water supply purposes in the tidal portion of the river. The withdrawal volume for HCGS in 2005 was much lower, at 19,561 million gallons (74 million m^3).

2.2.4.3 Water Quality Regulation

To regulate water quality in the basin, the DRBC has established water quality standards, referred to as Stream Quality Objectives, to protect human health and aquatic life objectives. To account for differing environmental setting and water uses along the length of the river basin, the DRBC has established Water Quality Management (WQM) Zones, and has established separate Stream Quality Objectives for each zone. The Salem and HCGS facilities are located within Zone 5, which extends from RM 48.2 to RM 78.8.

The DRBC Stream Quality Objectives are used by the NJDEP to establish effluent discharge limits for discharges within the basin. The EPA granted the State of New Jersey the authority to issue NPDES permits, and such a permit implies water quality certification under the Federal Clean Water Act (CWA) Section 401. The water quality and temperature of the discharges for both the Salem and HCGS discharges are regulated by NJDEP under NJPDES Permit Nos. NJ0025411 (for HCGS) and NJ005622 (for Salem). In addition, industrial facilities in New Jersey are required, under the New Jersey Administrative Code (NJAC) Title 7:1E – 5.3, to provide notification to NJDEP whenever any hazardous substance, as defined in NJAC 7:1E Appendix A is released.

2.2.4.4 Salem Nuclear Generating Station NJPDES Requirements

The current NJPDES Permit No. NJ005622 for the Salem facility was issued with an effective date of August 1, 2001, and an expiration date of July 31, 2006 (NJDEP, 2001a). The permit requires that a renewal application be prepared at least 180 days in advance of the expiration date. Correspondence provided with the applicant's ER indicates that a renewal application was filed on January 31, 2006. During the site audit, NJDEP staff confirmed that the application was still undergoing review.

The Salem NJPDES permit regulates water withdrawals and discharges associated with non-radiological industrial wastewater, including intake and discharge of once-through cooling water. The once-through cooling water, service water, non-radiological liquid waste, radiological liquid waste, and other effluents are discharged through the cooling water system intake. The specific discharge locations, and their associated reporting requirements and discharge limits, are presented in Table 2-2.

Stormwater discharge is not monitored through the Salem NJPDES permit. Stormwater is collected and discharged through outfall discharge serial numbers (DSNs) 489A (south), 488 (west), and 487/487B (north). The NJPDES permit requires that stormwater discharges be managed under an approved Stormwater Pollution Prevention Plan (SWPPP) and, therefore, does not specify discharge limits. The same SWPPP is also applicable to stormwater discharges from the HCGS facility. The plan includes a listing of potential sources of pollutants and associated best management practices (NJDEP, 2003).

Industrial wastewater from Salem is regulated at nine specific locations, designated outfall DSNs 048C, 481A, 482A, 483A, 484A, 485A, 486A, 487B, and 489A. Outfall DSN 048C is the discharge system for the NRLWDS, and also receives stormwater from DSN 487B. For DSN 048C, the permit establishes reporting requirements for discharge volume (in millions of gallons per day), and compliance limits for total suspended solids, ammonia, petroleum hydrocarbons, and total organic carbon (NJDEP, 2001a).

Outfall DSNs 481A, 482A, 483A, 484A, 485A, and 486A are the discharge systems for cooling water, service water, and the radiological liquid waste disposal system. Outfall DSNs 481A, 482A, and 483A are associated with Salem Unit 1, while outfall DSNs 484A, 485A, and 486A are associated with Salem Unit 2. The permit establishes similar, but separate, requirements for each of these six outfalls. For each, the permit requires reporting of the discharge volume (in MGD), the pH of the intake, and the temperature of the discharge. The permit also establishes compliance limits for the discharge from each outfall for pH and chlorine-produced oxidants (NJDEP, 2001a).

Outfall DSN 487B is the discharge system for the #3 skim tank. The permit establishes reporting requirements for discharge volume (in MGD) and compliance limits for pH, total suspended solids, temperature of effluent, petroleum hydrocarbons, and total organic carbon (NJDEP, 2001a).

Table 2-2. NJPDES Permit Requirements for Salem Nuclear Generating Station

Discharge	Description	Required Reporting	Permit Limits
DSN 048C	Input is NRLWDS and Outfall DSN 487B Discharges to outfall DSNs 481A, 482A, 484A, and 485A	Effluent flow volume	None
		Total suspended solids	50 mg/L monthly average 100 mg/L daily maximum
		Ammonia (Total as N)	35 mg/L monthly average 70 mg/L daily maximum
		Petroleum hydrocarbons	10 mg/L monthly average 15 mg/L daily maximum
		Total organic carbon	Report monthly average 50 mg/L daily maximum
DSNs 481A, 482A, 483A, 484A, 485A, and 486A (the same requirements for each)	Input is cooling water, service water, and DSN 048C Outfall is six separate discharge pipes	Effluent flow volume	None
		Effluent pH	6.0 daily minimum 9.0 daily maximum
		Intake pH	None
		Chlorine-produced oxidants	0.3 mg/L monthly average 0.2 and 0.5 mg/L daily maximum
		Temperature	None
DSN 487B	#3 skim tank, and stormwater from north portion	Effluent flow	None
		pH	6.0 daily minimum 9.0 daily maximum
		Total suspended solids	100 mg/L daily maximum
		Temperature	43.3°C daily maximum
		Petroleum hydrocarbons	15 mg/L daily maximum
		Total organic carbon	50 mg/L daily maximum
Discharge	**Description**	**Required Reporting**	**Permit Limits**
DSN 489A	Oil/water separator, turbine sumps, and stormwater from south portion	Effluent flow	None
		pH	6.0 daily minimum 9.0 daily maximum
		Total suspended solids	30 mg/L monthly average 100 mg/L daily maximum
		Petroleum hydrocarbons	10 mg/L monthly average 15 mg/L daily maximum
		Total organic carbon	50 mg/L daily maximum
DSN Outfall FACA	Combined for discharges 481A, 482A, and 483A	Net temperature (year round)	15.3°C daily maximum
		Gross temperature (June to September)	46.1°C daily maximum
		Gross temperature (October to May)	43.3°C daily maximum
DSN Outfall FACB	Combined for discharges 484A, 485A, and 486A	Net temperature (year round)	15.3°C daily maximum
		Gross temperature (June to September)	46.1°C daily maximum
		Gross temperature (October to May)	43.3°C daily maximum

Discharge	Description	Required Reporting	Permit Limits
DSN Outfall FACC	Combined for discharges 481A, 482A, 483A, 484A, 485A, and 486A	Influent flow Effluent thermal discharge	3,024 MGD monthly average 30,600 MBTU/hr daily maximum

MBTU/hr = million British thermal units per hour
Source: NJDEP, 2001a

Outfall DSN 489A is the discharge system for the oil/water separator. The permit establishes reporting requirements for discharge volume (in MGD) and compliance limits for pH, total suspended solids, petroleum hydrocarbons, and total organic carbon (NJDEP, 2001a).

In addition to the reporting requirements and contaminant limits for these individual outfalls, the permit establishes temperature limits for Salem Unit 1 as a whole, Salem Unit 2 as a whole, and the Salem facility as a whole. Outfall FACA is the combined discharge from outfalls 481A, 482A, and 483A to represent the overall thermal discharge from Salem Unit 1. For outfall FACA, the permit establishes an effluent net temperature difference of 15.3 °C (27.5°F), a gross temperature of 43.3 °C (110°F) from October to May, and a gross temperature of 46.1 °C (115°F)from June to September (NJDEP, 2001a).

Similarly, outfall FACB is the combined discharge from outfall DSNs 484A, 485A, and 486A to represent the overall thermal discharge from Salem Unit 2. The temperature limits for outfall FACB are the same as those established for outfall FACA (NJDEP, 2001a).

Outfall FACC is the combined results from outfall DSNs 481A through 486A, representing the overall thermal discharge and flow volume for the Salem facility as a whole. The permit establishes an overall intake volume of 3,024 MGD (11.4 million m^3/day) on a monthly average basis, and an effluent thermal discharge limit of 30,600 million British thermal units (BTUs) per hour as a daily maximum (NJDEP, 2001a).

In addition to the outfall-specific reporting requirements and discharge limits, the Salem NJPDES permit includes a variety of general requirements (NJDEP, 2001a). These include requirements for the following:

- additives that may be used, where they may be used, and procedures for proposing changes to additives
- toxicity testing of discharges and, depending on results, toxicity reduction measures
- implementation and operations of intake screens and fish return systems
- wetland restoration and enhancement through the estuary enhancement program
- implementation of a biological monitoring program
- installation of fish ladders at offsite locations
- performance of studies of intake protection technologies
- implementation of entrainment and impingement monitoring
- conduct of special studies, including intake hydrodynamics and enhancements to entrainment and impingement sampling

- funding of construction of offshore reefs
- compliance with DRBC regulations, NRC regulations, and the NOAA Fisheries Biological opinion

In the permit, the NJDEP reserves the right to re-open the requirements for intake protection technologies (NJDEP, 2001a).

2.2.4.5 Hope Creek Generating Station NJPDES Requirements

The current NJPDES Permit No. NJ0025411 for the HCGS facility was issued in early 2003, with an effective date of March 1, 2003, and an expiration date of February 29, 2008 (NJDEP, 2003). The permit requires that a renewal application be prepared at least 180 days in advance of the expiration date. Correspondence provided with the applicant's ER indicates that a renewal application was filed on August 30, 2007. During the site audit, NJDEP staff confirmed that the application was still undergoing review.

The HCGS NJPDES permit regulates water withdrawals and discharges associated with both stormwater and industrial wastewater, including discharges of cooling tower blowdown (NJDEP, 2003). The cooling tower blowdown and other effluents are discharged through an underwater pipe located on the bank of the river, 1,500 ft (457 m) upstream of the SWS intake. The specific discharge locations, and their associated reporting requirements and discharge limits, are presented in Table 2-3.

Stormwater discharge is not monitored through the HCGS NJPDES permit. Stormwater is collected and discharged through outfall DSNs 463A, 464A, and 465A. These outfalls were specifically regulated, and had associated reporting requirements, in the HCGS NJPDES permit through 2005. However, the revision of the permit in January 2005 modified the requirements for stormwater, and the permit now requires that stormwater discharges be managed under an approved SWPPP and, therefore, does not specify discharge limits. The same SWPPP is also applicable to stormwater discharges from the Salem facility. The plan includes a listing of potential sources of pollutants and associated best management practices (NJDEP, 2003).

Industrial wastewater is regulated at five locations, designated DSNs 461A, 461C, 462B, 516A (oil/water separator), and SL1A (sewage treatment plant [STP]). Discharge DSN 461A is the discharge for the cooling water blowdown, and the permit established reporting and compliance limits for intake and discharge volume (in MGD), pH, chlorine-produced oxidants, intake and discharge temperature, total organic carbon, and heat content in millions of BTUs per hour, in both summer and winter (NJDEP, 2003).

Discharge DSN 461C is a discharge for the oil/water separator system and has established reporting and compliance limits for discharge volume, total suspended solids, total recoverable petroleum hydrocarbons, and total organic carbon (NJDEP, 2003).

Table 2-3. NJPDES Permit Requirements for Hope Creek Generating Station

Discharge	Description	Required Reporting	Permit Limits
DSN 461A	Input is cooling water blowdown and DSN 461C Outfall is discharge pipe	Effluent flow	None
		Intake flow	None
		Effluent pH	6.0 daily minimum 9.0 daily maximum
		Chlorine-produced oxidants	0.2 mg/L monthly average 0.5 mg/L daily maximum
		Effluent gross temperature	36.2oC daily maximum
		Intake temperature	None
		Total organic carbon (effluent gross, effluent net, and intake)	None
		Heat content (June to August)	534 MBTU/hr daily maximum
		Heat content (September to May)	662 MBTU/hr daily maximum
DSN 461C	Input is low volume oily waste from oil/water separator Outfall is to DSN 461A	Effluent flow	None
		Total suspended solids	30 mg/L monthly average 100 mg/L daily maximum
		Total recoverable petroleum Hydrocarbons	10 mg/L monthly average 15 mg/L daily maximum
		Total organic carbon	50 mg/L daily maximum
DSN 462B	Sewage treatment plant effluent, discharges to 461A	Effluent flow	None
		Total suspended solids	30 mg/L monthly average 45 mg/L weekly average 83% removal daily minimum
		Biological oxygen demand (BOD)	8 kg/day monthly average 30 mg/L monthly average 45 mg/L weekly average 87.5 percent removal daily minimum
		Oil and grease	10 mg/L monthly average 15 mg/L daily maximum
		Fecal coliform	200 /100 ml monthly geometric 400 /100 ml weekly geometric average
		6 separate metal and inorganic contaminants (cyanide, nickel, zinc, cadmium, chromium, and copper)	None
S16A	Oil/water separator residuals from 461C	24 separate metal and inorganic contaminants	None
		24 separate organic contaminants	None
		Volumes and types of sludge produced and disposed	None

Discharge	Description	Required Reporting	Permit Limits
SL1A	STP system residuals from 462B	17 separate metal and inorganic contaminants	None
		Volumes and types of sludge produced and disposed	None

Source: NJDEP, 2005c

Discharge DSN 462B is the discharge for the onsite sewage treatment plant. The permit includes limits for effluent flow volume, total suspended solids, oil and grease, fecal coliform, and six inorganic contaminants (NJDEP, 2005c).

Discharge 516A is the discharge from the oil/water separator system. This discharge has reporting requirements established for 48 inorganic and organic contaminants, for the volume of sludge produced, and for the manner in which the sludge is disposed (NJDEP, 2003).

Discharge SL1A is the discharge from the STP system. This discharge has reporting requirements established for 17 inorganic contaminants, as well as sludge volume and disposal information (NJDEP, 2003).

In addition to the outfall-specific reporting requirements and discharge limits, the HCGS NJPDES permit includes a variety of general requirements. These include requirements for additives that may be used, where they may be used, and procedures for proposing changes to additives; and compliance with DRBC regulations and NRC regulations (NJDEP, 2003).

In the permit, the NJDEP reserves the right to revoke the alternate temperature provision for outfall DSN 461A if the NJDEP determines that the cooling tower is not being properly operated and maintained (NJDEP, 2003).

<u>Spill Reporting under NJAC 7:1E</u>

As discussed above, industrial facilities in New Jersey are required to provide notification to NJDEP whenever any hazardous substance, as defined in NJAC 7:1E Appendix A, is released. The list of hazardous substance in NJAC 7:1E Appendix A includes almost 2,000 substances that are commonly used at industrial facilities, including many chemicals that Salem and HCGS are specifically permitted to use in accordance with their NJPDES permits. This includes chemicals which are added to the steam systems for corrosion protection, including ammonium hydroxide and hydrazine. In compliance with NJAC 7:1E – 5.3, the facilities occasionally report releases of these chemicals, including hydrazine, ammonium hydroxide, and sodium hypochlorite, to NJDEP, and those reports are publicly available. In two recent instances, the facilities have been subject to enforcement action associated with these releases. In September 2005, the facilities paid a penalty of $7,500 associated with a release of 5,000 gallons (19 m^3) of boiler feed water containing 7 parts per million (ppm) hydrazine and 20 ppm ammonia. In April 2008, they paid a penalty of $15,000 associated with the May 10, 2006 release of 5,000 gallons (19 m^3) of water containing hydrazine and ammonium hydroxide, and with a separate release of sodium hypochlorite. A separate penalty of $8,250 was paid in February 2007, associated with the same May 10, 2006 release (NJDEP, 2010c).

2.2.5 Aquatic Resources – Delaware Estuary

2.2.5.1 Estuary Characteristics

Salem and HCGS are located at the south end of Artificial Island on the New Jersey shore of the Delaware Estuary, about 52 RM (84 river km) north of the mouth of the Delaware Bay (Figure 2-5). The estuary is the source of the cooling water for both facilities and receives their effluents. The Delaware Estuary supports an abundance of aquatic resources in a variety of habitats. Open water habitats include salt water, tidally-influenced water of variable salinities, and tidal freshwater areas. Moving south from the Delaware River to the mouth of the bay, there is a continual transition from fresh to salt water. Additional habitat types occur along the edges of the estuary in brackish and freshwater marshes. The bottom of the estuary provides many different benthic habitats, with their characteristics dictated by salinity, tides, water velocity, and substrate type. Sediments in the estuary near Artificial Island are primarily mud, muddy sand, and sandy mud (PSEG, 2006c).

At Artificial Island, the estuary is tidal with a net flow to the south and a width of approximately 16,000 ft (5,000 m) (Figure 2-1). The USACE maintains a dredged navigation channel near the center of the estuary and about 6,600 ft (2,000 m) west of the shoreline at Salem and HCGS. The navigation channel is about 40 ft (12 m) deep and 1,300 ft (400 m) wide. On the New Jersey side of the channel, water depths in the open estuary at mean low water are fairly uniform at about 20 ft (6 m). Predominant tides in the area are semi-diurnal, with a period of 12.4 hours and a mean tidal range of 5.5 ft (1.7 m). The maximum tidal currents occur in the channel, and currents flow more slowly over the shallower areas (NRC, 1984; Najarian Associates, 2004).

Salinity is an important determinant of biotic distribution in estuaries, and salinity near the Salem and HCGS facilities depends on river flow. The NRC (1984) reported that average salinity in this area during periods of low flow ranged from 5 to 18 parts per thousand (ppt) and during periods of higher flow, ranged from 0 to 5 ppt. Najarian Associates (2004) and PSEG Services Corporation (2005b) characterized salinity at the plant as ranging between 0 and 20 ppt and, in the summer during periods of low flow, as typically exceeding 6 ppt. Based on temperature and conductivity data collected by the USGS at Reedy Island, just north of Artificial Island, Najarian Associates (2004) calculated salinity from 1991 through 2002. According to Figure B6 in the Najarian Associates 2004 report, the median salinity was approximately 5 ppt and salinity exceeded 12 ppt in only two years, exceeded 13 ppt in only one year, and never exceeded 15 ppt during the 11 year period. Based on these observations, the Staff assumes that salinity in the vicinity of Salem and HCGS typically ranges from 0 to 5 ppt during periods of low flow (usually, but not always, in the summer) and from 5 to 12 ppt during periods of high flow (Table 2-4). Within these larger patterns, salinity at any specific location also varies with the tides (NRC, 2007).

Table 2-4. Salinities in the Delaware Estuary in the Vicinity of Salem Nuclear Generating Station and Hope Creek Generating Station

Condition	Salinity Range (ppt)
Low Flow	0-5
High Flow	5-12

Source: NRC, 2007

Monthly average surface water temperatures in the Delaware Estuary vary with season. Between 1977 and 1982, water temperatures ranged from -0.9°C (30°F) in February 1982 to 30.5°C (86.9°F) in August 1980. Although the estuary in this reach is generally well mixed, it can occasionally stratify, with surface temperatures 1° to 2°C (2° to 4°F) higher than bottom temperatures and salinity increasing as much as 2 ppt per meter of water depth (NRC, 1984).

Cowardin et al. (1979) classified estuaries into five categories based on salinity, varying from fresh (zero ppt) to hyperhaline (greater than 40 ppt). They further subdivide the brackish category (0.5 to 30 ppt) into three subsections: oligohaline (0.5 to 5 ppt), mesohaline (5 to 18 ppt), and polyhaline (18 to 30 ppt). These categories describe zones within the estuary. The estuary reach adjacent to Artificial Island is at the interface of the oligohaline and mesohaline zones; thus, it is oligohaline during high flow and mesohaline during low flow conditions. Based on water clarity categories of good, fair, or poor, the EPA (1998) classified the water clarity in this area of the estuary as generally fair (meaning that a wader in waist-deep water would not be able to see his feet). The EPA classified the water clarity directly upstream and downstream of this reach as poor (meaning that a diver would not be able to see his hand at arm's length). EPA (1998) classified most estuarine waters in the Mid-Atlantic as having good water clarity and stated that lower water clarity typically is due to phytoplankton blooms and suspended sediments and detritus (organic particles and debris from the beakdown of vegetation).

Delaware Bay is a complex estuary, with many individual species playing different roles in the system. Additionally, most estuarine species have complex lifecycles, and are present in the bay at different stages, so many species play several ecological roles throughout their lifecycles. Changes in the abundance of these species can have far reaching effects, both within and without the bay, including major trends in commercial fisheries. Major assemblages of organisms within the estuarine community include plankton, benthic invertebrates, and fish.

2.2.5.2 Plankton

Plankton are organisms that are moved throughout the water column by tides and currents. They are relatively unable to control their own movements (Moisan et al., 2007). Plankton can be primary producers (phytoplankton) or consumers (zooplankton and microbes).

Phytoplankton

Phytoplankton are microscopic, single-celled algae that are responsible for the majority of primary production in the water column. Primary production is typically limited to the upper 2 m (7 ft) of the water column due to light limitation from high turbidity (NRC, 1984). Water quality parameters such as salinity, temperature, and nutrient availability regulate species composition, abundance, and distribution. Seasonal changes in these parameters cause fluctuations in the density of plankton populations (Versar, 1991). Species composition also varies with water quality parameters. In the highly variable, tidally influenced zone, species with a high tolerance for widely fluctuating environments are found. Species composition also fluctuates seasonally (DRBC, 2008b).

Phytoplankton were sampled in the late 1960s and early 1970s as part of the pre-operational ecological investigations for Salem performed by Ichthyological Associates (PSEG, 1983). In 1978, NJDEP agreed that Salem operation had no effect on phytoplankton populations, and phytoplankton studies related to the operation of Salem Units 1 and 2 were discontinued (PSEG, 1984). Versar (1991) conducted a major literature survey for the Delaware Estuary Program to assess the various biological resources of the estuary and possible trends in their abundance or health. This study found that phytoplankton formed the basis of the primary production in the estuary. More recently, Monaco and Ulanowicz (1997) established that pelagic phytoplankton in the Delaware Bay are responsible for most of the primary production. Sutton et al (1996) determined that phytoplankton in the lower bay (polyhaline zone) where the water is less turbid account for most of the primary production in the system. The Delaware Estuary contains several hundred phytoplankton species, a few of which are highly abundant (Sutton et al., 1996). *Skeletonema potamos* and various cyanobacteria and green algae are numerically dominant in the oligohaline zone.

NJDEP currently surveys phytoplankton in the Delaware estuary. These surveys monitor harmful algal blooms by collecting samples for chlorophyll analysis. The occurrence of blooms is highly variable between years, but blooms most often occur in the spring (NJDEP, 2005b). Algal blooms can have large consequences for the entire estuary because they can contain flagellates that may make fish and shellfish inedible, and they can deplete the oxygen in the water column so severely that large fish kills can result. The EPA also monitors algal blooms using helicopter surveys (NJDEP, 2005a).

Zooplankton

Zooplankton are heterotrophic plankton that consume phytoplankton, other types of zooplankton, and detritus (Moisan et al., 2007). They serve as a vital link between the micro algae, detritus, and larger organisms in the Delaware Estuary. Zooplankton are very small, have limited mobility, and provide a source of food for many other organisms, including filter feeders, larvae of fish and invertebrates, and larger zooplankton. They are dependent on phytoplankton, detritus, or smaller zooplankton for food. In turn, they are either eaten by larger organisms or contribute to the energy web by being decomposed by the detritivores after they settle to the substrate. Zooplankton show seasonal and spatial variability in abundance and species composition (PSEG, 1983). Their distribution can be affected by factors such as currents, salinity, temperature, and light intensity (NRC, 1984).

Some zooplankton spend their entire life cycle in the water column and others spend only part of their life cycle in the water column. Among the former are invertebrates such as shrimp, mysids, amphipods, copepods, ctenophores (comb jellies), jellyfish, and rotifers. Among the animals that spend a only portion of their life cycle as plankton are larval fish and invertebrates that have a planktonic stage before their development into adult forms. The planktonic stage provides for these organisms an important dispersal mechanism, ensuring that larvae arrive in as many appropriate habitats as possible (Sutton et al., 1996). Studies in the Salem pre-operational phase found many such zooplankton in large numbers, including the larval stages of the estuarine mud crab (*Rhithropanopeus harrisii*), fiddler crab (*Uca minax*), grass shrimp (*Palaemonetes pugio*), and copepods (PSEG, 1983).

Zooplankton were sampled by Ichthyological Associates as part of the pre-operational ecological studies for Salem Units 1 and 2. Studies related to plant operations in the early to mid 1970s found that two types of crustaceans, opossum shrimp and amphipods of the genus *Gammarus*, constituted the numerical majority of the taxa collected. Due to the abundance of these two taxa, they were selected by NJDEP and NRC for future ecological studies related to Salem operations. They also are important as prey items for many of the fishes in the estuary. As a result, general studies of the zooplankton in the estuary were discontinued by PSEG in favor of an approach more focused on individual species (PSEG, 1984). Studies reviewed in Sutton et al (1996) did not show a major change in the zooplankton assemblage since the early 1960s. Copepods generally are the most abundant organisms and are a major prey resource for larval and adult fish in the Delaware Estuary (Sutton et al., 1996).

Since many of the fish species found in the Delaware Estuary are managed either Federally or by individual States, there have been extensive studies of ichthyoplankton (larval fish and eggs). Additionally, fish have been monitored by PSEG and the States of New Jersey and Delaware since before the operation of Salem Units 1 and 2. Initial ichthyoplankton studies were general surveys. Later studies focused on the 11 target species established during the NPDES permitting process. These studies included impingement and entrainment studies and general sampling consisting of plankton tows and beach seines (PSEG, 1984). Versar (1991) reviewed several studies with respect to ichthyoplankton. This review included both the power plant studies and more general surveys focused on managed fish species. The review revealed that ichthyoplankton of the tidal freshwater region (corresponding to the oligohaline region) had a high abundance of the alosid fishes, including the American shad (*Alosa sapidissima*), hickory shad (*A. mediocris*), alewife (*A. pseudoharengus*), and blueback herring (*A. aestivalis*), as well as other anadromous species. Due to alosid lifecycles, both eggs and larvae have seasonal peaks in abundance and distribution that vary with the species. The bay anchovy (*Anchoa mitchilli*) is abundant in the transitional region (corresponding to the mesohaline region) in which Artificial Island is located. Other common ichthyoplankton species in the Delaware Estuary include the naked goby (*Gobiosoma bosc*), blueback herring, alewife, Atlantic menhaden (*Brevoortia tyrannus*), weakfish (*Cynoscion regalis*), and Atlantic silverside (*Menidia menidia*). The number of species was highest in the spring and summer months, and bay anchovy always constituted a large portion of the ichthyoplankton samples (Versar, 1991). The lifecycles, habitats, and other characteristics of fish species identified among the ichthyoplankton are described in Section 2.2.5.4.

2.2.5.3 Benthic Invertebrates

Benthic invertebrates (or benthos) are organisms that live within (infauna) or on (epifauna) the substrates at the bottom of the water column, including groups such as worms, mollusks, crustaceans, and microorganisms (CAML, 2008). Parabenthos are organisms that spend some time in or on the substrate but can also be found in the water column, including crabs, copepods, and mysids (Versar, 1991). The species composition, distribution, and abundance of the benthic invertebrate community are affected by physical conditions, such as salinity, temperature, water velocity, and substrate type, and by interactions between individuals and species. Substrates within the Delaware Estuary include mud, sand, clay, cobble, shell, rock, and various combinations of these; those near Salem and HCGS are mostly fine-grained silts and clays with small areas of sand (USACE, 1992).

The benthic invertebrate community of the estuary performs many ecological functions. Some benthic species or groups of species form habitats by building reefs (such as oysters and some polychaete worms) or by stabilizing or destabilizing soft substrates (such as some bivalves, amphipods, and polychaetes). Some benthic organisms are filter feeders that clean the overlying water (such as oysters, other bivalves, and some polychaetes), and others consume detritus. While the benthic community itself contains many trophic levels, it also provides a trophic base for fish and shellfish (such as crabs) valued by humans.

A review of benthic data for the Delaware Estuary was included in a report for the Delaware Estuary Program (Versar, 1991). Benthic data have been collected in the estuary since the early 1800s. Most of the earlier reports were surveys describing species; however, large amounts of quantitative data were collected in the 1970s. Generally, benthic invertebrate species distributions were found to be limited by salinity and substrate type (Versar, 1991). Additionally, localized poor water quality can have a major effect on species composition. Species found in the lower bay are limited by salinity gradients; estuarine species, such as the razor clam (Ensis directus) and the polychaete Heteromastus filiformis, are found throughout the entire bay; and freshwater and oligohaline species, such as the clam Gemma gemma, occur in lower salinity waters in the upper bay. Pre-operational studies by Ichthyological Associates also concluded that species composition varied seasonally, reflecting higher diversity and abundance during periods of higher salinity. The authors postulated that this was a result of both recruitment dynamics and immigration from the lower bay (PSEG, 1983).

The benthos of the tidal fresh portion (oligohaline) of the estuary includes tubificid worms, chironomid larvae, sphaerid clams, and unionid mussels. These assemblages are greatly influenced by anthropogenic impacts to the water quality in the area due to proximity of pollutant sources on the river. Highly tolerant species are found here, often with only one extremely dominant species. In the transition zone (mesohaline) oligochaetes and amphipods generally are numerically dominant. The bay region (polyhaline) has abundant bivalves and polychaetes (Versar, 1991). As reported in the applicant's initial environmental report (PSEG, 1983), pre-operational studies for Salem Units 1 and 2 found mostly euryhaline species in the vicinity of the facility, including polychaetes, oligochates, and isopods (NRC, 1984).

Species composition and abundance of benthic organisms are often used as indicators of ecosystem health. Generally, the greater the diversity of species and the more abundant those species are, the healthier the system is considered. EPA collected benthic samples in the Delaware Estuary between 1990 and 1993 in an effort to assess the health of the system. As a result of this sampling effort, EPA determined that 93 percent of the tidal river between the Chesapeake and Delaware Canal and Trenton, NJ was either degraded or severely degraded. South of this area, EPA classified only 2 percent of the benthic invertebrate community as impaired, and none of the area was considered severely impaired (Delaware Estuary Program, 1995). More recently, EPA released a report describing the Delaware-Maryland-Virginia coastal bays as impacted over one-fourth of their total area. In the Delaware Bay itself, EPA considered the upper portion as severely impacted, the transition area as impacted, and the lower bay as mostly in good condition. The report described a large central area of the bay as impacted, possibly due to scouring from high currents or eutrophication resulting in high organic carbon levels in the sediments (EPA, 1998).

PSEG and its consultants conducted studies during the 1984 NPDES 316(b) permitting process (PSEG, 1984). They collected over 1,000 grab samples in the Delaware Estuary and identified a total of 57 taxa in 8 phyla. The most abundant species were the same as those found in previous studies. General densities of benthic organisms ranged between 17,000 per square meter (m^2; 183,000 per ft^2) and 25,000 per m^2 (269,000 per ft^2). As a result of the PSEG studies, NJDEP determined that benthic invertebrates would not be substantially affected by plant operations, and these organisms were no longer sampled as part of the monitoring effort (PSEG, 1984).

Mysids are a key biological resource in Delaware Bay because they are highly abundant and are prey for many other species, especially fish. They also are important predators of other invertebrates. Opossum shrimp are found in water with a salinity of 4 ppt or higher (mesohaline and polyhaline regions), most often in deeper areas. They migrate vertically into the water column at night and settle on the sediments during the day. Sand shrimp are more common in shallower waters and play the same ecological role as opossum shrimp. Amphipods are numerous in the transition region and are primarily represented by the genus Gammarus. These crustaceans also form a link between the smaller plankton and the larger fish species in this part of the estuary (Versar, 1991).

The benthos of the Delaware estuary also include mollusks and large crustaceans such as the blue crab (*Callinectes sapidus*) and horseshoe crab (*Limulus polyphemus*). These species can be difficult to sample with the equipment typically used for benthos sampling, sediment grab samplers (PSEG, 1984). PSEG monitoring survey efforts often caught blue crabs in the bottom trawl samples. Opossum shrimp and Gammarus spp. also are difficult to sample because they often inhabit vegetation in shallow marsh areas. These species were selected as target species during PSEG’s early ecological studies with respect to the operation of Salem Units 1 and 2, but NJDEP and PSEG later determined that they were unaffected by the facility and they were no longer specifically monitored (PSEG, 1999).

Several benthic invertebrate species that have been given special attention by Federal, regional, or State organizations. For example, the blue crab has been extensively monitored at Salem as an important species, the horseshoe crab has been the focus of several restoration efforts within Delaware Bay due to its general decline and the fact that the bay is considered a major nursery and spawning area for the species, and both the horseshoe crab and the oyster were noted as important species by NMFS (NMFS, 2010a). These three species are discussed below.

Blue Crab

The blue crab is an important ecological, cultural, commercial, and recreational resource in the Delaware Bay (Hill et al., 1989). Blue crabs mate in low-salinity portions of estuaries during the summer, usually from May through October (ASMFC, 2004). Males can mate several times, but females mate only once (ASMFC, 2004). Once the female has been fertilized, she migrates to higher salinity regions to complete the spawning process. The fertilized eggs are extruded over several months and remain attached to the abdomen of the female. The eggs hatch and are released after 1 to 2 weeks, initiating a series of larval transitions. In the first larval stage, the zoea, the larvae are planktonic filter feeders and develop in the higher-salinity waters outside of the estuary. These larvae molt seven to eight times in 31 to 49 days before progressing to the next stage, the megalops, which are more like crabs, with pincers and jointed legs (Hill et al., 1989). After 6 to 20 days, the megalops stage molts into the first crab stage, resembling an adult crab. Over a period of 1 year, these juveniles migrate up the estuary into lower-salinity regions until they have reached the adult stage (Hill et al., 1989). Initially, sea grass beds are an important habitat, but crabs then make extensive use of marsh areas as nurseries (ASMFC, 2004). Natural mortality rates for the blue crab are hard to define as they vary non-linearly with life stage and environmental parameters. The maximum age reached by blue crabs has been estimated to be 8 years (ASMFC, 2004).

The blue crab is an omnivore, feeding on many other commercially important species, such as oysters and clams. Young blue crabs also are prey for other harvested species, especially those that use the estuary as a nursery area (Hill et al., 1989). Blue crabs are important in energy transfer within estuarine systems (ASMFC, 2004). They play different roles in the ecosystem depending on their life stage. Zoea larvae consume other zooplankton as well as phytoplankton. Megalops larvae consume fish larvae, small shellfish, aquatic plants, and each other. Post-larval stages consume detritus, carcasses, fish, crabs, and mollusks. Crab eggs are eaten by fish. Larval stages are eaten by other planktivores, including fish, jellyfish, and shellfish. Juvenile crabs are consumed by shore birds, wading birds, and fish. Adult crabs are consumed by mammals, birds, and large fish, including the striped bass (*Morone saxatitlis)*, American eel (*Anguilla rostrata*), and sandbar shark (*Carcharhinus plumbeus*) (Hill et al., 1989).

Blue crab population estimates are difficult, as recruitment is highly variable and dependent on temperature, dissolved oxygen, rainfall, oceanographic conditions, parasitism, and contaminant and predation levels (Hill et al., 1989; ASMFC, 2004). Landings of blue crabs on the east coast were in decline in the early 2000s, prompting a symposium led by the ASMFC in an attempt to assess the status of the fishery and to assist in developing sustainable landing limits. Participants in the symposium theorized that declines in blue crab populations could be a result of attempts to increase populations of other fisheries species that prey upon crabs (ASMFC, 2004).

Horseshoe Crab

The horseshoe crab is an evolutionarily primitive species that has remained relatively unchanged for 350 million years. It is not a true crab but is more closely related to spiders and other arthropods (FWS, 2006). The largest spawning population in the world inhabits the Delaware Bay. They migrate offshore during the winter months and return to shore in spring to spawn on beaches (ASMFC, 2008a). Spawning peaks in May and June, and crabs spawn repeatedly during the season (ASMFC, 2010a). Spawning occurs during high spring tides on sandy beaches with low wave action (ASMFC, 2008a). The female will partially burrow into the sand and deposit several thousand eggs. Eggs hatch in 3 to 4 weeks, and the larvae (which resemble the adult crabs without tails) will enter the water about 1 month later (FWS, 2006). They spend their first 6 days swimming in shallow water, and then settle to the bottom (FWS, 2006; ASMFC, 1998a). Juveniles will spend their first 2 year on intertidal sand flats. Older juveniles and adults inhabit subtidal habitats (ASMFC, 2010a). Molting continues after the juvenile stage, with each molt increasing the crab's size by up to 25 percent. After about 17 molts, or 9 to 12 years, the crabs are sexually mature (ASMFC, 2008a). Crabs can live up to 10 additional years after the last molt (ASMFC, 2010a). Horseshoe crabs exhibit limited beach fidelity, usually returning to their native beaches to spawn (FWS, 2003). However, crabs tagged in the Delaware Bay have been recaptured in New Jersey, Delaware, Maryland, and Virginia (ASMFC, 2008b).

Horseshoe crabs play a major ecological role in the migration patterns of shore birds from the Arctic to the southern Atlantic. Many bird species eat horseshoe crab eggs during their seasonal migrations on the Atlantic flyway (ASMFC, 2008a; FWS, 2006). Juvenile and adult horseshoe crabs eat mostly mollusks, such as clams and mussels, but also arthropods, annelids, and nemerteans. Larvae consume small polychaetes and nematodes (ASMFC, 1998a). In addition to providing a rich food source for birds, eggs and larvae are consumed by fish, crabs, gastropods, and loggerhead sea turtles (*Caretta caretta*) (ASMFC, 1998a). Seagulls often eat overturned adults on the beach (FWS, 2003).

Commercial uses for horseshoe crabs include applications in the fishing, biomedical, and livestock and fertilizer industries. Fisherman use horseshoe crabs as bait in the American eel and conch (*Busycon carica* and *B. canaliculatum*) fisheries. The biomedical industry uses their blood to detect contaminated medicine. This fishery captures, bleeds and releases the crabs (FWS 2003). At the turn of the 20th century, between 1.5 and 4 million horseshoe crabs were harvested annually for use by the livestock and fertilizer industries. Variations and reductions in harvests since that time are partially due to management and partially due to a decrease in demand. Stock status is currently unknown due to lack of commercial fishing data. Evidence from trawl surveys suggests that the population is growing in Delaware Bay. Harvests have been reduced in Delaware, but are increasing in Massachusetts and New York (ASMFC, 2008a). The management plan for the horseshoe crab provides limits on harvet seasons for male and female crabs, and for total hauls (ASMFC, 2008b).

Threats to horseshoe crab habitat include coastal erosion, development (particularly shoreline stabilization structures such as bulkheads, groins, seawalls, and revetments), sea level rise/land subsidence, channel dredging, contaminants, and oil spills in spawning areas. Habitats of concern include nearshore shallow water and intertidal sand flats, and beach spawning areas (ASMFC, 2010a).

American Oyster

The American oyster is also known as the eastern oyster and the Atlantic oyster. Oysters inhabit the Delaware Bay from the mouth of the bay to Bombay Hook on the Delaware side and to just south of Artificial Island on the New Jersey side (USACE, 2007). There are three physiological races recognized coast wide, each spawning at different temperatures. The oysters in the Delaware Bay are part of the population that spawns at 20 °C (68 °F). Spawning occurs in the summer months, with several events per season. During spawning events, males release their sperm and a pheromone into the water column and the females respond by releasing their eggs. Larvae remain in the water column for 2 to 3 weeks, dispersing with the water currents. Larvae pass through several morphological changes before settling, preferably on other oyster shells. Adult oysters are sessile and found in beds or reefs in dense masses. They often are the only large organism in the bed and can change water currents enough to affect the sediment deposition rate of the local environment. They are dioecious, but are capable of changing sex, with more oysters becoming female as they age. Growth is affected by environmental variables, such as temperature, salinity, intertidal exposure, turbidity, and food availability (Sellers and Stanley, 1984).

Oysters are tolerant of a wide array of environmental variables, as they have evolved to live in estuaries, which experience high and low temperatures, high and low salinities, submersion and exposure, and clear to muddy water. Optimal temperatures for adults are between 20°C and 30°C (68°F and 86°F). Salinities higher than 7.5 ppt are required for spawning, but adults will tolerate salinities between 5 and 30 ppt. Because oysters are filter feeders, water velocity is highly important. The water above a bed must be recharged 72 times every 24 hours for maximum feeding. Tidal flows of greater than 5 to 8.5 fps (152 to 259 centimeters per second [cm/sec]) provide for optimal growth (Sellers and Stanley, 1984).

Oyster larvae feed on plankton. Adults are stationary filter feeders, feeding on plankton as well as detritus and other particulate matter. They can filter up to 1.5 liters of water an hour, making them an important ecological resource. Due to their reef building abilities, they are also important because they create three-dimensional habitats, which can be home to over 300 other species. A wide variety of other filter feeders eat oyster larvae. Predators of adult oysters include gastropod oysterdrills (*Urosalpinx cinerea* and *Eupleura caudata*), the whelk *Busycon canaliculatum,* the starfish *Asterias forbesi*, the boring sponge (*Cliona* sp.), the flatworm *Stylochus ellipticus*, and crabs. Competitors for resources include slipper limpets (*Crepidula* sp.), jingle shells (*Anomia* sp.), barnacles, and the mussel *Brachiodontes exustus* (Sellers and Stanley, 1984).

The oyster is a commercially important species that has been harvested in Delaware Bay since the early 1800s (Delaware Estuary Program, 2010). By the mid 1850s, oyster fisherman had begun transplanting oysters from the naturally occurring seed beds of New Jersey to other areas in the bay for growth, due to concern over the smaller size of oysters being harvested. The natural seed beds are now protected outside of the leasing system, as these are the sources of the oysters transplanted to other beds. In the early 1900s, one to two million bushels were harvested from the bay annually, concurrent with the use of the new oyster dredge. Production remained relatively stable until the mid 1950s when disease decimated the population. Currently, the oyster harvest remains limited due mainly to diseases such as MSX ("multinucleated sphere unknown," later classified as *Haplosporidium nelson)* and Dermo (caused by the southern oyster parasite, *Perkinsus marinus*). Oysters now are directly harvested from the seed beds (Delaware Estuary Program, 2010).

Delaware, New Jersey, and the USACE currently are undertaking a joint effort to reestablish oyster beds and an oyster fishery in Delaware Bay. The majority of these efforts are focused on increasing recruitment and sustaining a population by shell and bed planting and seeding. Since 2001, despite management, oyster abundance has continued to decline due to below average recruitment. Recruitment enhancement is deemed important to stabilize stock abundance, to permit continuation and expansion of the oyster industry, to guarantee increased abundance that produces the shell necessary to maintain the bed, and to minimize the control of oyster population dynamics by disease. These goals will allow the oyster to play its ecological role as a filterer that enhances general water quality (USACE, 2007).

2.2.5.4 Fish

The Delaware Bay, Estuary, and River make up an ecologically and hydrologically complex system that supports many fish species. Most estuarine fish species have complex life cycles and are present in the estuary at various life stages; thus, they may play several ecological roles during their lives. Changes in the abundance of these species can have far-reaching effects, both within the bay and beyond, including effects on commercial fisheries. Given the complexity of the fish community of this system, the description below is based on species considered to be of particular importance for a variety of reasons.

Representative Species

To determine the impacts of operation from Salem and HCGS on the aquatic environment of the Delaware Estuary, monitoring has been performed in the estuary annually since 1977. The 1977 permitting rule for Section 316(b) of the CWA included a provision to select representative species (RS) to focus such investigations (the terms target species or representative important species have also been used) (PSEG, 1984; 1999). RS were selected based on several criteria: susceptibility to impingement and entrainment at the facility, importance to the ecological community, recreational or commercial value, and threatened or endangered status. PSEG currently monitors 12 species as RS: blueback herring (*Alosa aestivalis*), alewife (*Alosa pseudoharengus*), American shad (*Alosa sapidissima*), bay anchovy (*Anchoa mitchilli*), Atlantic menhaden (*Brevoortia tyrannus*), weakfish (*Cynoscion regalis*), spot (*Leiostomus xanthurus*), Atlantic silverside (*Menidia menidia*), Atlantic croaker (*Micropogonias undulatus*), white perch (Morone americana), striped bass (*Morone saxatilis*), and bluefish (*Pomatomus saltatrix*). These species are described below.

Blueback Herring and Alewife

The blueback herring and alewife can be difficult to differentiate and are collectively known and managed as "river herring." The NMFS currently classifies both species as species of concern (NMFS, 2009).

The entire length of the Delaware River and portions of Delaware Bay are confirmed spawning runs for river herring (NJDEP, 2005d). River herring are anadromous, migrating inshore to spawn in freshwater rivers and streams in a variety of habitats. They are reported to return to their natal rivers, suggesting a need for management more focused on specific populations as opposed to establishing fishery-wide limits. Spawning migration begins in spring, with the alewife arriving inshore approximately one month before the blueback herring (NMFS, 2009). The adults of both species return to the ocean after spawning (ASMFC, 2009a).

Blueback herring can reach 16 inches (41 cm) long and have an average life span of 8 years. Males usually mature at 3 to 4 years of age, females at 5 years. Young of the year and juveniles of less than 2 inches (5 cm) are found in fresh and brackish estuarine nursery areas. They then migrate offshore to complete their growth. The juveniles use many habitats in the estuaries, including submerged aquatic vegetation, rice fields, swamps, and small tributaries outside the tidal zone (NMFS, 2009). Blueback herring prefer swiftly flowing water for spawning in their northern range.

Alewife reach maturity at approximately 4 years and can live 10 years, reaching up to 15 inches (38 cm) long (NMFS, 2009). They spawn over gravel, sand, detritus, and submerged aquatic vegetation in slow-moving water. Spawning is more likely to occur at night, and a single female may spawn with 25 males simultaneously. The eggs initially stick to the bottom, but they soon become pelagic and hatch within 2 to 25 days. The yolk sac is absorbed within 5 days and the larvae may remain in the spawning areas or migrate downstream to more brackish waters. Juveniles inhabit the brackish areas in estuaries, near their spawning location. As they develop and the temperature drops, they migrate toward the ocean, completing this process in the beginning of the winter months (NMFS, 2009).

While at sea, many predators eat river herring, including marine mammals, sharks, tuna, and mackerel. While in the estuaries, American eel, striped bass, largemouth bass, mammals, and birds consume them. The blueback herring and alewife minimize interspecific competition using several mechanisms, including the timing of spawning, juvenile feeding strategies and diets, and ocean emigration timing (ASMFC, 2009a). Blueback juveniles feed on benthic organisms and copepods, cladocerans, and larval dipterans at or just below the water surface (ASMFC, 2009a). While offshore, blueback herring feed on plankton, including ctenophores, copepods, amphipods, mysids, shrimp, and small fish (NMFS, 2009). During the spawning migration (unlike the alewife, which does not feed), the blueback herring feeds on invertebrates and fish eggs (ASMFC, 2009a). Juveniles are opportunistic feeders on a variety of invertebrates (ASMFC, 2009a). Alewife are schooling, pelagic omnivores while offshore, feeding mainly on zooplankton but also small fishes and their eggs and larvae (NMFS, 2009). Alewife not only migrate seasonally to spawn in response to temperatures but also migrate daily in response to zooplankton availability (NMFS, 2009). Adult alewife are eaten by many other fish. Alewife are also important as hosts to parasitic larvae of freshwater mussels, some species of which are threatened or endangered (ASMFC, 2009a). Both species are ecologically important due to their trophic position in both estuarine and marine habitats. As planktivores, they link zooplankton to piscivores, providing a vital energy transfer (Bozeman and VanDen Avyle, 1989).

River herring are directly consumed by humans and also are ingredients in fish meal, fish oil, pet and farm animal food, and bait. The eggs (roe) are canned for human consumption. The ASMFC manages the river herring fishery (ASMFC, 2009a). River herring also are often taken as bycatch in other fisheries (NMFS, 2009). The river herring fishery has been active in the United States for 350 years. Alewife landings peaked in the 1950s and the 1970s, then abruptly declined (NMFS, 2009). Blueback herring landing data are limited, but a severe decline was observed in the early 2000s. In addition to the commercial industry, there is an extensive recreational fishery. Blueback herring are exhibiting signs of overfishing in several of the estuary systems on the east coast, including the Delaware River (ASMFC, 2009a). River herring population declines have been attributed to overfishing and the loss of historic spawning habitat all along the east coast of the United States (NMFS, 2009). Reasons for habitat loss include dam construction, stream bank erosion, pollution, and siltation (ASMFC, 2009a). New Jersey currently has a small commercial bait fishery for river herring. Delaware also has a small river herring fishery associated with the white perch fishery. Neither State has specific regulations for river herring, but pending legislation in Delaware could eliminate the fishery in that State (ASMFC, 2009a).

American Shad

The American shad has been a commercially and culturally important species on the east coast of the United States since colonial times. The entire length of the Delaware River is a confirmed spawning run for the American shad. There is no confirmed information available on Delaware Bay itself, although shad would have to migrate through the bay to get to the river (NJDEP, 2005d). American shad adults are highly abundant in Delaware Bay, potentially confirming the use of the estuary as part of the spawning run (ASMFC, 1998b).

The American shad is a schooling, anadromous fish that migrates to freshwater to spawn in winter, spring, or summer, with the timing depending on water temperature. Mature shad can spawn up to six times over their lifetimes of 5 to 7 year. Preferred spawning substrates include sand, silt, muck, gravel, and boulders. Water velocity must be rapid enough to keep the eggs off the bottom. Eggs are spawned in areas that will allow them to hatch before drifting downstream into saline waters. At 4 weeks, the larvae become juveniles and spend their first summer in the freshwater systems (Mackenzie et al., 1985). The juveniles migrate toward the ocean in the fall months, cued by water temperature changes. In the Delaware River, this happens when the water reaches 20°C (68°F), usually in October and November. The juveniles will remain in the estuary until they are 1 year old (ASMFC, 1998b), then they migrate into the ocean. Juveniles remain in the ocean until they are mature, approximately 3 to 5 years for males and 4 to 6 years for females. Adults are likely to return to their natal rivers to spawn (MacKenzie et al., 1985).

Ecologically, the American shad plays an important role in the coastal estuary systems, providing food for some species and preying on others. It also transfers nutrients and energy from the marine system to freshwater areas because many shad die after they spawn (ASMFC, 1998b). Young American shad in the river systems feed in the water column on a variety of invertebrates. While at sea, they feed on invertebrates, fish eggs, and small fish (MacKenzie et al. 1985; ASMFC, 1998b). During the spawning run, shad consume mayflies and small fish.

Many species prey on shad while they are small, including striped bass, American eels, and birds. Seals, porpoises, sharks, bluefin tuna (Thunnus thynnus), and kingfish (Scomberomorus regahni) consume larger shad (Weiss-Glanz et al., 1986). Much of the American shad's life cycle is dictated by changes in ambient temperature. The peak of the spawning run and the ocean emigration happen when the water temperature is approximately 20°C (68°F). Deformities develop if eggs encounter temperatures above 22°C (72°F) and they do not hatch above 29°C (84°F). Juveniles actively avoid rises in temperature of 4°C (39°F) (MacKenzie et al., 1985).

Historically, huge numbers of American shad were harvested during their annual spring spawning runs. The Atlantic catch in 1896 was 50 million lbs (22,700 metric tons [MT]) (MacKenzie et al., 1985). By the end of the 19th century, only 17.6 million lbs (8,000 MT were caught, representing a severe decline in the American shad stock, and the fishery began fishing in the waters of the lower bays. Several States, including Maryland, closed the American shad fishery by 1985 (MacKenzie et al., 1985). The ASMFC currently manages the American shad fishery. The ASMFC stock assessment (2007a) showed American shad stocks are continuing to depete severley and are not recovering, with Atlantic harvests of approximately 550 tons (500 MT). The shad coastal intercept fishery in the Atlantic has been closed since 2005; additionally there is a 10 fish limit for the recreational inshore fishery. The reasons for their decline include dams, habitat loss, pollution, and overfishing (ASMFC, 2007a). A report published by the ASMFC (1998a) theorized that increased predation by the striped bass is also a factor in the decline of shad abundance (ASMFC, 1998b).

Bay Anchovy

The bay anchovy is an abundant forage fish in Delaware Bay. It is a small, schooling, euryhaline fish that grows to approximately 4 inches (10 cm) and can live for several years (Morton, 1989; SMS, 2008). It lives in waters ranging from fresh to hypersaline over almost any bottom type, including sand, mud, and submerged aquatic vegetation (Morton, 1989; Newberger and Houde, 1995). The bay anchovy spawns almost all year, typically in waters of less than 65 ft (20 m) deep. In the Middle Atlantic region, spawning occurs in estuaries in water of at least 12°C (54°F) and over 10 ppt salinity. The eggs are pelagic and hatch after about 24 hours. Newly hatched fish move upstream into lower-salinity areas to feed, eventually migrating to the lower estuary in the fall (Morton, 1989).

The bay anchovy is highly important both ecologically and commercially due to its abundance and widespread distribution (Morton, 1989). It plays a large role in the food webs that support many commercial and sport fisheries by converting zooplankton biomass into food for piscivores (Morton, 1989; Newberger and Houde, 1995). Young bay anchovies feed mainly on copepods, and adults consume mysids, small crustaceans, mollusks, and larval fish. Copepods are the primary food source of bay anchovies in Delaware Bay. Adult bay anchovies are tolerant of a range of temperatures and salinities and move to deeper water for the winter (Morton, 1989). There is no bay anchovy fishery, so they are not directly economically important. However, they support many other commercial fisheries as they are often the most abundant fish in coastal waters (Morton, 1989). Several authors count them as the most important link in the food web, as they are a primary forage item for many other fish, birds, and mammals (Morton, 1989; SMS, 2008; Newberger and Houde, 1995). Juvenile fish and gelatinous predators such as sea nettles and ctenophores consume bay anchovy eggs. Bay anchovy often account for over half the fish, eggs, or larvae caught in research trawls (SMS, 2008). Striped bass are heavily dependent on bay anchovies as larvae, juveniles, and adults, especially since the menhaden and river herring populations have declined in recent years (CBF, 2010).

Atlantic Menhaden

The Atlantic menhaden is a small schooling fish inhabiting the Atlantic coast from Nova Scotia to northern Florida in estuarine and nearshore coastal waters. It migrates seasonally, spending early spring through early winter in estuaries and nearshore waters, with the larger and older fish moving farther north during summer (ASMFC, 2005a). Spawning occurs offshore in fall and early winter between New Jersey and North Carolina (ASMFC, 2005a). The eggs are pelagic and hatch in 1 to 2 days. Once the yolk sac is absorbed at 4 days old, larvae begin to feed on plankton. Larvae enter estuary nursery areas after 1 to 3 months, between October and June in the Mid-Atlantic. Prejuvenile fish use the shallow, low salinity areas in estuaries as nurseries, preferring vegetated areas in fresh tidal marshes and swamps, where they become juveniles (Rogers and Van Den Ayvle, 1989). Juveniles spend approximately 1 year in the estuarine nurseries before joining the adult migratory population in late fall (ASMFC, 2005a). Larvae that entered the nursery areas late in the year may remain until the next fall. Once juveniles metamorphose to adults, they switch from individual capture to a filter feeding strategy. Fish are mature at age 2 or 3 and will then begin the spawning cycle (Rogers and Van Den Ayvle, 1989). Atlantic menhaden can live up to 8 years, but fish older than 6 years are rare (ASMFC, 2001).

Due to its high abundance and trophic positioning in the nearshore and estuarine ecosystems, the Atlantic menhaden is ecologically vital along the Atlantic coast (Rogers and Van Den Ayvle, 1989). It is a filter feeder that strains plankton from the water column and provides a trophic link between primary producers and the larger predatory species in nearshore waters (ASMFC, 2005a). It also transfers energy in and out of estuary systems and on and off the coastal shelf (Rogers and Van Den Avyle, 1989). It is especially important in this regard, as most marine fish species cannot use plankton as a food source (ASMFC, 2001). Rogers and Van Den Avyle (1989) hypothesized that due to its abundance and migratory movements, the Atlantic menhaden may change the assemblage structure of plankton in the water column. Larvae in the estuaries feed preferentially upon copepods and copepodites and may eat detritus as well. Young fish and adults filter feed on anything larger than 7 to 9 micrometers, including zooplankton, large phytoplankton, and chain diatoms (Rogers and Van Den Avyle, 1989). The Atlantic menhaden provides a food source for many larger fish (ASMFC, 2001; Rogers and Van Den Avyle, 1989). Its filter-feeding habits also have lead to a variety of physiological characteristics, such as high lipid content, which enables their survival during periods of low prey availability (Rogers and Van Den Avyle, 1989).

The Atlantic menhaden has been an important commercial fish along the Atlantic coast since colonial times. It has been fished since the early 1800s, and landings increased over time as new technologies developed (ASMFC, 2005a). The ASMFC manages the fishery. Currently, the reduction industry uses Atlantic menhaden for fish meal and oil, and both commercial and recreational fisheries use them as bait. Atlantic menhaden populations suffered in the 1960s when they were severely overfished, but they recovered in the 1970s. A stock assessment completed in 2003 declared that the Atlantic menhaden were not overfished, and a review in 2004 resulted in a decision not to require an assessment in 2006 (ASMFC, 2005a).

Weakfish

The weakfish inhabits the Atlantic coast from Nova Scotia to southern Florida, but is more common between New York and North Carolina (ASMFC, 2009b). Its growth varies geographically, with northern populations becoming much larger and living longer than the more southern populations. Within the Delaware Bay, the oldest females (age 9 years) were an average of 28 inches (710 mm) long, and the oldest males (6 years) were an average of 27 inches (686 mm) long (Mercer, 1989). Spring warming induces inshore migration from offshore wintering areas and spawning (ASMFC, 2009b). Spawning occurs in estuaries and nearshore areas between May and July in the New York Bight (Delaware Bay to New York) (Mercer, 1989). The weakfish is a batch spawner that continuously produces eggs during the spawning season, allowing more than one spawning event per female (ASMFC, 2002). Larval weakfish migrate into estuaries, bays, sounds, and rivers to nursery habitats, where they remain until they are 1 year old (ASMFC, 2009b; Mercer, 1989). Eggs are pelagic and hatch between 36 and 40 hours after fertilization. Larvae become demersal soon after this. Juvenile weakfish use the deeper waters of estuaries, tidal rivers, and bays extensively but do not often inhabit the shallower areas closer to shore. Within Delaware Bay, juvenile weakfish migrate toward lower salinities in the summer, higher salinities in the fall, and offshore for the winter months. Adults migrate inshore seasonally to spawn in large bays or the nearshore ocean. As temperatures cool for the winter, weakfish migrate to ocean wintering areas, the most important of which is the continental shelf between the Chesapeake Bay and North Carolina (Mercer, 1989).

The weakfish plays an important ecological role as both predator and prey in the estuarine and nearshore food webs (Mercer, 1989). Adults feed on peneid and mysid shrimps and a variety of other fishes. Younger weakfish consume mostly mysids and other zooplankton and invertebrates (Mercer, 1989; ASMFC, 2002). Weakfish are tolerant of a relatively wide variety of temperatures and salinities. In Delaware Bay, weakfish have been collected in temperatures between approximately 62.6°F and 82.4°F (17°C and 28°C) and salinities of 0 to 32 ppt (Mercer, 1989).

The weakfish is part of a mixed stock fishery that has been economically vital since the early 1800s (ASMFC, 2009b). It was historically highly abundant in Delaware Bay. It topped commercial landings in the State of Delaware until the 1990s and was consistently within the top five species in recreational landings (DNREC, 2006a). Weakfish biomass has declined significantly in recent years, with non-fishing pressures such as increased natural mortality, predation, competition, and environmental variables hypothesized as the cause for the decline (ASMFC, 2009b). Commercial landings have fluctuated since the beginning of the fishery, without apparent trend or sufficient explanation (ASMFC, 2009b; Mercer, 1989). Landings along the Atlantic coast peaked in the 1970s then declined throughout the 1980s and early 1990s. Management measures increased stock and commercial harvest until 1998, when the fishery declined again, this time continuously until 2008 (ASMFC, 2009b). Between 1995 and 2004, commercial landings in Delaware dropped by 82 percent and the recreational harvest dropped by 98 percent, reflecting a coast-wide drop of 78 percent (DNREC, 2006a). The results of the 2009 stock assessment defined the fishery as depleted, but not overfished, with natural sources of mortality listed as the cause of the low biomass levels. The ASMFC is currently developing an amendment to the management plan to address the decline (ASMFC, 2009b).

Spot

The range of spot along the Atlantic coast stretches from Maine to Florida. They are most abundant from the Chesapeake Bay to North Carolina (ASMFC, 2008c). During fall and summer, they are highly abundant in estuarine and near-shore areas from Delaware Bay to Georgia (Phillips et al., 1989). Spot migrate seasonally, spawning offshore in fall and winter at 2 to 3 years of age and spending the spring months in estuaries (ASMFC, 2008c). Spawning occurs offshore over the continental shelf from October to March. The eggs are pelagic and hatch after approximately 48 hours, producing buoyant larvae that become more demersal and migrating from the mid-depths during the day to the surface at night. The larvae move slowly toward shore, entering the post-larval stages when they reach nearshore areas and developing into juveniles when they reach the inlets (Phillips et al., 1989). Juveniles move into the low-salinity coastal estuaries, where they grow before moving into higher-salinity areas as they mature (ASMFC, 2008c). Seagrass beds and tidal creeks are important nursery habitats for spot, which often make up 80 to 90 percent of the total number of fish found in these habitats. Juveniles remain in the nursery areas for approximately a year, migrating back to the ocean in September or October (Phillips et al., 1989). Spot are tolerant of a wide range of environmental conditions; they inhabit water temperatures between 46.4 and 87.8°F (8 and 31°C) and salinities between 0 and 61 ppt (Phillips et al., 1989).

Due to their large numbers and use of a variety of habitats throughout their lifetimes, spot are an ecologically important species as both prey and predators. Spot may significantly reduce zooplankton biomass during their migration to the ocean. Juvenile and young spot eat benthic invertebrates. Adult spot are also benthic feeders, scooping up sediments and consuming large numbers of polychaetes, copepods, decapods, nematodes, and diatoms. Spot are important prey for fish such as spotted seatrout and striped bass and for birds such as cormorants. Spot make up a major portion of the fish biomass and numbers in estuarine waters of the Mid-Atlantic Region (Phillips et al., 1989).

Commercial landings of spot fluctuate widely because spot are a short-lived species (4 to 6 years) and most landings are composed of a single age class (ASMFC, 2008c). Commercial landings varied between 3.8 and 14.5 million lbs (1.7 and 6.6 million kg) between 1950 and 2005 (Austin et al., 2006). In addition, spot are a large component of the bycatch in other fisheries, including the south Atlantic shrimp trawl fishery (ASMFC, 2008c). Spot also are a very popular recreational species, with recreational landings sometimes surpassing commercial landings (Austin et al., 2006).

Atlantic Silverside

The Atlantic silverside inhabits salt marshes, estuaries, and tidal creeks along the Atlantic coast from Nova Scotia to Florida. It can be the most abundant fish in these habitats. Juveniles and adults inhabit intertidal creeks, marshes, and shore areas in bays and estuaries during spring, summer, and fall. During winter in the Mid-Atlantic Region, Atlantic silversides often migrate to deeper water within the bays or offshore (Fay et al., 1983a). Spawning occurs in the intertidal zones of estuaries between March and July in the Mid-Atlantic Region. Most Atlantic silversides die after their first spawning season, though they may spawn between 5 and 20 times in one season (NYNHP, 2009). Atlantic silverside spawning is a complex behavior in which fish swim parallel to the shore until the appropriate tidal level is reached, then the school rapidly turns shoreward to spawn in the shallows in areas where eggs may attach to vegetative substrates.

Eggs are demersal and adhesive, sticking to eel grass, cordgrass, and filamentous algae. Eggs hatch after 3 to 27 days, depending on temperature. The sex of an individual fish is determined by water temperature during the larval stage – colder temperatures produce more females and warmer temperatures produce more males. Larvae usually inhabit shallow, low salinity (8 to 9 ppt) water in estuaries and are most often found at the surface (Fay et al., 1989a). Eggs and larvae tolerate a wide degree of environmental conditions. Juveniles and adults appear to prefer temperatures between 64.4°F and 77°F (18°C and 25°C). The optimum salinity for hatching and early development is 30 ppt, but juveniles and adults tolerate a wide range of salinities (0 ppt to 38 ppt) (Fay et al., 1983a).

Ecologically, the Atlantic silverside is an important forage fish and plays a large role in the aquatic food web and in linking terrestrial production to aquatic systems. Due to their short life span and high winter mortality (up to 99 percent), they play a vital part in the export of nutrients to the near and offshore ecosystem. Little is known about the larval diet. Juvenile and adult fish are opportunistic omnivores and eat invertebrates, fish eggs, algae, and detritus. They feed in large schools over gravel and sand bars, open beaches, tidal creeks, river mouths, and tidally-flooded zones of marsh vegetation. They are prey for many species of commercially and recreationally important fish, crabs, and shorebirds (Fay et al., 1983a). There is no direct commercial or recreational fishery for this species, although many recreational fishers net these minnows for use as bait (Fay et al., 1983a).

Atlantic Croaker

The Atlantic croaker is a migratory species that appears to move inshore in the warmer months and southward in winter, although its movements have not been well defined (ASMFC, 2007b). It ranges from Cape Cod to Argentina and is uncommon north of New Jersey. Atlantic croaker are estuarine dependant at all life stages, especially as postlarvae and juveniles (Lassuy, 1983). Spawning occurs at 1 to 2 years of age in nearshore and offshore habitats between July and December (ASMFC, 2007b). Atlantic croaker can live for up to 12 years, and will spawn more than once in a season. Eggs are pelagic and are found in waters of varying salinities. Larvae have been found from the continental shelf to inner estuaries. Recruitment to the nursery habitats in the estuaries depends largely on currents and tides and appears to have seasonal peaks depending on latitude. Peak recruitment in the Delaware Estuary occurs in August through October. Ages at recruitment may vary from 2 months to 10 months. Larvae complete their development into juveniles in brackish, shallow habitats. Juveniles slowly migrate downstream, preferring stable salinity regimes in deeper water, and eventually enter the ocean in late fall as adults. They prefer mud bottoms with detritus and grass beds that provide a stable food source, but they are considered generalists (ASMFC, 2005b). Adult croaker are usually found in estuaries in spring and summer and offshore for the winter; their distribution is related to temperature and depth. They prefer muddy and sandy substrates that can support plant growth, but have also been found over oyster reefs. They are euryhaline, depending on the season, and are also sensitive to low oxygen levels. Atlantic croaker are bottom feeders that eat benthic invertebrates and fish. Larvae tend to consume large amounts of zooplankton, and juveniles feed on detritus (ASMFC, 2005b).

The Atlantic croaker is an important commercial and recreational fish on the Atlantic coast and the most abundant bottom-dwelling fish in this region. It has been harvested as part of a mixed stock fishery since the 1880s. Commercial landings appear to be cyclical, with catches ranging between 2 million lbs and 30 million lbs (0.9 million kg and 13.6 million kg). This may be due to variable annual recruitment, which appears to be dependent on natural environmental variables. Recreational landings have been increasing. The 2003 stock assessment determined that the Atlantic croaker was not overfished in the Mid-Atlantic Region (ASMFC, 2007b). A 2005 amendment to the management plan established fishing mortality and spawning stock biomass targets and thresholds for this species. There are no recreational or commercial management measures in this amendment, but some states have adopted internal management measures for the Atlantic croaker fishery (ASMFC, 2005b).

White Perch

The white perch is a member of the bass family that fills a vital trophic niche as both predator and prey to many species. It is a commercially and recreationally important species inhabiting coastal waters from Nova Scotia to South Carolina, with its highest abundance in New Jersey, Delaware, Maryland, and Virginia (Stanley and Danie, 1983). The white perch is a schooling fish that can grow up to 10 inches (25 cm) long in freshwater, 15 inches (38 cm) long in brackish water, and can live up to 10 years (PFBC, 2010; MDNR, 2008). It spawns in a wide variety of habitats, such as rivers, streams, estuaries, lakes, and marshes, usually in freshwater. Water speed and turbidity are not important in choosing a spawning location. Rising water temperature induces spawning in April through May in freshwater and in May through July in estuaries (Stanley and Danie, 1983). Marine and estuarine populations migrate to freshwater areas to spawn and, thus, are anadromous (PFBC, 2010). A single female spawns with several males. The eggs attach to the bottom immediately. Hatchlings remain in the spawning area for up to 13 days, then they drift downstream or with estuarine currents and become more demersal as they grow. Larvae can tolerate up to 5 ppt salinity, and adults can tolerate full seawater. Juveniles often inhabit upper estuarine nurseries, where they may stay for a year, preferring habitats with silt, mud, or plant substrates. Older juveniles move to offshore beach and shoal areas during the day, but return to the more protected nursery areas at night (Stanley and Danie, 1983).

Ecologically, the white perch plays several important roles in its lifecycle. It is omnivorous and will feed on both plankton and benthic species, but it concentrates on fish after it is fully grown. Freshwater populations feed on aquatic insects, crustaceans, fishes, and detritus (Stanley and Danie, 1983). Estuarine populations consume fish (such as alewife, gizzard shad, and smelt), fish eggs, and invertebrates (Stanley and Danie, 1983; PFBC, 2010). White perch provide food for Atlantic salmon, brook trout, chain pickerel, smallmouth bass, largemouth bass, and other piscivorous fish and terrestrial vertebrates (Stanley and Danie, 1983).

The largest commercial landings of white perch occurred at the turn of the 20th century. Catch levels then decreased, rising sporadically to reflect large year classes. White perch are a popular recreational fish in freshwater and estuaries. They are often the most abundant species caught recreationally in the northern Atlantic states (Stanley and Danie, 1983).

Striped Bass

Striped bass inhabit the Atlantic coast from the St. Lawrence River in Canada to northern Florida. They are highly abundant in both the Delaware Bay and Chesapeake Bay. Females can grow up to 65 lbs (29.4 kg) and live for 29 years, whereas males over 12 years old are uncommon (Fay et al., 1983b). Striped bass migrate along the coast seasonally and are anadromous, spawning in rivers and estuaries after reaching an age of 2 years (males) to 4 years (females) (ASMFC, 2008d). There are known riverine and estuarine spawning areas in the upper Delaware and Chesapeake bays. Spawning occurs in April through June in the Mid-Atlantic Region, with some of the most important spawning areas found in the upper Chesapeake Bay and the Chesapeake-Delaware Canal (Fay et al., 1983b). In the Delaware River, the main spawning grounds are located between Wilmington, DE, and Marcus Hook, PA (Delaware Division of Fish and Wildlife, 2010b). The eggs are pelagic and both eggs and larvae tend to remain in the spawning area throughout the early developmental stages. Most juveniles also remain in the estuaries where they were spawned until they reach adult size, tending to move downstream after the first year. On the Atlantic coast, some adults leave the estuaries and join seasonal migrations to the north in the warmer months, while others remain in the estuaries. Some of these adults will also migrate into coastal estuaries to overwinter. Reproduction is highly variable, with several poorly successful seasons between each strong year class. Variability in adult and juvenile behavior and the unpredictable importance of strong year classes makes management of the fishery challenging. There are four different stocks identified along the Atlantic coast, including the Roanoke River-Albemarle Sound, Chesapeake Bay, Delaware River, and Hudson River stocks (Fay et al., 1983b).

Striped bass are tolerant of a wide variety of environmental variables but require specific conditions for successful reproduction. Higher water flows and colder winters may produce successful year classes. Eggs tolerate temperatures of between 57.2°F and 73.4°F (14°C and 23 °C), salinities of 0 to 10 ppt, dissolved oxygen of 1.5 to 5.0 mg/L, turbidity of 0 to 500 mg/L, pH of 6.6 to 9.0, and a current velocity of 1.4 to 197 inches/sec (30.5 to 500 cm/sec). Larvae are slightly more tolerant of variables outside these ranges, and juveniles are even more tolerant (Fay et al., 1983b). Young and juveniles tend to inhabit sandy bottoms in shallow water, but can also inhabit areas over gravel, mud, and rock. Adults use a wide variety of bottom types, such as rock, gravel, sand, and submerged aquatic vegetation (ASMFC, 2010b). Larvae and juveniles consume invertebrates,fish eggs, and small fish. Young striped bass eat invertebrates and small fish. Adults are mainly piscivorous, consuming schooling bait fish as well as invertebrates (Fay et al., 1983b; DNREC, 2006b). Young striped bass provide food for weakfish, bluefish, white perch, and other large fishes; a variety of predators eat larvae and eggs. Adult striped bass probably compete with weakfish and bluefish, and juveniles are likely to compete with white perch in the nursery areas (Fay et al., 1983b). Striped bass do not feed while on spawning runs (DNREC, 2006b).

The striped bass is historically one of the most important fishery species along the Atlantic coast from Maine to North Carolina, with recreational landings exceeding commercial landings (ASMFC, 2003; 2008d). Its population has recovered since a sharp decline from its peak in the 1970s (ASMFC, 2008d). The 2007 stock assessment declared the fishery recovered, fully exploited, and not overfished. This recovery is considered one of the greatest successes in fisheries management (ASMFC, 2008d). The recovery of the striped bass fishery may be the cause of a decline in weakfish abundance (DNREC, 2006b).

Bluefish

The bluefish is a migratory schooling fish that inhabits estuaries and the oceans over the continental shelf in tropical and temperate waters globally. It occurs in the Atlantic from Nova Scotia to northern Mexico. Adults migrate north during summer between Cape Hatteras and New England and spend winter in the south near Florida in the Gulf Stream. Bluefish spawn in the open ocean (Pottern et al., 1989). There is a single spawning event that begins in the south in the late winter and continues northward into the summer as the fish migrate (ASMFC, 1998c). Eggs are pelagic and larvae drift with the offshore currents until coastal waters become warmer (Pottern et al., 1989; ASMFC, 1998c). Larvae transform to a pelagic juvenile stage in 18 to 25 days (NOAA, 2006). Spring-spawned juveniles then migrate into bays and estuaries at 1 to 2 months old, where they complete their development before joining the adult population in the fall (Pottern et al., 1989). Summer-spawned juveniles enter the estuaries for only a short time before migrating south for the winter (ASMFC, 1998c). Some juveniles will spend a second summer in the estuaries (Pottern et al., 1989). Bluefish can live for up to 12 years and reach lengths of 39 inches (91.4 cm) and weights of 31 lbs (14 kg) (ASMFC, 2006).

Due to its large size and numbers, the bluefish probably plays a large role in the community structure of forage species along the Atlantic coast. Larval bluefish consume large quantities of zooplankton, mostly copepods, in the open ocean (Pottern et al., 1989; NOAA, 2006). Juveniles in the estuaries eat small shrimp and fish. Adult bluefish are mostly piscivorous but also eat invertebrates. (Pottern et al., 1989). Bluefish are highly sensitive to temperature, preferring an optimum range of 64 °F to 68 °F (18 °C to 20 °C). Temperatures above or below this range can induce rapid swimming, loss of interest in food, loss of equilibrium, and changes in schooling and diurnal behaviors. They are found in estuaries at 10 ppt and waters of up to 38 ppt in the ocean (Pottern et al., 1989).

The bluefish has been a highly important recreational fish species since the 1800s. It is harvested for human consumption but there is no commercial bluefish industry. Slightly less than half the recreational catch is in inland bays and estuaries (Pottern et al., 1989). A bluefish management plan was developed in 1990 due to the continuous decline in landings since the early 1980s (ASMFC, 2006; 1998c). Recent numbers have been rising in response to the management plan amendment developed in 1998 (ASMFC, 2006).

Species with Essential Fish Habitat (EFH)

In addition to the 12 species monitored by PSEG and discussed above, there are 14 species that have designated EFH in the upper portion of the Delaware Estuary in the vicinity of Salem and HCGS. EFH is defined as "those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity" (16 U.S.C. 1802(10); 50 CFR 600.10). This definition includes all developmental stages of the particular fishes in question. Thus, EFH for a given species can vary by life stage.

The Magnuson-Stevens Fishery Conservation and Management Act (MSA) was reauthorized in 1996 and amended to focus on the importance of habitat protection for healthy fisheries (16 USC 1801 et seq.). The MSA amendments, known as the Sustainable Fisheries Act, required the eight regional fishery management councils to describe and identify EFH in their regions, to identify actions to conserve and enhance their EFH, and to minimize the adverse effects of fishing on EFH. The act strengthened the authorities of the governing agencies to protect and conserve the habitats of marine, estuarine, and anadromous fish, crustaceans, and mollusks (NEFMC, 1999). EFH was defined by Congress as those waters and substrates necessary for spawning, breeding, feeding, or growth to maturity (MSA, 16 USC 1801 et seq.). The National Marine Fisheries Service (NMFS) designates EFH. The consultation requirements of Section 305(b) of the MSA provide that Federal agencies consult with NMFS on all actions or proposed actions authorized, funded, or undertaken by the agency that may adversely affect EFH.

EFH is an essential component in the development of Fishery Management Plans to assess the effects of habitat loss or degradation on fishery stocks and to take actions to mitigate such damage. Many managed species are mobile and migrate seasonally, so some species are managed coast-wide, others are managed by more than one fishery management council, and still others are managed for the entire coast by a single council. In Delaware Bay, various fisheries species are managed by the Atlantic States Marine Fisheries Commission (ASMFC), the New England Fisheries Management Council (NEMFC), the Mid-Atlantic Fishery Management Council (MAFMC), and the South Atlantic Fishery Management Council (SAFMC). Several species are regulated by the states of New Jersey and Delaware as well, in some cases with more rigid restrictions than those of the regional councils.

Salem and HCGS are located near the interface of the salinity zones classified by NMFS as tidal freshwater and mixing salinity zones. The area of the Delaware Estuary adjacent to Artificial Island is designated by NMFS as EFH for various life stages of several species of fish. The Staff considered all the designated EFH that could occur in the vicinity of Salem and HCGS based on geographic coordinates; some species and life stages with EFH requirements that are outside of the conditions that normally occur in the local area were eliminated from further consideration.

NMFS identifies EFH on their website for the overall Delaware Bay (NOAA, 2010e) and for smaller squares within the estuary defined by 10 minutes (') of latitude by 10' of longitude. NMFS provides tables of species and life stages that have designated EFH within the 10' by 10' squares. The 10' by 10' square that includes Salem and HCGS is defined by the following coordinates:

North: 39° 30.0'N South: 39° 20.0'N

East: 75° 30.0'W West: 75° 40.0'W

The following description of the general location and New Jersey shoreline within this square confirms that it includes Artificial Island and the Salem and HCGS facilities (NOAA, 2010e):

> Atlantic Ocean waters within the square within the Delaware River, within the mixing water salinity zone of the Delaware Bay affecting both the New Jersey and Delaware coasts. On the New Jersey side, these waters affect: from Hope Creek on the south, north past Stoney Point, and Salem Nuclear Power Plant on Artificial Island, to the tip of Artificial Island as well as affecting Baker Shoal.

NMFS identified 14 fish species with EFH in the Delaware Estuary in the vicinity of Salem and HCGS (NMFS, 2010a). These species and their life stages with EFH in this area are identified in Table 2-5. Some of the species were eliminated from further consideration due to salinity requirements of the species; the salinity requirements of these eliminated species and life stages are provided in Table 2-6. Salinities in the vicinity of Artificial Island are described above in Section 2.2.5.1 and summarized in Table 2-4. For each of these EFH species, the Staff compared the range of salinities in the vicinity of Salem and HCGS with the salinity requirements of the potentially affected life stages (Table 2-6). The salinity requirements of many of these EFH species and life stages were found to be higher than salinity ranges in the vicinity of Salem and HCGS or to overlap these salinity ranges only during periods of low flow (Table 2-6). This comparison allowed the list of species with EFH that potentially could be affected by Salem or HCGS to be further refined. If the salinity requirements of an EFH species life stage were not met in the vicinity of the Salem and HCGS facilities, the EFH for that species and life stage was eliminated from further consideration because its potential to be affected by the proposed action would be negligible. As a result, four species were identified that have potentially affected EFH for one or more life stages in the vicinity of Salem and HCGS (Table 2-7): winter flounder (Pleuronectes americanus), windowpane flounder (Scophthalmus aquosus), summer flounder (Paralichthys dentatus), and Atlantic butterfish (Peprilus triacanthus). Descriptions of these four species are included below.

Table 2-5. Designated Essential Fish Habitat by species and life stage in NMFS' 10 ' x 10 ' square of latitude and longitude in the Delaware Estuary that includes Salem Nuclear Generating Station and Hope Creek Generating Station

Scientific Name	Common Name	Eggs	Larvae	Juveniles	Adults
Urophycis chuss	Red hake				
Pleuronectes americanus	Winter flounder	X	X	X	X
Scophthalmus aquosus	Windowpane flounder	X	X	X	X
Pomotomus saltatrix	Bluefish			X	X
Paralichthys dentatus	Summer flounder			X	X
Peprilus triacanthus	Atlantic butterfish			X	
Stenotomus chrysops	Scup	n/a	n/a	X	
Centropristes striatus	Black sea bass	n/a		X	
Scomberomorus cavalla	King mackerel	X	X	X	X
Scomberomorus maculatus	Spanish mackerel	X	X	X	X
Rachycentron canadum	Cobia	X	X	X	X
Leucoraja eglantaria	Clearnose skate			X	X
Leucoraja erinacea	Little skate			X	X
Leucoraja ocellata	Winter skate			X	X

X indicates designated EFH within this area. Blank indicates no designated EFH in this area. n/a indicates that the species does not have this life stage or has no EFH designation for this life stage.

Sources: NOAA, 2010e; NOAA, 2010f

Table 2-6. Potential Essential Fish Habitat species eliminated from further consideration due to salinity requirements

Species, Life Stage	EFH Salinity Requirement (ppt) [a]	Site Salinity[e] Matches Requirement
Windowpane, juvenile	5.5-36	low flow only
Windowpane, adult	5.5-36	low flow only
Windowpane, spawner	5.5-36	low flow only
Bluefish, juvenile	23-36	no
Bluefish, adult	>25	no
Scup, juvenile	>15	no
Black sea bass, juvenile	>18	no
King mackerel	>30	no
Spanish mackerel	>30	no
Cobia	>25	no
Clearnose skate, juvenile	probably >22 [b]	no
Clearnose skate, adult	probably >22 [b]	no
Little skate, juvenile	mostly 25-30 [c]	no
Little skate, adult	probably >20 [c]	no
Winter skate, juvenile	probably >20 [d]	no
Winter skate, adult	probably >20[d]	no

(a) Salinity data from NOAA table “Summary of Essential Fish Habitat (EFH) and General Habitat Parameters for Federally Managed Species” unless otherwise noted.
(b) NOAA Technical Memorandum NMFS-NE-174 (NOAA, 2003a).
(c) NOAA Technical Memorandum NMFS-NE-175 (NOAA, 2003b).
(d) NOAA Technical Memorandum NMFS-NE-179 (NOAA, 2003c).
(e) Salinities in Delaware Estuary in vicinity of Salem/HCGS: high flow 0-5 ppt, low flow 5-12 ppt.

Table 2-7. Fish Species and Life Stages with Potentially Affected Essential Fish Habitat in the Vicinity of Salem Nuclear Generating Station and Hope Creek Generating Station

Species	Eggs	Larvae	Juveniles	Adults
Winter flounder	X	X	X	X
Windowpane flounder	X	X	X	X
Summer flounder			X	X
Atlantic butterfish			X	

Source: NRC, 2007

Winter Flounder

There are two major populations of winter flounder in the Atlantic: one inhabits estuarine and coastal waters from Newfoundland to Georgia, the other lives offshore on Georges Bank and Nantucket Shoal (Buckley, 1989). In the Mid-Atlantic, winter flounder are most common between the Gulf of Saint Lawrence and Chesapeake Bay (Grimes et al., 1989). In the Delaware Bay region, winter flounder spawn in coastal waters in February and March. Spawning occurs at depths of 7 to 260 ft (2 to 79 m) over sandy substrates in inshore coves and inlets at salinities of 31 to 32.5 ppt (Buckley, 1989; NOAA, 1999a). Sexual maturity is dependent on size rather than age, with southern individuals (age 2 or 3 years) reaching spawning size more rapidly than northern fish (age 6 or 7 years). The eggs are demersal, stick to the substrate, and are most often found at salinities between 10 and 30 ppt (Buckley, 1989). Larvae initially are planktonic but become increasingly benthic as they develop (NOAA, 1999a). Juveniles and adults are completely benthic, with juveniles preferring a sandy or silty substrate in estuarine areas (Buckley, 1989). Juveniles move seaward as they grow, remaining in estuaries for the first year (Buckley, 1989; Grimes et al., 1989). Water temperature appears to dictate adult movements; south of Cape Cod, winter flounder spend the colder months in inshore and estuarine waters and move farther offshore in the warmer months (Buckley, 1989). Winter flounder can live for up to 15 years and may reach 23 inches (58 cm) in length (NOAA, 1999a). Winter flounder tolerate salinities of 5 to 35 ppt and prefer waters temperatures of 32 °F to 77 °F (0 °C to 25 °C). Higher temperatures for extended periods can cause mortality (Buckley, 1989).

Winter flounder larvae feed on small invertebrates, invertebrate eggs, and phytoplankton (Buckley, 1989; NOAA, 1999a). Adults feed on benthic invertebrates such as polychaetes, cnidarians, mollusks, and hydrozoans. Adults and juveniles are an important food source for predatory fish such as the striped bass (Morone saxatilis), bluefish (Pomatomus saltatrix), goosefish (Lophius americanus), spiny dogfish (Squalus acanthias), and other flounders, and birds such as the great cormorant (Phalacrocorax carbo), great blue heron (Ardea herodias), and osprey (Pandion haliaetus) (Buckley, 1989).

Winter flounder are highly abundant in estuarine and coastal waters and, therefore, are one of the most important species of the commercial and recreational fisheries on the Atlantic coast (Buckley, 1989). The NEFMC and ASMFC manage the winter flounder fishery as part of the groundfish fishery, which comprises 15 demersal species (NEFMC, 2010). Winter flounder also are very popular recreational fish, with the recreational catch sometimes exceeding the commercial catch (Buckley, 1989). Biomass in the New England Mid-Atlantic winter flounder stock declined from 1981 to 1992, and the fishery was declared overexploited. As of 1999, biomass remains significantly lower than prior to overexploitation (NOAA, 1999a). As part of the management program, EFH has been established for the winter flounder along the Atlantic coast. The Delaware Bay’s mixing and saline waters are EFH for all parts of the winter flounder lifecycle, including eggs, larvae, juveniles, adults, and spawning adults (NEFMC, 1998a).

Windowpane Flounder

Windowpane flounder inhabit estuaries, coastal waters, and oceans over the continental shelf along the Atlantic coast from the Gulf of Saint Lawrence to Florida. They are most abundant in bays and estuaries south of Cape Cod in shallow waters, over sand, sand and silt, or mud substrates (NOAA, 1999b). They spawn from April to December, and in the Mid-Atlantic Region spawning peaks in May and September (NOAA, 1999b; Morse and Able, 1995). The eggs are pelagic and buoyant and hatch in approximately 8 days. Larvae begin life as plankton, but soon settle to the bottom (at 0.39 to 0.78 inches [10 to 20 mm] in length) and become demersal. This settling occurs in estuaries and over the continental shelf for spring-spawned fish, which inhabit the polyhaline portions of the estuary throughout the summer. Fall-spawned fish settle mostly on the shelf. Juveniles migrate to coastal waters from the estuaries as they grow larger during autumn, and they overwinter in deeper waters. Adults remain offshore throughout the year and are highly abundant off southern New Jersey. Sexual maturity is reached between 3 and 4 years of age, and length generally does not exceed 18 inches (46 cm) (NOAA, 1999b).

Juvenile and adult windowpane flounder have similar food sources, including small crustaceans and fish larvae (NOAA, 1999b). Adult windowpane tolerate a wide range of temperatures and salinities, from 23 °F to 80.2 °F (0 °C to 26.8 °C), and 5.5 ppt to 36 ppt. Adults and juveniles are abundant in the mixing and saline zones of Delaware Bay (NOAA, 1999b), and these zones as well as the inland bays are EFH for all life stages of the windowpane flounder, including eggs, larvae, juveniles, adults, and spawning adults (NEFMC, 1998b). The windowpane flounder is managed by the NEFMC under the multispecies groundfish plan (NEFMC, 2010). The fishery does not directly target windowpane, but groundfish trawls take them as bycatch (NOAA, 1999b; Morse and Able, 1995).

Summer Flounder

The summer flounder is a demersal fish inhabiting coastal waters over sandy substrates from Nova Scotia to Florida, but it is most abundant between Cape Cod and Cape Fear (ASMFC, 2008e). It lives in bays and estuaries in spring, summer, and autumn, and migrates offshore for the winter (NEFSC, 2006a). Migrating adults tend to return to the same bay or estuary every year (NOAA, 1999c). Spawning occurs in autumn and early winter as the fish are migrating over the continental shelf (NEFSC, 2006a; NOAA, 1999c). Eggs are pelagic and buoyant, as are the early stages of larvae (NOAA, 1999c). Larvae move inshore between October and May, where they develop in estuaries and bays (NEFSC, 2006a; ASMFC, 2008e). Larvae become demersal as soon as the right eye migrates to the top of the head, then they bury themselves in the substrate while they are in the inshore nursery areas. Within the estuaries, marsh creeks, seagrass beds, mud flats, and open bay areas are important habitats for juveniles. Some juveniles stay in the estuary habitat until their second year, while others migrate offshore for the winter. Juveniles inhabit the deeper parts of the Delaware Bay throughout the winter (NOAA, 1999c). Sexual maturity is reached by age 2 years, females may live up to 20 years and reach 26 lbs (12 kg) in weight, but males generally live for only 10 years (NEFSC, 2006a).

Tidal movements of juveniles may be due to the desire to stay within a desired set of environmental variables, including temperature, salinity, and dissolved oxygen. Larvae and juveniles live in waters with temperatures between 32 and 73 °F (0 and 23 °C) and usually inhabit the higher-salinity portions of estuaries. Newly recruited juveniles live over a variety of substrates, including mud, sand, shell hash, eelgrass beds, and oyster bars, but as they grow, they are more often over sand. Larvae feed on invertebrates and small fish, with benthic prey items becoming increasingly important with age. Adult summer flounder most often live over substrates of sand, coarse sand, or shell fragments and may occur in marsh creeks and seagrass beds. Their diet consists of varioius invertebrates and fish. Large predators, such as sharks, rays, and goosefish, consume adult summer flounder (NOAA, 1999c).

The summer flounder is a highly important commercial and recreational species along the Atlantic coast. Both the ASMFC and the MAFMC manage the fishery under the summer flounder, scup, and black sea bass fishery management plan. The recreational harvest makes up a sizeable portion of the total and is occasionally larger than the commercial harvest. In 1999, the summer flounder stock was considered overexploited, but as of 2005, the stock was considered not overfished (NOAA, 1999c; NEFSC, 2006a). In 2009, the ASMFC increased total allowable landings. Although the stock is currently considered not overfished, it has not reached rebuilt status (ASMFC, 2008e).

The Delaware Bay is important as a habitat for adults and as a nursery for juveniles, and NMFS has designated EFH for summer flounder larvae, juveniles, and adults in the Delaware Bay (NOAA, 2010g). Summer flounder adults and juveniles are present in the Delaware Bay in salinity zones of 0.5 ppt to above 25 ppt (CCMA, 2005), which includes the vicinity of Salem and HCGS.

Atlantic Butterfish

The Atlantic butterfish is a pelagic schooling fish that is ecologically important as a forage fish for many larger fishes, marine mammals, and birds. Its range includes the Atlantic coast from Newfoundland to Florida, but it is most abundant from the Gulf of Maine to Cape Hatteras (NEFSC, 2006b; NOAA, 1999d). Butterfish migrate seasonally in response to changes in water temperature. During summer, they migrate inshore into southern New England and Gulf of Maine waters, and in winter they migrate to the edge of the continental shelf in the Mid-Atlantic Bight (Cross et al., 1999). Butterfish inhabit bays, estuaries, and coastal waters up to 200 mi (322 km) offshore during the summer. Butterfish spawn offshore and in large bays and estuaries from June through August. They are broadcast spawners that spawn at night in the upper part of the water column in water of 15°C (59°F) or more. Eggs are pelagic and buoyant (NOAA, 1999d). Butterfish eggs and larvae are found in water with depths ranging from the shore to 6,000 ft (1828 m) and temperatures between 9°C (48°F) and 19°C (66°F). Juvenile and adult butterfish are found in waters from 33 to 1,200 ft (10 to 366 m) deep and at temperatures ranging from 3°C (37°F) to 28°C (82°F) (NMFS 2010b). Butterfish reach sexual maturity by age 1, rarely live more than 3 years, and normally reach a weight of up to 1.1 lbs (0.5 kg) (NEFSC, 2006b). Adult butterfish prey on small fish, squid, crustaceans, and other invertebrates and in turn are preyed upon by many species of fish and squid. In summer, butterfish can be found over the entire continental shelf, including sheltered bays and estuaries, to a depth of 656 ft (200 m) over substrates of sand, rock, or mud (Cross et al., 1999).

The Atlantic butterfish is an important commercial fish species that is also bycatch in other fisheries (NEFSC, 2004; 2006b). The fishery has been in operation since the late 1800s (NOAA, 1999d). U.S. commercial landings peaked in 1984 and a record low catch occurred in 2005 (NEFSC, 2006b). The MAFMC manages the Atlantic butterfish under the Atlantic mackerel, squid, and butterfish fishery management plan (NEFSC, 2006b). Due to a lack of data, it has not been established if overfishing is currently occurring, but during the last stock assessment in 1993, it was established that biomass was at medium levels, the catch was not excessive, and recruitment was high (NEFSC, 2004). EFH for Atlantic butterfish juveniles may exist in the vicinity of Salem and HCGS. Inshore EFH for the butterfish includes the mixing or saline zones of estuaries where butterfish eggs, larvae, juveniles, and adults are common or abundant on the Atlantic coast, from Passamaquoddy Bay in Maine to the James River in Virginia (NMFS 2010b).

2.2.6 Terrestrial Resources

This section describes the terrestrial resources in the immediate vicinity of the Salem and HCGS facilities on Artificial Island and within the transmission line ROWs connecting these facilities to the regional power grid. For this assessment, terrestrial resources were considered to include plants and animals of uplands as well as wetlands of Artificial Island and bodies of freshwater located on Artificial Island or the ROWs.

2.2.6.1 Artificial Island

The project site is within the Middle Atlantic coastal plain of the eastern temperate forest ecoregion. This ecoregion, which runs along the eastern seaboard from Delaware to the South Carolina/Georgia border, is characterized by low, flat plains with many marshes, swamps, and estuaries (EPA, 2007). As discussed in Section 2.2.1, Land Use, Artificial Island, on which the Salem and HCGS facilities are situated, is a man-made island approximately 3 mi (4.8 km) long and 5 mi (8 km) wide that was created by the deposition of dredge spoil material atop a natural sandbar. All terrestrial resources on the island have become established since creation of the island approximately 100 years ago. Consequently, Artificial Island contains poor quality soils and very few trees. Approximately 65 percent of the island is undeveloped and dominated by tidal marsh, which extends from the higher areas along the river eastward to the marshes of the former natural shoreline adjacent to the eastern boundary of Artificial Island. Terrestrial, non-wetland habitats of the island, which are limited and occur primarily on the periphery of the developed portions of PSEG property, consist principally of areas covered by grasses and other herbs with scrub/shrubs and planted trees. Almost all of the undeveloped portions of the island consist of estuarine emergent wetlands (tidal), with scattered occurrences of freshwater wetlands. Small, isolated, freshwater impoundments are also present, particularly along the northwest shoreline.

The Salem and HCGS facilities were constructed on adjacent portions of the PSEG property, which occupies the southwest corner of Artificial Island. The PSEG property is low and flat with elevations rising to about 18 ft (5.5 m) above the level of the river at the highest point. Developed areas covered by facilities and pavement occupy over 70 percent of the 740 ac (300 ha) PSEG site (approximately 525 ac [212 ha]). Maintained areas of grass, including two baseball fields, cover about 12 ac (5 ha) of the site interior. The remaining 27 percent of the

1

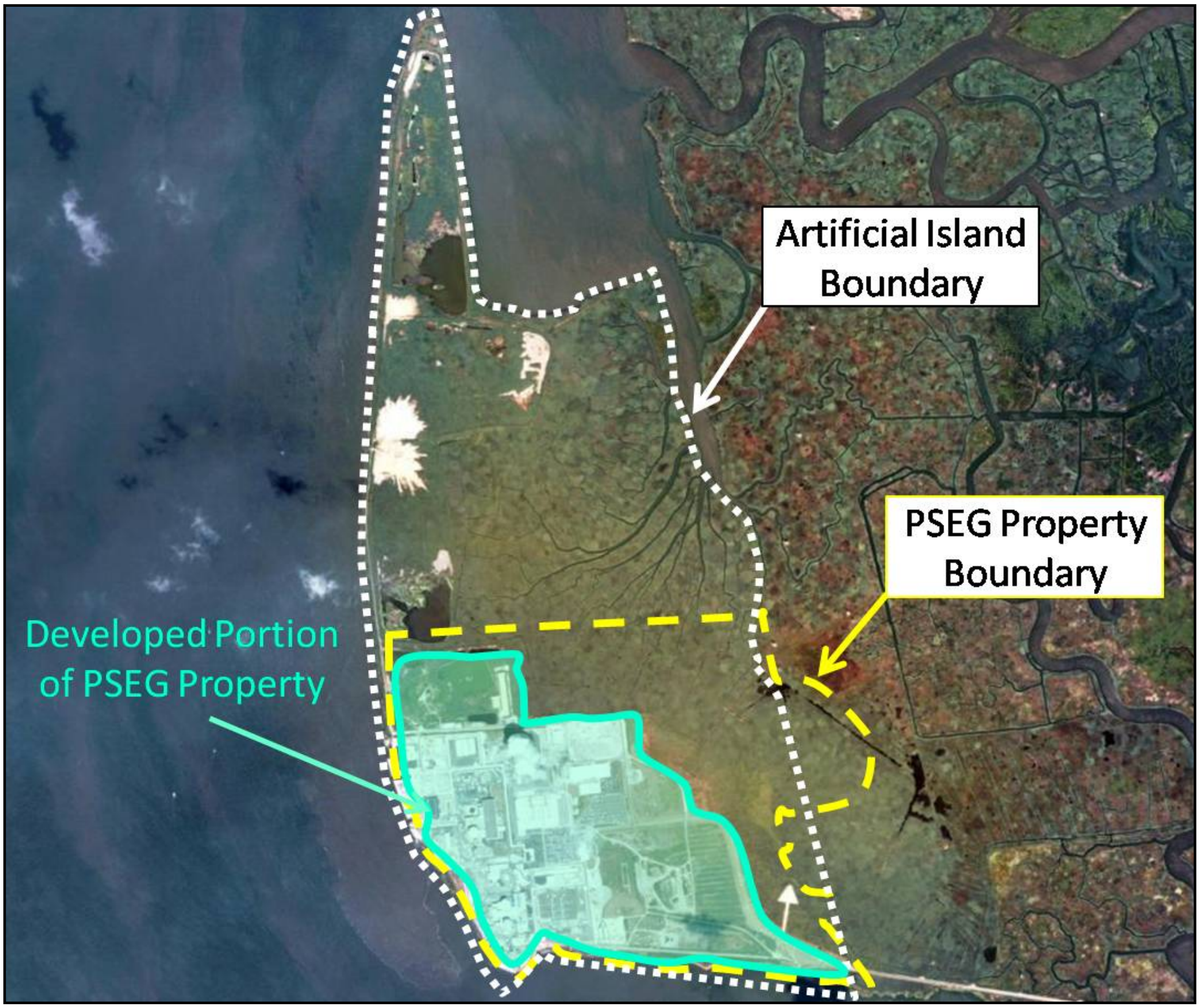


Figure 2-11. Aerial Photo Showing the Boundaries of Artificial Island (dotted), PSEG Property (dashed), and Developed Areas (solid).

PSEG property (approximately 200 ac [81 ha]) consists primarily of tidal marsh dominated by the common reed (*Phragmites australis*) and several cordgrass species (*Spartina* spp.) (PSEG, 2009b).

The U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) classifies all land on the project site as Urban, while the soils on the remainder of Artificial Island are Udorthents consisting of dredged fine material (NRCS, 2010). The National Wetlands Inventory (NWI) identifies a non-tidal inland marsh/swamp area on the periphery of the project site adjacent to Hope Creek Road and two small, man-made freshwater ponds immediately north of the Hope Creek reactor. NWI classifies the rest of Artificial Island as estuarine emergent marsh, with the exception of the northernmost 1 mi (1.6 km) of the island, which is contains freshwater emergent wetlands and freshwater ponds (FWS, 2010c).

The tidal marsh vegetation of the site periphery and adjacent areas is dominated by common reed, but other plants present include big cordgrass (*Spartina cynosuroides*), salt marsh cordgrass (*S. alterniflora*), saltmeadow cordgrass (*S. patens*), and saltmarsh bulrush (*Scirpus robustus*) (PSEG, 2009b). Fragments of this marsh community exist along the eastern edge of the PSEG property. The non-estuarine vegetation on the undeveloped areas within the facilities consists mainly of small areas of turf grasses and planted shrubs and trees around buildings, parking lots, and roads.

Tidal marshes in this region are commonly used by many migrant and resident birds because they provide habitat for breeding, foraging, and resting (PSEG, 2004b). A total of 44 avian species, including many shorebirds, wading birds, and waterfowl associated with open water and emergent marsh areas of the estuary were observed within a 4-mi (6-km) radius of the Salem site during preconstruction surveys conducted in 1972 (AEC, 1973). Several avian species were observed on the project site, itself, including the red-winged blackbird (*Agelaius phoeniceus*), common grackle (*Quiscalus quiscula*), northern harrier (*Circus cyaneus*), song sparrow (*Melospiza melodia*), and yellowthroat (*Geothlypis trichas*) (AEC, 1973). HCGS construction studies reported the occurrence of 178 bird species within 10 mi (16 km) of the project site, approximately half of which were recorded within tidal marsh and the open water of the Delaware River and roughly 45 of the 178 total observed species were classified as permanent resident species (PSEG, 1983). Osprey (*Pandion haliaetus*) have used Artificial Island transmission line towers and other suitable high perches on and near the site since the construction of the plants (PSEG, 1983; NRC, 1984; NJDFW, 2009b). Resident songbirds, such as the marsh wren (*Cistothorus palustris*), and migratory songbirds, such as the swamp sparrow (*Melospiza georgiana*), use the nearby Alloway Creek Estuary Enhancement Program restoration site for breeding (PSEG, 2004b).

Mammals such as the eastern cottontail (*Sylvilagus floridanus*), the Norway rat (*Rattus norvegicus*), the house mouse (*Mus musculus*), and raccoon (*Procyon lotor*) were observed on and in the vicinity of the Salem and HCGS sites during preconstruction surveys (AEC, 1973). Other mammals likely to occur in the vicinity of the two facilities include the white-tailed deer (*Odocoileus virginianus*), eastern gray squirrel (Sciurus carolinensis), red fox (Vulpes fulva), gray fox (Urocyon cinereoargenteus), muskrat (*Ondatra zibethica*), opossum (*Didelphis marsupialis*), and striped skunk (*Mephitis mephitis*).

Twenty-six reptile species were observed during HCGS preconstruction surveys PSEG, 1983). Three species, the snapping turtle (*Chelydra serpentina*), northern water snake (*Natrix sipedon*), and eastern mud turtle (*Kinosternon subrubrum*), prefer freshwater habitats but also occur in brackish marsh. The northern diamondback terrapin (*Malaclemys terrapin*), inhabits saltwater and brackish habitats and occurs in tidal marsh adjacent to the project site. Other common reptiles likely to inhabit the area include the spotted turtle (Clemmys guttata), eastern box turtle (Terrapene carolina), eastern painted turtle (Chrysemys picta), and eastern garter snake (Thamnophis sirtalis) (PSEG, 1983). Amphibians likely to occur in the upland and/or freshwater wetland habitats of the island include the New Jersey chorus frog (*Pseudoacris triseriata kalmi*), southern leopard frog (*Rana utricularia*), and Fowler's toad (*Bufo woodhousii fowleri*) (NJDEP, 2001b).

Two Wildlife Management Areas (WMAs) managed by the New Jersey Division of Fish and Wildlife are located near Salem and HCGS:

- Abbotts Meadow WMA encompasses approximately 1,000 ac (405 ha) and is about 4 mi (6.4 km) northeast of HCGS.
- Mad Horse Creek State WMA encompasses roughly 9,500 acres (3,844 ha), of which the northernmost portion is less than 1 mi (1.6 km) northeast of the PSEG property boundary. The southern portion of this WMA includes Stowe Creek, which is designated as an Important Bird Area (IBA) in New Jersey. Stowe Creek IBA provides breeding habitat for several pairs of bald eagles (*Haliaeetus leucocephalus*), which are State-listed as endangered, and the adjacent tidal wetlands support large populations of the northern harrier (Circus cyaneus), which also is State-listed as endangered, as well as many other birds dependent on salt marsh/wetland habitats (NAS, 2010).

Alloway Creek Wetland Restoration Site is a restoration area less than 3 mi (5 km) northeast of HCGS and Salem that is owned and maintained by PSEG. Over 1,600 ac (647 ha) of wetlands and uplands of the 3,096 ac (1,253 ha) Alloway Creek Wetland Restoration Site were restored by PSEG between 1996 and 1999 to increase fish habitat and reduce invasive species, such as *Phragmites australis* from spreading (PSEG 2009c). The site includes two nature trails, several observation platforms, a boardwalk to the beach, and a wildlife viewing blind.

The Supawna Meadows National Wildlife Refuge (NWR), part of the Cape May NWR Complex, is located approximately 7 mi (11 km) north of the HCGS and Salem sites and, like Artificial Island, consists primarily of brackish tidal marshes (FWS, 2010d). Supawna Meadows NWR is adjacent to the Delaware River and estuary and is recognized as a wetland of international importance and an international shorebird reserve that provides important feeding and resting grounds for migratory shorebirds and waterfowl (FWS, 2010d). Black ducks (Anas rubripes), mallards (Anas platyrhynchos), and northern pintails (Anas acuta) winter in the refuge, and sandpipers (Actitis hypoleucos) and other shorebirds use the marshes and beaches as a feeding area during summer months (FWS, 2010d).

2.2.6.2 Transmission Line Right-of-Ways

Section 2.2.1 describes the existing power transmission system that distributes electricity from Salem and HCGS to the regional power grid. There are four 500-kV transmission lines within three ROWs that extend beyond the PSEG property on Artificial Island. Two ROWs extend northeast approximately 40 mi (64 km) to the New Freedom substation south of Philadelphia.

The other ROW extends north then west approximately 25 mi (40 km), crossing the Delaware River to end at the Keeney substation in Delaware (Figure 2-8).

In total, the three ROWs for the Salem and HCGS power transmission system occupy approximately 4,376 ac (1,771 ha) and pass through a variety of habitat types, including marshes and other wetlands, agricultural or forested land, and some urban and residential areas (PSEG, 2009a). The major land cover types crossed by these ROWs are cultivated land (23 percent), palustrine forested wetland (19 percent), deciduous forest (13 percent), scrub/shrub (12 percent), and estuarine emergent wetland (11 percent). Other types, such as pasture/hay, urban/developed, and water, collectively cover less than 22 percent of the land crossed by these ROWs (PSEG 2010). As the three ROWs exit the PSEG property, they cross estuarine tidal marsh to the east and north of Artificial Island.

The initial segments of the New Freedom North and New Freedom South ROWs traverse approximately 3 mi (5 km) of estuarine emergent marsh east of the PSEG property boundary. This tidal marsh is part of the northern portion of the Mad Horse Creek State WMA. The middle segments of the New Freedom North and New Freedom South ROWs, extend a distance of approximately 30 mi (48 km) and cross a mixture of mainly agricultural and forested lands.

The Keeney ROW turns north after exiting HCGS and traverses approximately 5 mi (8 km) of emergent marsh and swamp paralleling the New Jersey shore of the Delaware Estuary before crossing 8 mi (13 km) of agricultural, sparsely forested, and rural residential lands. The Keeney ROW then continues west across the Delaware River approximately 3 mi (5 km) to the Red Lion substation. From the substation, the Red Lion-Keeney portion of the line within the Keeney ROW remains exclusively within Delaware and crosses primarily highly developed, residential land.

Animals likely to occur within the Salem and HCGS transmission line ROWs are similar to those described in Section 2.2.6.1 as occurring on the Salem and HCGS sites. Generally, species that prefer open fields, agricultural areas, marshes, and forest edges are the most likely to inhabit transmission line ROWs.

Before their termination at the New Freedom substation, the New Freedom ROWs traverse the New Jersey Pinelands National Reserve (PNR) for the last one-quarter of their length (NPS, 2006a). The New Freedom North and New Freedom South ROWs cross a total of approximately 10 mi (16 km) and 17 mi (27 km) of the PNR, respectively. The PNR contains the New Jersey Pinelands, also known as the Pine Barrens, which is a heavily forested area of the southern New Jersey Coastal Plain that supports a unique and diverse assemblage of unusual species, including orchids and carnivorous plants; low, dense forests of oak and pine; a 12-ac (5-ha) stand of pygmy pitch pines; and scattered bogs and marshes (NJPC, 2010). The United Nations Educational, Scientific, and Cultural Organization (UNESCO) designated the Pinelands a U.S. Biosphere Reserve in 1988. Biosphere Reserves are areas of terrestrial and coastal ecosystems with three complementary roles: conservation; sustainable development; and logistical support for research, monitoring, and education (UNESCO, 2010). The PNR's future development is guided by the Pinelands Comprehensive Management Plan, which is implemented by the New Jersey Pinelands Commission.

The two New Freedom ROWs also cross the Great Egg Harbor River, a designated National Scenic and Recreational River located within the PNR. This 129-mi (208-km) river system (including 17 tributaries) starts in suburban towns near Berlin, NJ and meanders southeast for approximately 60 mi (97 km) and gradually widens as tributaries enter, until it terminates at the Atlantic Ocean.

PSEG vegetation management practices provide guidance to ensure that all vegetation under HCGS and Salem transmission lines is regularly inspected and maintained to avoid vegetation-caused outages to transmission systems in accordance with regulations of the New Jersey Board of Public Utilities (NJ-BPU, 2009) and standards of the North American Electric Reliability Council (NERC, 2006). If removal of woody vegetation is necessary within ROWs, PSEG coordinates its removal with the New Jersey BPU. In addition, PSEG follows protocol to prevent impacts to wetlands and threatened and endangered species as outlined in their vegetative management guidelines (PSEG, 2010c). As part of their protective measures, PSEG conducts annual surveys for threatened and endangered species in its ROWs (PSEG, 2010c).

The New Jersey Pinelands Commission regulates the maintenance of the ROW portions within the PNR. The commission's Comprehensive Management Plan directs the creation and maintenance of early successional habitats within ROWs that represent characteristic Pinelands communities (Lathrop and Bunnell, 2009).

2.2.7 Threatened and Endangered Species

This discussion of threatened and endangered species is organized based on the principal ecosystems in which such species may occur in the vicinity of the Salem and HCGS facilities and the associated transmission line ROWs. Thus, Section 2.2.7.1 discusses aquatic species that may occur in adjacent areas of the Delaware Estuary, and Section 2.2.7.2 discusses terrestrial species that may occur on Artificial Island or the three ROWs, as well as freshwater aquatic species that may occur in the relatively small streams and wetlands within these terrestrial areas.

2.2.7.1 Aquatic Species of the Delaware Estuary

There are five aquatic species with a Federal listing status of threatened or endangered that have the potential to occur in the Delaware Estuary in the vicinity of the Salem and HCGS facilities. These species include four sea turtles and one fish (Table 2-8). In addition, there is one fish species that is a Federal candidate for listing (NMFS, 2010b; FWS, 2010a). These six species also have a State listing status of threatened or endangered in New Jersey and/or Delaware (DNREC, 2008).These species are discussed below.

Table 2-8. Threatened and Endangered Aquatic Species of the Delaware Estuary

Scientific Name	Common Name	Status[(a)]		
		Federal	New Jersey	Delaware
Reptiles				
Caretta caretta	Loggerhead sea turtle	T	E	E
Chelonia mydas	Green sea turtle	T	T	E
Lepidochelys kempii	Kemp's ridley sea turtle	E	E	E
Dermochelys coriacea	Leatherback sea turtle	E	E	E
Fish				

Scientific Name	Common Name	Status[(a)]		
		Federal	New Jersey	Delaware
Acipenser brevirostrum	Shortnose sturgeon	E	E	-
A. oxyrinchus oxyrinchus	Atlantic sturgeon	C	-	E

(a) E = Endangered; T = Threatened; C = Candidate

<u>Loggerhead, Green, Kemp's Ridley, and Leatherback Sea Turtles</u>

The four species of sea turtles identified by NMFS as potentially occurring in the Delaware Estuary are the threatened loggerhead (*Caretta caretta*) and green (*Chelonia mydas*) and the endangered Kemp's ridley (*Lepidochelys kempii*) and leatherback (*Dermochelys coriacea*). Kemp's ridley, loggerhead, and green sea turtles have been documented in the Delaware Estuary at or near the Salem and HCGS facilities; the leatherback sea turtle is less likely to occur in the vicinity (NMFS, 2010b).

Kemp's ridley, loggerhead, and green sea turtles have a similar appearance, though they differ in maximum size and coloration. The Kemp's ridley is the smallest species of sea turtle; adults average approximately 100 pounds (lbs; 45 kilograms [kg]) with a carapace length of 24 to 28 inches (61 to 71 centimeters [cm]) and a shell color that varies from gray in young individuals to olive green in adults. The loggerhead is the next largest of these three species; adults average about 250 lbs (113 kg) with a carapace length of 36 inches (91 cm) and a reddish brown shell color. The green is the largest of the three; adults average 300 to 350 lbs (136 to 159 kg) with a length of more than 3 ft (1 m) and brown coloration (its name comes from its greenish colored fat). The leatherback is the largest species of sea turtle and the largest living reptile; adults can weigh up to about 2,000 lbs (907 kg) with a length of 6.5 ft (2 m). The leatherback is the only sea turtle that lacks a hard, bony shell. Instead, its carapace is approximately 1.5 inches (4 cm) thick with seven longitudinal ridges and consists of loosely connected dermal bones covered by leathery connective tissue (NMFS, 2010c).

The Kemp's ridley has a carnivorous diet that includes fish, jellyfish, and mollusks. The loggerhead has an omnivorous diet that includes fish, jellyfish, mollusks, crustaceans, and aquatic plants. The green has a herbivorous diet of aquatic plants, mainly seagrasses and algae, that is unique among sea turtles. The leatherback has a carnivorous diet of soft-bodied, pelagic prey such as jellyfish and salps. All four of these sea turtle species nest on sandy beaches; none nest on the Delaware Estuary (NMFS, 2010c).

Major threats to these sea turtles include the destruction of beach nesting habitats and incidental mortality from commercial fishing activities. Sea turtles are killed by many fishing methods, including longline, bottom, and mid-water trawling; dredges; gillnets; and pots/traps. The required use of turtle exclusion devices has reduced bycatch mortality. Additional sources of mortality due to human activities include boat strikes and entanglement in marine debris (NMFS and FWS, 2007a; 2007b; 2007c; NOAA, 2010i).

<u>Shortnose Sturgeon</u>

The shortnose sturgeon *(Acipenser brevirostrum)* is a primitive fish, similar in appearance to other sturgeon (NOAA, 2010j), and has not evolved significantly for the past 120 million years (NEFSC, 2006). This species was not specifically targeted as a commercial fishery species, but has been taken as bycatch in the Atlantic sturgeon (*A.oxyrinchus oxyrinchus*) and shad fisheries. As they were not easily distinguished from Atlantic sturgeon, early data is unavailable for this species (NMFS, 1998). Furthermore, since the 1950s, when the Atlantic sturgeon fishery declined, shortnose sturgeon data has been almost completely lacking. Due to this lack of data, the U.S. Fish and Wildlife Service (FWS) believed that the species had been extirpated from most of its range; reasons noted for the decline included pollution and overfishing. Later research indicated that the construction of dams and industrial growth along the larger rivers on the Atlantic coast in the late 1800s also contributed to their decline due to loss of habitat.

Shortnose sturgeon can live from 30 years (males) to 67 years (females), grow up to 4.7 ft (143 cm) long, and reach a weight of 51 lbs (23 kg). Age at sexual maturity varies within their range from north to south, with individuals in the Delaware Bay area reaching maturity at 3 to 5 years for males and approximately 6 years for females (NOAA, 2010j). Shortnose sturgeon are demersal and feed predominantly on benthic invertebrates (NMFS, 1998).

The shortnose sturgeon is found along the Atlantic coast from Canada to Florida in habitats that include fast-flowing rivers, estuaries, and, in some locations, offshore marine areas over the continental slope. They are anadromous, spawning in coastal rivers and later migrating into estuaries and nearshore environments during non-spawning periods. They do not appear to make long-distance offshore migrations like other anadromous fishes (NOAA, 2010j). Migration into freshwater to spawn occurs between late winter and early summer, depending on latitude (NEFSC, 2006). Spawning occurs in deep, rapidly flowing water over gravel, rubble, or boulder substrates, to which the demersal eggs adhere before hatching in 9 to 12 days (NMFS, 1998). Juveniles remain in freshwater or the fresher areas of estuaries for 3 to 5 years, then they move to more saline areas, including nearshore ocean waters (NEFSC, 2006). In the Delaware Bay drainage, shortnose sturgeon most often occur in the Delaware River and may be found occasionally in the nearshore ocean, but little is known of the distribution of juveniles in the Delaware Estuary. Their abundance is greatest in the river between Trenton, New Jersey, and Philadelphia, Pennsylvania. Adults overwinter in large groups between Trenton and Bordentown, New Jersey (USACE, 2009).

NMFS began a status review of the shortnose sturgeon in 2007 (NMFS, 2008) which is ongoing. Due to its distinct population segments, the status of the species varies depending on the river in question. NMFS (2008) estimated the size of the population in the Delaware River system as 12,047 adults based on surveys from 1999 through 2003. Current threats to the shortnose sturgeon vary among rivers. Generally, over the entire range, most threats include dams, pollution, and general industrial growth. Drought and climate change could aggravate the existing threats due to lowered water levels, which can reduce access to spawning areas, increase thermal injury, and concentrate pollutants. Additional threats include discharges, dredging or disposal of material into rivers, development activities involving estuaries or riverine mudflats and marshes, and mortality due to bycatch in the shad gillnet fishery. NMFS (2008) determined that the Delaware River population is most threatened by dredging operations and water quality issues.

Atlantic Sturgeon

Atlantic sturgeon supported a large commercial fishery by 1870, but the fishery crashed in approximately 100 years due to overfishing. The effects of overfishing were exacerbated by the fact that this species takes a very long time to reach sexual maturity. The ASMFC adopted a Fishery Management Plan in 1990 that implemented harvest quotas. The current status of the

Atlantic sturgeon stock is unknown due to little reliable data. In 1998, a coastwide stock assessment by ASMFC determined that biomass was much lower than it had been in the early 1900s (ASMFC, 2009c). This assessment resulted in an amendment to the Fishery Management Plan that instituted a coastwide moratorium on Atlantic sturgeon harvest that will remain in place until 2038 in an effort to accumulate 20 years worth of breeding stock. The Federal government similarly enacted a moratorium in 1999 prohibiting harvest in the exclusive economic zone offshore (ASMFC, 2009c). Concurrent with the coastwide stock assessment, NMFS decided that listing the Atlantic sturgeon as threatened or endangered was not warranted (ASMFC, 2009c).

NMFS initiated a second status review in 2005 and concluded that the stock should be broken into five distinct population segments: Gulf of Maine, New York Bight, Chesapeake Bay, Carolina, and South Atlantic stocks (ASMFC, 2009c). The Delaware River and Estuary are in the New York Bight segment. NMFS determined that three of these distinct population segments are likely (>50 percent chance) to become endangered in the next 20 years (New York Bight, Chesapeake Bay, and Carolina), and these three were recommended by NMFS for listing as threatened under the ESA. The other two population segments were determined by NMFS to have a moderate (<50 percent) chance of becoming endangered in the next 20 years and were not recommended for listing (ASMFC, 2009c; Greene et al., 2009). In October 2009, the Natural Resources Defense Council submitted a petition under the ESA to list the Atlantic sturgeon. NMFS announced in January 2010 that it agreed listing may be warranted and decided to request public comment to update the 2007 species status review before beginning a 12-month finding and determination on whether to propose listing (NOAA, 2010c).

ASMFC (2009c) lists threats to the Atlantic sturgeon that include bycatch mortality, poor water quality, dredging activities, and for some populations, habitat impediments (dams blocking access to spawning areas) and ship strikes. As of 2009, NMFS designates the Atlantic sturgeon over its entire range as a species of concern and a candidate species. Reasons for the listing include genetic diversity (distinct populations) and lack of adequate estimates of the size of most population segments (NOAA, 2009b).

Atlantic sturgeon inhabit the Atlantic coast in the ocean, large rivers, and estuaries from labrador to northern Florida. Populations have been extirpated from most coastal systems except for the Hudson River, the Delaware River, and some South Carolina systems (ASMFC 2010c).

Atlantic sturgeon are anadromous, migrating inshore to coastal estuaries and rivers to spawn in the spring. A single fish will spawn only every 2 to 6 years (ASMFC, 2009c). Females broadcast eggs in fast-flowing, deep water with hard bottoms (ASMFC, 2010c). Eggs are demersal and stick to the substrate after 20 min of dispersal time. Larvae are pelagic and swim in the water column before they become benthic juveniles within 4 weeks (Greene et al., 2009). Juveniles remain where they hatch for 1 to 6 years before migrating to the ocean to complete their growth (ASMFC, 2009c). Little is known about the distribution and timing of juveniles and their migration, but aggregations at the freshwater/saltwater interface suggest that these areas are nurseries (ASMFC, 2010c). At between 30 and 36 inches (76 to 91 cm) in length, juveniles move offshore (NOAA, 2009b). Data are lacking regarding adult and sub-adult distribution and habitats in the open ocean (ASMFC, 2010c). Atlantic sturgeon can live for up to 60 years and can reach 14 ft (4.3 m) and 800 lbs (363 kg). Females reach sexual maturity between 7 and 30 years of age and by males between 5 and 24 years (ASMFC, 2009c).

Atlantic sturgeon feed predominantly on benthic invertebrates, such as mussels, worms, and shrimps, as well as on small fish (ASMFC, 2009c). Juveniles consume annelid worms, isopods, amphipods, insect larvae, small bivalve mollusks, and mysids. Little is known of the adult and subadult feeding habits in the marine environment, but some studies have found that these life stages consume mollusks, polychaetes, gastropods, shrimps, amphipods, isopods, and small fish (ASMFC, 2009c).

The Delaware River and associated estuarine habitats may have historically supported the largest Atlantic sturgeon stock on the east coast. Juveniles once were caught as bycatch in numbers large enough to be a nuisance in the American shad fishery. Over 180,000 females spawned annually in the Delaware River before 1890. Juveniles have more recently been captured in surveys near Trenton, New Jersey. Gill net surveys by the DNREC have captured juveniles frequently near Artificial Island. The DNREC also tracks mortality during the spawning season. In 2005 and 2006, 12 large adult fish carcasses were found with severe external injuries presumed to be caused by boat strikes (Greene et al., 2009).

2.2.7.2 Terrestrial and Freshwater Aquatic Species

There are five terrestrial species Federally listed as threatened or endangered that have recorded occurrences or the potential to occur either in Salem County, in which the Salem and HCGS facilities are located, or the counties crossed by the three ROWs (Gloucester and Camden Counties, New Jersey and New Castle County, Delaware). These species include the bog turtle (*Clemmys muhlenbergii*) and four plants (Table 2-9) (FWS, 2010a). Four of these species are also listed as endangered in New Jersey, and the bog turtle is listed as endangered in both New Jersey and Delaware (DNREC, 2008). In letters provided in accordance with the consultation requirements under Section 7 of the Endangered Species Act, FWS confirmed that no Federally-listed species under their jurisdiction are known to occur in the vicinity of the Salem and HCGS facilities (FWS, 2010b). However, two of the species Federally-listed as threatened, the bog turtle and swamp pink (*Helonias bullata*), were identified by the New Jersey Field Office of FWS (FWS, 2010b) as having known occurrences or other areas of potential habitat along the New Freedom North and New Freedom South transmission line ROWs. Because the bog turtle and swamp pink have the potential to occur within the transmission line ROWs, these species are discussed in more detail below.

Table 2-9. Listed Terrestrial and Freshwater Aquatic Species. *This table lists the status of Federally listed and/or State-listed as threatened, endangered, or special concern species that may occur on the HCGS or Salem sites or within the in-scope transmission line ROWs.*

Scientific Name	Common Name	Status			County(ies)	Habitat
		Federal[a]	New Jersey[b]	Delaware[c]		
Birds						
Accipiter cooperii	Cooper's hawk	-	T/T[d]	E-BR	Gloucester, Salem	Deciduous, coniferous, and mixed riparian or wetland forests
Ammodramus henslowii	Henslow's sparrow	-	E	E	Gloucester	Open fields with high, thick herbaceous vegetation; grassy fields between salt marsh and uplands
A. savannarum	grasshopper sparrow	-	T/S	SCC	Salem	Grasslands; pastures; agricultural lands
Bartramia longicauda	upland sandpiper	-	E	E	Gloucester, Salem	Open meadows and fallow fields often associated with pastures
Buteo lineatus	red-shouldered hawk	-	E/T	SCC	Gloucester	Deciduous, riparian, or mixed woodlands in old growth forests; hardwood swamps with standing water
Circus cyaneus	northern harrier	-	E/U	E-BR	Salem	Freshwater, brackish, and saline tidal marshes; emergent wetlands; fallow fields; grasslands; meadows
Cistothorus platensis	sedge wren	-	E	E	Salem	Wet meadows; freshwater marshes; bogs; drier portions of salt or brackish coastal marshes

Scientific Name	Common Name	Status			County(ies)	Habitat
		Federal[a]	New Jersey[b]	Delaware[c]		
Dolichonyx oryzivorus	bobolink	-	T/T	-	Salem	Hayfields, pastures, grassy meadows; coastal and freshwater marshes during migration
Falco peregrinus	peregrine falcon	-	E	SCC	Camden, Gloucester, Salem	Open areas near water
Haliaeetus leucocephalus	bald eagle	-	E	E	Gloucester, Salem	Forests near water or tidal areas
Melanerpes erythrocephalus	red-headed woodpecker	-	T/T	E	Camden, Gloucester, Salem	Upland and wetland open woods that contain dead or dying trees and sparse undergrowth
Pandion haliaetus	osprey	-	T/T	SCC	Gloucester, Salem	Dead trees or platforms near coastal/inland rivers, marshes, bays, inlets
Passerculus sandwichensis	savannah sparrow	-	T/T	-	Salem	Open habitats such as alfalfa fields, grasslands, meadows, fallow fields, and salt marsh edges
Podilymbus podiceps	pied-billed grebe	-	E/S	E-BR	Salem	Freshwater marshes associated with bogs, lakes, or slow-moving rivers
Pooecetes gramineus	vesper sparrow	-	E	-	Gloucester, Salem	Pastures, grasslands, cultivated fields, and other open areas
Strix varia	barred owl	-	T/T	SCC	Gloucester, Salem	Remote, contiguous, old growth wetland forests, including deciduous wetland forests; Atlantic white cedar swamps associated with stream corridors

Scientific Name	Common Name	Status			County(ies)	Habitat
		Federal[a]	New Jersey[b]	Delaware[c]		
Reptiles and Amphibians						
Ambystoma tigrinum	eastern tiger salamander	-	E	SCC	Gloucester, Salem	Uplands and wetlands containing breeding ponds, forests, and burrowing-appropriate soil types such as old fields, and deciduous or mixed woods
Clemmys muhlenbergii	bog turtle	T	E	E	Camden, Gloucester, Salem, New Castle	Open, wet, grassy pastures or bogs with soft, muddy bottoms
Crotalus horridus horridus	timber rattlesnake	-	E	-	Camden	Deciduous upland forests or pinelands habitats, often near cedar swamps and along streambanks
Hyla andersoni	pine barrens treefrog	-	E	-	Camden, Gloucester, Salem	Specialized acidic habitats such as Atlantic white cedar swamps and pitch pine lowlands with open canopies, dense shrub layers, and heavy ground cover
Pituophis melanoleucus	northern pine snake	-	T	-	Camden, Gloucester, Salem	Dry pine-oak forest types growing on infertile sandy soils
Invertebrates						
Callophrys irus	frosted elfin	-	T	SCC	Camden	Dry clearings and open areas, savannas, power-line ROWs, roadsides
Lampsilis cariosa	yellow lampmussel	-	T	E	Gloucester	Medium to large rivers, lakes and ponds
Leptodea ochracea	tidewater mucket	-	T	E	Camden, Gloucester	Freshwater water with tidal influence on the lower coastal plain, pristine rivers

Scientific Name	Common Name	Status			County(ies)	Habitat
		Federal[a]	New Jersey[b]	Delaware[c]		
Ligumia nasuta	eastern pond mussel	-	T	E	Camden, Gloucester	Lakes, ponds, streams and rivers of variable depths with muddy, sandy, or gravelly substrates
Lycaena hyllus	bronze copper		E	SCC	Salem	Brackish and freshwater marshes, bogs, fens, seepages, wet sedge meadows, riparian zones, wet grasslands, and drainage ditches
Pontia protodice	checkered white	-	T	-	Camden	Open areas, savannas, old fields, vacant lots, power-line ROWs, forest edges
Plants						
Aeschynomene virginica	sensitive joint vetch	T	E	-	Camden, Gloucester, Salem	Fresh to slightly salty (brackish) tidal marshes
Aplectrum hyemale	putty root	-	E	-	Gloucester	Moist, deciduous upland to swampy forests
Aristida lanosa	wooly three-awn grass	-	E	-	Camden, Salem	Dry fields, uplands, pink-oak woods, primarily in sandy soil
Asimina triloba	pawpaw	-	E	-	Gloucester	Shady, open-woods areas in wet, fertile bottomlands, or upland areas on rich soils
Aster radula	low rough aster	-	E	-	Camden, Gloucester, Salem	Wet meadows, open boggy woods, and along the edges; or openings in wet spruce or tamarack forests
Bouteloua curtipendula	side oats grama grass	-	E	-	Gloucester	Rocky, open slopes, woodlands, and forest openings

Scientific Name	Common Name	Status			County(ies)	Habitat
		Federal[a]	New Jersey[b]	Delaware[c]		
Cacalia atriplicifolia	pale Indian plantain	-	E	-	Camden, Gloucester	Dry, open woods, thickets, and rocky openings
Calystegia spithamaea	erect bindweed	-	E	-	Camden, Salem	Dry, open, sandy to rocky sites such as pitch pine/scrub oak barrens, sandy roadsides, riverbanks, and ROWs
Carex aquatilis	water sedge	-	E	-	Camden	Swamps; bogs, marshes; ponds; lakes; marshy meadows
C. bushii	Bush's sedge	-	E	-	Camden	Dry to mesic grasslands; forest margin[s]
C. limosa	mud sedge	-	E	-	Gloucester	Fens; sphagnum bogs; wet meadows; shorelines
C. polymorpha	variable sedge	-	E	-	Gloucester	Dry, sandy, open areas of scrub; forests; swampy woods; bank and marsh edge[s]
Castanea pumila	chinquapin	-	E	-	Gloucester, Salem	High ridges and slopes within mixed hardwood forests, dry pinelands, and ROWs
Cercis canadensis	redbud	-	E	-	Camden	Rich, moist wooded areas in the forest understory, streambanks, and abandoned farmland[s]
Chenopodium rubrum	red goosefoot	-	E	-	Camden	Moist, often salty soils along the coast

Scientific Name	Common Name	Status			County(ies)	Habitat
		Federal[a]	New Jersey[b]	Delaware[c]		
Cyperus lancastriensis	Lancaster flat sedge	-	E	-	Camden, Gloucester	Riverbanks, floodplains, and other disturbed, sunny or partly sunny places in mesic, or dry-mesic soils
C. polystachyos	coast flat sedge	-	E	-	Salem	Along shores; in ditches; swales between dunes
C. pseudovegetus	marsh flat sedge	-	E	-	Salem	Open mesic forests; stream edges; swamps; moist sandy areas; bottomland prairies
Diodia virginiana	larger buttonweed	-	E	-	Camden	Wet meadows; pond margins
Eleocharis melanocarpa	black-fruit spike-rush	-	E	-	Salem	Fresh, oligotrophic, often drying, sandy shores; ponds; ditches
E. equisetoides	knotted spike-rush	-	E	-	Gloucester	Fresh lakes; ponds; marshes; streams; cypress swamps
E. tortilis	twisted spike-rush	-	E	-	Gloucester	Bogs; ditches; seeps
Eriophorum tenellum	rough cotton-grass	-	E	-	Camden, Gloucester	Bogs and other wet, peaty substrates
Eupatorium capillifolium	dog fennel thoroughwort	-	E	-	Camden	Coastal meadows; fallow fields; flatwoods; marshes; disturbed habitat
E. resinosum	pine barren boneset	-	E	-	Camden, Gloucester	Tidal marshes; wetlands; open swamps; wet ditches; sandy acidic soils of grass-sedge bogs; pocosin-savannah ecotones

Scientific Name	Common Name	Status			County(ies)	Habitat
		Federal[a]	New Jersey[b]	Delaware[c]		
Euphorbia purpurea	Darlington's glade spurge	-	E	-	Salem	Rich, cool woods along seeps, streams, or swamps
Glyceria grandis	American manna grass	-	E	-	Camden	Grassy areas
Hemicarpha micrantha	small-flower halfchaff sedge	-	E	-	Camden	Emergent shorelines, but rarely freshwater tidal shores
Hottonia inflata	featherfoil	-	E	-	Salem	Quiet, shallow water of pools; streams; ditches
Hydrastis canadensis	golden seal	-	E	-	Camden	Mesic, deciduous forests, often on clayey soil
Hydrocotyle ranunculoides	floating marsh-pennywort	-	E	-	Salem	Ponds; marshes
Hypericum adpressum	Barton's St. John's-wort	-	E	-	Salem	Pond shore
Isotria meleoloides	small-whorled pogonia	T	-	-	-	Mixed deciduous forests in second- or third-growth successional stages, coniferous forests
Juncus caesariensis	New Jersey rush	-	E	-	Camden	Borders of wet woods; wet springy bogs; swamps
J. torreyi	Torrey's rush	-	E	-	Camden	Edge of sloughs; wet sandy shores; along slightly alkaline watercourses; swamps

Scientific Name	Common Name	Status			County(ies)	Habitat
		Federal[(a)]	New Jersey[(b)]	Delaware[(c)]		
Kuhnia eupatorioides	false boneset	-	E	-	Camden	Limestone edges of bluffs; rocky wooded slopes; rocky limestone talus
Lemna perpusilla	minute duckweed	-	E	-	Camden, Salem	Mesotrophic to eutrophic, quiet waters
Limosella subulata	awl-leaf mudwort	-	E	-	Camden	Freshwater marshes
Linum intercursum	sandplain flax	-	E	-	Camden, Salem	Open, dry, sandplain grasslands or moors; sand barrens; mown fields; ROWs
Luzula acuminate	hairy wood-rush	-	E	-	Gloucester, Salem	Grassy areas
Melanthium virginicum	Virginia bunchflower	-	E	-	Camden, Gloucester, Salem	Fens; bottomland prairies; mesic upland forests; mesic upland prairies; along streams and roadsides
Muhlenbergia capillaries	long-awn smoke grass	-	E	-	Gloucester	Sandy, pine openings; dry praires; and exposed ledges
Myriophyllum tenellum	slender water-milfoil	-	E	-	Camden	Sandy soil with water to 5 ft deep
M. pinnatum	cut-leaf water-milfoil	-	E	-	Salem	Floodplain marsh
Nelumbo lutea	American lotus	-	E	-	Camden, Salem	Mostly floodplains of major rivers in ponds, lakes, pools in swamps and marshes; backwaters of reservoirs
Onosmodium virginianum	Virginia false-gromwell	-	E	-	Camden, Gloucester, Salem	Sandy soils in dry open woods
Ophioglossum vulgatum pycnostichum	southern adder's tongue	-	E	-	Salem	Rich wooded slopes; shaded secondary woods; forested bottomlands; and floodplain woods
Penstemon laevigatus	smooth beardtongue	-	E	-	Gloucester	Rich woods; fields

Scientific Name	Common Name	Status			County(ies)	Habitat
		Federal[(a)]	New Jersey[(b)]	Delaware[(c)]		
Platanthera flava flava	southern rein orchid	-	E	-	Camden	Floodplain forests; white cedar, hardwood, and cypress swamps; riparian thickets; wet meadows
Polemonium reptans	Greek-valerian	-	E	-	Salem	Moist, stream banks; deciduous woods
Prunus angustifolia	chickasaw plum	-	E	-	Camden, Gloucester, Salem	Woodland edges; forest openings; open woodlands; savannahs; prairies; plains; meadows; pastures; roadsides
Pycnanthemum clinopodioides	basil mountain mint	-	E	-	Camden	Dry south or west facing slopes on rocky soils; open oak-hickory forests, woodlands, or savannas with exposed bedrock
P. torrei	Torrey's mountain mint	-	E	-	Gloucester	Open, dry areas including red cedar barrens, rocky summits, roadsides and trails, and dry upland woods
Quercus imbricaria	shingle oak	-	E	-	Gloucester	Rich bottomlands; dry to moist uplands
Q. lyrata	overcup oak	-	E	-	Salem	Lowlands; wet forests; streamside forests; periodically inundated areas
Rhododendron atlanticum	dwarf azalea	-	E	-	Salem	Moist, flat, pine woods; savannas
Rhynchospora globularis	coarse grass-like beaked-rush	-	E	-	Camden, Gloucester, Salem	Sandy and rocky stream banks; sink-hole ponds; upland prairies; open rocky and sandy areas
R. knieskernii	Knieskern's beaked-rush	T	E	-	Camden	Moist to wet pine barrens; borrow pits; sand pits
Sagittaria teres	slender arrowhead	-	E	-	Camden	Swamps of acid waters and sandy pool shores

Scientific Name	Common Name	Status			County(ies)	Habitat
		Federal[a]	New Jersey[b]	Delaware[c]		
Schwalbea americana	chaffseed	E	E	-	Camden	Acidic, sandy or peaty soils in open flatwoods; streamhead pocosins; pitch pine lowland forests; longleaf pine/oak sandhills; seepage bogs; palustrine pine savannahs ecotonal areas between peaty wetlands
Scirpus longii	Long's woolgrass	-	E	-	Camden	Marshes
Scutellaria leonardii	small skullcap	-	E	-	Salem	Fields; meadows; prairies
Spiranthes laciniata	lace-lip ladies' tresses	-	E	-	Gloucester	Coastal plain marshes; swamps; dry to damp roadsides; meadows; ditches; fields
Triadenum walteri	Walter's St. John's wort	-	E	-	Camden	Buttonbush swamps; swamps; thickets; streambanks
Utricularia biflora	two-flower bladderwort	-	E	-	Gloucester, Salem	Shores and shallows
Valerianella radiata	beaked cornsalad	-	E	-	Gloucester	Pastures; prairies; valleys; creek beds; wet meadows; roadsides
Verbena simplex	narrow-leaf vervain	-	E	-	Camden, Gloucester	Fields, meadows, and prairies
Vernonia glauca	broad-leaf ironweed	-	E	-	Gloucester, Salem	Dry fields; clearings; upland forests
Vulpia elliotea	squirrel-tail six-weeks grass	-	E	-	Camden, Gloucester, Salem	Grassy habitats
Wolffiella floridana	sword bogmat	-	E	-	Salem	Quiet waters
Xyris fimbriarta	fringed yellow-eyed grass	-	E	-	Camden	Low pine savanna; bogs; seeps; peats and mucks of pond shallows; sluggish shallow streams
Aeschynomene virginica	sensitive joint vetch	T	E	-	Camden, Gloucester, Salem	Fresh to slightly salty (brackish) tidal marshes
Aplectrum hyemale	putty root	-	E	-	Gloucester	Moist, deciduous upland to swampy forests

Scientific Name	Common Name	Status			County(ies)	Habitat
		Federal[a]	New Jersey[b]	Delaware[c]		
Aristida lanosa	wooly three-awn grass	-	E	-	Camden, Salem	Dry fields; uplands; pink-oak woods with sandy soil
Asimina triloba	pawpaw	-	E	-	Gloucester	Shady, open-woods areas in wet, fertile bottomlands; rich-soiled uplands
Aster radula	low rough aster	-	E	-	Camden, Gloucester, Salem	Wet meadows; open boggy woods; wet spruce or tamarack forest openings
Bouteloua curtipendula	side oats grama grass	-	E	-	Gloucester	Rocky, open slopes; woodlands; forest openings
Cacalia atriplicifolia	pale Indian plantain	-	E	-	Camden, Gloucester	Dry, open woods, thickets; rocky openings
Calystegia spithamaea	erect bindweed	-	E	-	Camden, Salem	Dry, open, sandy to rocky sites such as pitch pine/scrub oak barrens, sandy roadsides, riverbanks, and ROWs
Carex aquatilis	water sedge	-	E	-	Camden	Swamps; bogs; marshes; ponds; lakes; marshy meadows
C. bushii	Bush's sedge	-	E	-	Camden	Dry to mesic grasslands; forest margins
C. limosa	mud sedge	-	E	-	Gloucester	Fens; sphagnum bogs; wet meadows; and shorelines
C. polymorpha	variable sedge	-	E	-	Gloucester	Dry, sandy, open areas of scrub; forests; swampy woods; bank and marsh edges
Castanea pumila	chinquapin	-	E	-	Gloucester, Salem	High ridges and slopes within mixed hardwood forests, dry pinelands, and ROWs

Scientific Name	Common Name	Status			County(ies)	Habitat
		Federal[a]	New Jersey[b]	Delaware[c]		
Cercis canadensis	redbud	-	E	-	Camden	Rich, moist wooded areas in the forest understory; streambanks; abandoned farmlands
Chenopodium rubrum	red goosefoot	-	E	-	Camden	Moist, often salty soils along the coast
Cyperus lancastriensis	Lancaster flat sedge	-	E	-	Camden, Gloucester	Riverbanks; floodplains; disturbed, sunny or partly sunny places in mesic, or dry-mesic soils
C. polystachyos	coast flat sedge	-	E	-	Salem	Along shores; in ditches; swales between dunes
C. pseudovegetus	marsh flat sedge	-	E	-	Salem	Open mesic forests; stream edges; swamps; moist sandy areas; bottomland prairies
Diodia virginiana	larger buttonweed	-	E	-	Camden	Wet meadows; pond margins
Eleocharis melanocarpa	black-fruit spike-rush	-	E	-	Salem	Fresh, oligotrophic, often drying, sandy shores, ponds, and ditches

Sources: DNREC 2002; DNREC 2008; FWS 2009b; FWS 2009c; NJDEP 2008b; NJDEP 2008c

(a) E = Endangered; T = Threatened; C = Candidate; - = Not Listed

(b) E = Endangered; T = Threatened; - = Not Listed; S = Stable species (a species whose population is not undergoing any long-term increase/decrease within its natural cycle); U = Undetermined (a species about which there is not enough information available to determine the status). SC = Species Concern (a species showing evidence of decline, may become threatened)

(c) BR = Breeding Population only; E = Endangered; SCC = Species of Conservation Concern; - = Not Listed; Note that Delaware does not maintain a T&E species lists by county. Upon request, the DNREC provided PSEG the locations of species of greatest conservation need that occur within 0.5 mi (0.8 km) of the transmission corridor in New Castle County

(d) State status for birds separated by a slash (/) indicates a dual status. The first status refers to the breeding population in the state, and the second status refers to the migratory or winter population in the state.

1

Bog Turtle

The bog turtle (now also referred to as *Glyptemys muhlenbergii*) has two discontinuous populations. The northern population, which occurs in Connecticut, Delaware, Maryland, Massachusetts, New Jersey, New York, and Pennsylvania, was Federally listed as threatened in 1997 under the ESA (16 USC 1531 *et seq*.). The southern population was listed as threatened due to its similarity of appearance to the northern population. The bog turtle was Federally listed due to declines in abundance caused by loss, fragmentation, and degradation of early successional wet-meadow habitat, and by collection for the wildlife trade (FWS, 2001b). The northern population was listed as endangered by the state of New Jersey in 1974 (NJDFW, 2010a). In New Jersey, bog turtles occur in rural areas of the state, including Salem, Sussex, Warren, and Hunterdon Counties, and as of 2003 were found in over 200 individual wetlands (NJDFW, 2010b).

The bog turtle is one of the smallest turtles in North America. Its upper shell is 3 to 4 in. (7.6 to 10.2 cm) long and light brown to black in color, and each side of its black head has a distinctive patch of color that is red, orange, or yellow. Its life span is generally 20 to 30 years. In New Jersey, the bog turtle is active from April through October and hibernates the remainder of the year in densely vegetated areas near the edges of woody plants (FWS, 2004; NJDFW, 2010b).

The bog turtle is diurnal and semi-aquatic, foraging on land and in water for a diet of plants (seeds, berries, duckweed), animals (slugs, snails, and insects), and carrion (FWS, 2001b; 2004; NJDFW, 2004). Northern bog turtles primarily inhabit wetlands fed by groundwater or associated with the headwaters of streams and dominated by emergent vegetation. These habitats typically include wet meadows with open canopies and shallow, cool water that flows slowly (FWS, 2001b). Bog turtle habitats in New Jersey typically are characterized by native communities of low-lying grasses, sedges, mosses, and rushes; however, many of these areas are in need of restoration and management due to the encroachment of woody species and invasive species such as common reed (*Phragmites australis*), cattail, and Japanese stiltgrass (*Microstegium vimineum*) (NJDFW, 2010c). Livestock grazing maintains the early successional stage vegetation favorable for bog turtles (NJDFW, 2010a). Areas of potential habitat for the bog turtle occur along the New Freedom North and New Freedom South transmission line ROWs. However, the FWS (2010) have indicated that this species is not known to occur on or in the vicinity of the Salem or HCGS sites.

Swamp Pink

Swamp pink historically occurred between New York State and the southern Appalachian Mountains of Georgia. In the species current habitats of Georgia, North Carolina, South Carolina, Delaware, Maryland, New Jersey, New York, and Virginia, the largest concentrations are found in New Jersey (CPC, 2010). Swamp pink was Federally listed as a threatened species in 1988 due to population declines and threats to its habitat (FWS, 1991). It also was listed as endangered by the State of New Jersey in 1991 and currently is also designated as endangered in Delaware and six other states (CPC, 2010). New Jersey contains 70 percent of the known populations of swamp pink, most of which are on private lands. Swamp pink continues to be threatened by direct loss of habitat to development, and by development adjacent to populations, which can interfere with hydrology and reduce water quality (FWS, 2010e).

Swamp pink, a member of the lily family, has smooth evergreen leaves. It flowers in April and May. The flower stem is 1 to 3 ft (30 to 91 cm) tall with small leaves, and pink flowers are clustered (30 to 50 flowers) at the top of the stalk (FWS, 2010e). Fruits are trilobed, heart-shaped, and contain many seeds (Center for Plant Conservation, 2010; FWS, 1991). Swamp pink is not very successful at dispersing through seeds; rhizomes are the main source of new plants (FWS, 1991). Swamp pink has a highly clumped distribution where it occurs. Populations can vary from a few individuals to several thousand plants and could be considered colonies due to the the rhizomes connecting the plants (FWS, 1991).

Swamp pink is a wetland plant that usually grows on hummocks in soil that is saturated but not persistently flooded. It is thought to be limited to shady areas. Specific habitats include Atlantic white-cedar (*Chamaecypa tisthyoides*) swamps, swampy forested wetlands that border small streams, meadows, and spring seepage areas. It is most commonly found with other wetland plants such as red maple (*Acer rubrum*), sweet pepperbush (*Clethra alnifolia*), sweetbay magnolia (*Magnolia virginiana*), sphagnum moss (Sphagnum spp.), cinnamon fern (*Osmunda cinnamomea*), and skunk cabbage (*Symplocarpus foetidus*) (FWS, 2010e; CPC, 2010).

As of 1991, when a recovery plan for swamp pink was completed, New Jersey supported over half the known populations of the species, with 71 confirmed occurrences mostly on the coastal plain in pinelands fringe areas in the Delaware River drainage (FWS, 1991). In Delaware, 15 sites were confirmed in the coastal plain province in the counties of New Castle, Kent, and Sussex (FWS, 1991). In Delaware, one occurrence of swamp pink was recorded in New Castle County. Delaware does not have regulations specifically for protection of rare plant species (FWS, 2008). As of 2008 in New Jersey, Salem County had 20 confirmed occurrences of swamp pink, Gloucester County had 13, and Camden County had 28 (FWS, 2008). The swamp pink has potential habitat occur along the New Freedom North and New Freedom South transmission line ROWs. However, the FWS (2010) have indicated that this species is not known to occur on or in the vicinity of the Salem or HCGS sites.

2.2.8 Socioeconomic Factors

This section describes current socioeconomic factors that have the potential to be directly or indirectly affected by changes in operations at Salem and HCGS. Salem, HCGS, and the communities that support them can be described as dynamic socioeconomic systems. The communities provide the people, goods, and services required to operate Salem and HCGS. Salem and HCGS operations, in turn, create the demand and pay for the people, goods, and services in the form of wages, salaries, and benefits for jobs and dollar expenditures for goods and services. The measure of the communities' ability to support the demands of Salem and HCGS depends on their ability to respond to changing environmental, social, economic, and demographic conditions.

The socioeconomic region of influence (ROI) for Salem and HCGS is defined as the areas in which Salem and HGCS employees and their families reside, spend their income, and use their benefits, thereby affecting the economic conditions of the region. The Salem and HCGS ROI consists of a four-county region where approximately 85 percent of Salem and 82 percent of HCGS employees reside: Salem, Gloucester, and Cumberland counties in New Jersey and New

Castle County in Delaware. Salem and HCGS staff include shared corporate employees and matrixed workers (i.e., employees who work collaboratively between both facilities). The following sections describe the housing, public services, offsite land use, visual aesthetics and noise, population demography, and the economy in the ROI for Salem and HCGS.

Salem employs a permanent workforce of approximately 644 employees and the HCGS permanent workforce includes approximately 521 employees (PSEG, 2010d). Salem and HCGS share an additional 340 PSEG corporate and 109 matrixed employees. Approximately 85 percent of the Salem workforce, 82 percent of the HCGS workforce, and 79 percent of the PSEG corporate and matrixed employees live in Salem, Gloucester, and Cumberland counties in New Jersey and New Castle County in Delaware (Table 2-10). The remaining 15 percent of the Salem workforce are divided among 14 counties in New Jersey, Pennsylvania, and Maryland, as well as one county in Georgia, with numbers ranging from 1 to 42 employees per county. The remaining 18 percent of the HCGS workforce are divided among 16 counties in New Jersey, Pennsylvania, and Maryland, as well as one county in each of three States (Delaware, New York, and Washington), with numbers ranging from 1 to 38 employees per county. The remaining 21 percent of the corporate and matrixed employees reside in 13 counties in New Jersey, Pennsylvania, and Maryland, as well as one county in Delaware, one county in North Carolina, and the District of Columbia. Given the residential locations of Salem and HCGS employees, the most significant impacts of plant operations are likely to occur in Salem, Gloucester, and Cumberland counties in New Jersey and New Castle County in Delaware. Therefore, the socioeconomic impact analysis in this draft SEIS focuses on the impacts of Salem and HCGS on these four counties.

Table 2-10. Salem Nuclear Generating Station and Hope Creek Generating Station Employee Residence by County

County	Number of Salem Employees	Number of HCGS Employees	Number of Corporate and Matrixed Employees	Total Number of Employees	Percent of Total Workforce
Salem , NJ	253	198	189	640	39.7
Gloucester, NJ	100	74	68	242	15.0
Cumberland, NJ	73	51	35	159	9.8
New Castle, DE	123	106	64	293	18.2
Other	95	92	93	280	17.3
Total	**644**	**521**	**449**	**1,614**	**100**

Source: PSEG, 2010d

Refueling outages at Salem and HCGS generally occur at 18-month intervals for both stations. During refueling outages, site employment increases by as many as 600 workers at each station for approximately 23 days (PSEG, 2009a; 2009b). Most of these workers are assumed to be located in the same geographic areas as the permanent Salem and HCGS Staff.

2.2.8.1 Housing

Table 2-11 lists the total number of occupied and vacant housing units, vacancy rates, and median value in the four-county ROI. According to the 2000 census, there were nearly 373,600 housing units in the ROI, of which approximately 353,000 were occupied. The median value of owner-occupied units ranged from $91,200 in Cumberland County to $136,000 in New Castle County. The vacancy rate was highest in Salem County (7.1 percent) and Cumberland County (7.0 percent) and lower in New Castle County (5.3 percent) and Gloucester County (4.6 percent).

By 2008, the total number of housing units within the four-county ROI had grown by approximately 28,000 units to 401,673 housing units, while the total number of occupied units grew by 17,832 units to 370,922. The median house value increased approximately $101,600 between the 2000 census and the 3-year estimation period (2006 through 2008). As a result, the vacancy rate increased from 6 percent to 8 percent of total housing units.

Table 2-11. Housing in Cumberland, Gloucester, and Salem Counties, New Jersey, and New Castle County, Delaware

	Cumberland	Gloucester	Salem	New Castle	ROI
2000					
Total Housing Units	**52,863**	**95,054**	**26,158**	**199,521**	**373,596**
Occupied housing units	49,143	90,717	24,295	188,935	353,090
Vacant units	3,720	4,337	1,863	10,586	20,506
Vacancy rate (percent)	7	4.6	7.1	5.3	5.5
Median value (dollars)	91,200	120,100	105,200	136,000	113,125
2008[(a)]					
Total Housing Units	**55,261**	**106,641**	**27,463**	**212,308**	**401,673**
Occupied housing units	50,648	100,743	24,939	194,592	370,922
Vacant units	4,613	5,898	2,524	17,716	30,751
Vacancy rate (percent)	8.3	5.5	9.2	8.3	7.7
Median value (dollars)	171,600	238,200	197,100	252,000	214,725

(a) Housing values for the 2008 estimates are based on 2006–2008 American Community Survey 3-Year Estimates, U.S. Census Bureau.

Source: USCB, 2010a.

2.2.8.2 Public Services

This section presents a discussion of public services, including water, education, and transportation.

Water Supply

Information for the major municipal water suppliers in the three New Jersey counties, including firm capacity and peak demand, is presented in Table 2-12. Population served and water source for each system is also provided. The primary source of potable water in Cumberland County is groundwater withdrawn from the Cohansey-Maurice watershed. In Gloucester County, the water is primarily groundwater obtained from the Lower Delaware watershed. The major suppliers in Salem County obtain their drinking water supply from surface water or groundwater from the Delaware Bay watershed.

Information for the major municipal water suppliers in New Castle County, DE, is provided in Table 2-13, including maximum capacity and average daily production, as well as population served and water source for each system. The majority of the potable water supply is surface water withdrawn from the Brandywine-Christina watershed.

Table 2-12. Major Public Water Supply Systems in Cumberland, Gloucester, and Salem Counties, New Jersey

Water System	Population Served	Primary Water Source	Peak Daily Demand[(a)] (MGD)	Total Capacity (MGD)
Cumberland County				
City of Bridgeton	22,770	GW	4.05	3.35
City of Millville	27,500	GW	5.71	7.83
City of Vineland	33,000	GW	15.26	16.49
Gloucester County				
Borough of Clayton	7,155	GW	1.09	1.22
Deptford Township	26,000	SW (Purchased)	4.79	8.80
Borough of Glassboro	19,238	GW	4.29	6.31
Mantua Township	11,713	SW (Purchased)	2.19	2.74
Monroe Township	26,145	GW	6.22	7.15
Borough of Paulsboro	6,200	GW	1.25	1.80
Borough of Pitman	9,445	GW	0.96	1.59
Washington Township	48,000	GW	8.25	12.92
West Deptford Township	20,000	GW	4.26	7.03
Borough of Westville	6,000	GW	0.70	1.73
City of Woodbury	11,000	SW (Purchased)	1.76	4.32
Salem County				
Pennsville Township	13,500	GW	1.63	1.87
City of Salem	6,199	SW	1.66	4.27

MGD = million gallons per day; GW = groundwater; SW = surface water

(a) Current peak yearly demand plus committed peak yearly demand.

Sources: EPA, 2010c (population served and primary water source); NJDEP, 2009d (peak annual demand and available capacity)

Table 2-13. Major Public Water Supply Systems in New Castle County, Delaware

Water System	Population Served	Primary Water Source	Average Daily Production (MGD)	Maximum Capacity (MGD)
City of Middletown	16,000	GW	NA	NA
City of New Castle	6,000	GW	0.5	1.3
City of Newark	36,130	SW	4	6
City of Wilmington	140,000	SW	29	61

GW = groundwater; SW = surface water; NA = not available

Sources: EPA, 2010c (population served and primary water source); PSEG, 2009a and PSEG, 2009b (reported production and maximum capacity)

Education

Salem and HCGS are located in Lower Alloways Creek School District, which had an enrollment of approximately 223 students in pre-Kindergarten through 8th grade for the 2008–2009 school year. Salem County has 15 public school districts, with a total enrollment of 12,012 students. Cumberland County has a total of 15 school districts with 26,739 students enrolled in public schools in the county in 2008–2009. Gloucester County has 28 public school districts with a total 2008–2009 enrollment of 49,782 students (NJDOE, 2010). There are five public school districts in New Castle County, DE; total enrollment in the 2009–2010 school year is 66,679 students (DDE, 2010).

Transportation

Figures 2.1-1 and 2.1-2 show the Salem and HCGS location and highways within a 50-mi (80 km) radius and a 6-mi (10-km) radius of the facilities. At the larger regional scale, the major highways serving Salem and HCGS are Interstate 295 and the New Jersey Turnpike, located approximately 15 mi (24 km) north of the facilities. Interstate 295 crosses the Delaware River via the Delaware Memorial Bridge, providing access to Delaware and, via Interstate 95, to Pennsylvania.

Local road access to Salem and HCGS is from the northeast via Alloway Creek Neck Road, a two-lane road which leads directly to the facility access road. Alloway Creek Neck Road intersects County Route (CR) 658 approximately 4 mi (6.4 km) northeast of Salem and HCGS. CR 658 leads northward to the City of Salem, where it intersects New Jersey State Route 49, which is the major north-south route through western Salem County and connects local traffic to the Delaware Memorial Bridge to the north. Approximately 1 mi (1.6 km) east of its intersection with Alloway Creek Neck Road, CR 658 intersects with CR 623 (a north-south road) and CR 667 (an east-west road). Employees who live to the north, northeast, and northwest of Salem and HCGS, as well as those from Delaware and Pennsylvania, could travel south on State Route 49, connecting to CR 658 and from there to Alloway Creek Neck Road to reach the facilities. Employees from the south could travel north on CR 623, connecting to Alloway Creek Neck Road via CR 658. Employees living farther south or to the southeast could use State Route 49, connecting to Alloway Creek Neck Road via CR 667, and CR 658 or CR 623 (PSEG, 2009a; 2009b).

Traffic volumes in Salem County are highest on roadways in the northern and eastern parts of the county, where all of the annual average daily traffic counts greater than 10,000 were measured. The highest annual average daily traffic count in the county is 27,301 on Interstate 295 in the northeastern corner of the county. In western Salem County, in the vicinity of Salem and HCGS, annual average daily traffic counts range from 236 to 1,052, while within the City of Salem they range from 4,218 to 9,003. At the traffic count location closest to Salem and HCGS, located on CR 623, the annual average daily traffic count is 895 (NJDOT, 2009). Level of service data, which describe operational conditions on a roadway and their perception by motorists, are not collected by the State of New Jersey (PSEG, 2009a; PSEG, 2009b).

2.2.8.3 Offsite Land Use

This section describes offsite land use in the four-county ROI, including Salem, Gloucester, and Cumberland counties in New Jersey and New Castle County in Delaware, which is where the majority of Salem and HCGS employees reside. Salem and HCGS are located in western Salem County adjacent to the Delaware River, which is the border between New Jersey and Delaware.

Salem County, New Jersey

Salem County is rural in nature, consisting of more than 338 square miles (mi^2; 875 square kilometers [km^2]) of land with an estimated 66,141 residents, a 2.9 percent increase since 2000 (USCB, 2010a). Only 13 percent of the land area in the county is considered urban (in residential, commercial, or industrial use), with development concentrated in western Salem County along the Delaware River. The remaining 87 percent of the county is dedicated farmland under active cultivation (42 percent) or undeveloped natural areas, primarily tidal and freshwater wetlands (30 percent) and forests (12 percent) (Morris Land Conservancy, 2008). There are 199 farms for a total of 26,191 ac (10,600 ha), or 12 percent of the county, which have been preserved in Salem County under the New Jersey Farmland Preservation Program (SADC, 2009).

Two municipalities within Salem County, Lower Alloways Creek Township and the City of Salem, receive annual real estate tax payments from Salem and from HCGS. Over half of the land area in Lower Alloways Creek Township is wetlands (65 percent), 15 percent is used for agriculture, and 8 percent is urban. The City of Salem is largely urban (49 percent), with 24 percent of its area wetlands and 12 percent in agricultural use (Morris Land Conservancy, 2006).

Land use within Salem County is guided by the *Smart Growth Plan* (Rukenstein & Associates, 2004), which has the goal of concentrating development within a corridor along the Delaware River and Interstate 295/New Jersey Turnpike in the northwestern part of the county and encouraging agriculture and the preservation of open space in the central and eastern parts of the county. Land development is regulated by the municipalities within Salem County through the use of zoning and other ordinances.

Lower Alloways Creek Township has a master plan to guide development, which includes a land use plan (LACT, 1992). The plan encourages development in those areas of the township most capable of providing necessary services, continuation of agricultural use, and restriction on development in the conservation district (primarily wetlands). The land use plan includes an industrial district adjacent to Artificial Island. The master plan was updated in the *2005 Master*

Plan Reexamination Report (Alaimo Group, 2005), which looked at key issues and reaffirmed the importance of preserving farmland, open space, and environmental resources.

Cumberland County, New Jersey

Cumberland County, which is located to the south and east of Salem County, occupies about 489 mi^2 (1,300 km^2) of land along the Delaware Bay at the south end of New Jersey. In 2008, the county had an estimated population of 156,830 residents, which is a 7.1 percent increase since 2000 (USCB, 2010a). Over 60 percent of the land area in the county is forest (32 percent) or wetlands (30 percent). Approximately 19 percent is occupied by agriculture, mostly concentrated in the northwestern part of the county near Salem County. Only 12 percent of Cumberland County is considered urban (DVRPC, 2009). Under the New Jersey Farmland Preservation Program, 117 farms, including a total of 14,569 ac (5,900 ha) of farmland, have been preserved in Cumberland County (SADC, 2009).

Cumberland County has assembled a series of planning initiatives that together provide a strategic plan for the future of the county (Orth-Rodgers, 2002). A recently completed *Farmland Preservation Plan* for the county seeks to maintain its productive farmland in active use. The *Western/Southern Cumberland Region Strategic Plan* (issued as a draft in 2005) identifies 32 existing community centers in the county for concentration of future residential and commercial growth, and the county Master Plan, prepared in 1967, is in the process of being updated. The municipalities within Cumberland County regulate land development through zoning and other ordinances (DVRPC, 2009).

Gloucester County, New Jersey

Gloucester County is located northeast of Salem County. Gloucester County has approximately 325 mi^2 (840 km^2) of land and in 2008, had an estimated population of 287,860 residents, which represents a 12.6 percent increase since 2000 (USCB, 2010a). It is the fastest growing county in New Jersey (based on percent increase in population) and has the fastest growing municipality (Woolwich Township) on the East Coast (Gloucester County, 2010). Major land uses in the county are urban (26 percent) and agriculture (26 percent), with 30 percent of the county land area vacant and 10 percent wetlands (Gloucester County, 2009). There are 113 farms with a total of 9,527 ac (3,800 ha; 4 percent of the county land area) that have been preserved in Gloucester County under the New Jersey Farmland Preservation Program (SADC, 2009).

The County *Development Management Plan* and its various elements provide guidance for land use planning in Gloucester County. It encourages a growth pattern that will concentrate development rather than disperse it, enhancing existing urban areas and preserving natural resources. The Gloucester County *Northeast Region Strategic Plan* goals include taking advantage of infill opportunities to avoid sprawl into undeveloped areas and creating compact development that allows preservation of farms and open spaces. Land development is regulated by the municipalities within Gloucester County through zoning and other ordinances (GCPD, 2005).

New Castle County, Delaware

New Castle County, the northernmost county in the State of Delaware, is located east of Salem County across the Delaware River. The county encompasses slightly more than 426 mi^2 (1,100 km^2) and has an estimated resident population of 529,641, which is a 5.9 percent increase from 2000 to 2008. It is the most populous of the three counties in Delaware (USCB, 2010a). The three major land uses in New Castle County are agriculture (29 percent), residential (28 percent), and forests (15 percent) (New Castle County, 2007). In 2007, the county had a total of 347 farms (less than 14 percent of all farms in the State) located on approximately 67,000 ac (27,000 ha) of land. This reflects a decrease of 6 percent in land used for farming compared to 2000 (USDA, 2007).

The New Castle County *Comprehensive Development Plan* addresses county policies with regard to zoning, density, and open space preservation. It seeks to concentrate new growth, as well as redevelopment, in established communities in order to preserve limited resources. This is accomplished through the use of a future land use map. The plan proposes policies to encourage development in the northern part of the county with growth in the southern portion more centralized and compact (New Castle County, 2007).

2.2.8.4 Visual Aesthetics and Noise

Salem and HCGS are bordered by the Delaware River to the west and south and by a large expanse of wildlife management areas on the north, east, and southeast. The access road runs east to west along the shoreline of Artificial Island then continues east through the wetlands. The immediate area is flat in relief, consisting of open water and large expanses of tidal and freshwater marsh. Across the bay, in Delaware, the shoreline consists of State parks and wildlife areas with low profile marshy habitats and very few structures to interrupt the view. Beyond the parks and wetland areas are farmlands and then small to medium sized towns, in both Delaware and New Jersey.

The main vertical components of the Salem and HCGS building complex are the HCGS natural draft cooling tower (514-ft [157-m] tall), the most prominent feature on Artificial Island, and the three-domed reactor containment buildings (190 to 200-ft [58 to 61-m] tall). The structures are most visible from the Delaware River. Portions of the Salem and HCGS building complex can be seen from many miles away, in particular the cooling tower and the plume it produces. The complex can easily be seen from the marsh areas and the river itself, while in the more populated areas, it is often blocked by trees or houses and can only be seen from certain angles. The structures within the Salem and HCGS building complex are for the most part made of concrete and metal, with exposed non-concrete buildings and equipment painted light, generally neutral colors, such as brown and blue (AEC, 1973; PSEG, 1983). The overhead transmission lines leading away to the north, northeast, and east can also be seen from many directions as they cross over the low profile expanses of the marshes. Farther inland, portions of the transmission lines are visible, especially as they pass over roads and highways.

Sources of noise at Salem and HCGS include the cooling tower, transformers, turbines, circuit breakers, transmission lines and intermittent industrial noise from activities at the facilities. Noise studies were conducted prior to the operation of the Salem generating units. The transformers were each estimated to produce between 82 and 85 adjusted decibels (dBA) at 6 ft (1.8 m) away and the turbines were each estimated to produce 95 dBA at 3 ft (0.9 m) away. The combined noise from all sources was estimated at 36 dBA at the site boundary. The noise from the plant at the nearest residence, approximately 3.5 mi (5.6 km) from the Salem and HCGS facilities, was estimated to be approximately 27 dBA. The U. S. Department of housing and urban development (HUD) criterion guidelines for non-aircraft noise define 45 dBA as the maximum noise level for the “clearly acceptable” range. An ambient noise survey, within a radius of 5 mi (8 km), established that most of the existing sound levels were within New Jersey's limits for industrial operations, as measured at residential property boundaries (PSEG, 1983).

Given the industrial nature of these two stations, noise emissions are generally nothing more than an intermittent minor nuisance. Noise levels may sometimes exceed the 55 dBA level that the U.S. Environmental Protection Agency (EPA) uses as a threshold level to protect against excess noise during outdoor activities (EPA, 1974). However, according to the EPA this threshold does "not constitute a standard, specification, or regulation," but was intended to provide a basis for state and local governments establishing noise standards. To date, no noise complaints associated with operations at Salem and HCGS have been reported from neighboring communities.

2.2.8.5 Demography

According to the 2000 census, approximately 501,820 people lived within a 20-mi (32-km) radius of Salem and HCGS, which equates to a population density of 450 persons per mi^2. This density translates to a Category 4 (greater than or equal to 120 persons per mi^2 within 20 mi) using the generic environmental impact statement (GEIS) measure of sparseness. Approximately 5,201,842 people live within 50 mi (80 km) of Salem and HCGS, for a density of 771 persons per mi^2 (PSEG, 2009a; 2009b). Applying the GEIS proximity measures, this density is classified as Category 4 (greater than or equal to 190 persons per mi^2 within 50 mi [80 km]). Therefore, according to the sparseness and proximity matrix presented in the GEIS, a Category 4 value for sparseness and for proximity indicates that Salem and HCGS are located in a high population area.

Table 2-14 shows population projections and growth rates from 1970 to 2050 in Cumberland, Gloucester, and Salem counties in New Jersey and New Castle County in Delaware. All of the four counties experienced continuous growth during the period 1970 to 2000, except for Salem County, which saw a 1.5 percent decline in population between 1990 and 2000. Gloucester County experienced the greatest rate of growth during this period. Beyond 2000, county populations are expected to continue to grow in the next decades, with Gloucester County projected to experience the highest rate of growth.

Table 2-14. Population and Percent Growth in Cumberland, Gloucester, and Salem Counties, New Jersey, and New Castle County, Delaware from 1970 to 2000 and Projected for 2010 to 2050

Year	Cumberland County		Gloucester County		Salem County		New Castle County	
	Population	Percent Growth[(a)]	Population	Percent Growth[(a)]	Population	Percent Growth[(a)]	Population	Percent Growth[(a)]
1970	121,374	—	172,681	—	60,346	---	385,856	----
1980	132,866	9.5	199,917	15.8	64,676	7.2	398,115	3.2
1990	138,053	3.9	230,082	15.1	65,294	1.0	441,946	11.0
2000	146,438	6.1	254,673	10.7	64,285	-1.5	500,265	13.2
2008	**155,388**	**6.1**	**284,886**	**11.9**	**65,952**	**2.6**	**526,414**	**5.2**
2010	157,745	7.7	289,920	13.8	66,342	3.2	535,572	7.1
2020[(b)]	164,617	4.4	307,688	6.1	69,433	4.7	564,944	5.5
2030[(b)]	176,784	7.4	338,672	10.1	74,576	7.4	586,387	3.8
2040[(c)]	185,421	4.9	360,845	6.5	78,351	5.1	613,116	4.6
2050[(c)]	194,941	5.1	385,221	6.8	82,468	5.3	638,524	4.1

— = Not applicable

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

(b) The 2020 and 2030 population projections for Cumberland, Gloucester, and Salem counties are for 2018 and 2028, respectively.

(c) Calculated.

Sources: Population data for 1970 through 1990 (USCB, 1995a; 1995b); population data for 2000 (USCB, 2000d); Population estimates for 2008 (USCB, 2010a); New Jersey counties estimated population for 2009 (USCB, 2010b); New Castle County projected population for 2010 to 2040 (DPC, 2009); New Jersey counties projected population for 2018 and 2028 (CUPR, 2009).

The 2000 demographic profile of the four-county ROI is included in Table 2-15. Persons self-designated as minority individuals comprise approximately 30 percent of the total population. This minority population is composed largely of Black or African American residents.

Table 2-15. Demographic Profile of the Population in the Salem Nuclear Generating Station and Hope Creek Generating Station Region of Influence in 2000

	Cumberland, NJ	Gloucester, NJ	Salem, NJ	New Castle, DE	ROI
Total Population	**146,438**	**254,673**	**64,285**	**500,265**	**965,661**
Race, Not-Hispanic or Latino (percent of total population)					
White	58.4	85.7	79.6	70.7	73.4
Black or African American	19.2	8.9	14.4	19.9	16.5
American Indian and Alaska Native	0.7	0.2	0.3	0.2	0.3
Asian	0.9	1.5	0.6	2.6	1.9
Native Hawaiian and Other Pacific Islander	0.03	0.02	0.02	0.03	0.03
Some other race	0.1	0.1	0.1	0.1	0.1
Two or more races	1.63	1.1	1.1	1.2	1.2
Ethnicity					
Hispanic or Latino	27,823	6,583	2,498	26,293	63,197
Percent of total population	19.0	2.6	3.9	5.3	6.5
Minority Populations (including Hispanic or Latino ethnicity)					
Total minority population	60,928	36,411	13,114	146,505	256,958
Percent minority	41.6	14.3	20.4	29.3	26.6

Source: USCB, 2000d

According to the U.S. Census Bureau's 2006-2008 American Community Survey 3-Year Estimates, minority populations were estimated to have increased by approximately 61,000 persons and comprised 30.8 percent of the four-county ROI population (see Table 2–16). Most of this increase was due to an estimated influx of Hispanic or Latinos (over 25,000 persons), an increase in population of over 39.8 percent from 2000. The next largest increases in minority populations were Black or African American and Asian populations with increases of approximately 23,000 and 9,700 persons or 14.4 and 53 percent, respectively, from 2000.

Table 2-16. Demographic Profile of the Population in the Salem and HCGS Region of Influence, 2006-2008 Three-Year Estimate

	Cumberland, NJ	Gloucester, NJ	Salem, NJ	New Castle, DE	Region of Influence
Total Population	155,388	284,886	65,952	526,414	1,032,640
Race (percent of total population, Not-Hispanic or Latino)					
White	53.6	82.8	77.8	65.3	69.2
Black or African American	19.2	9.5	14.8	22.0	17.7
American Indian and Alaska Native	0.8	0.1	0.3	0.2	0.2
Asian	1.1	2.3	0.6	3.7	2.7
Native Hawaiian and Other Pacific Islander	0.01	0.03	0.00	0.02	0.02
Some other race	0.2	0.1	0.3	0.2	0.2
Two or more races	1.6	1.6	0.9	1.4	1.4
Ethnicity					
Hispanic or Latino	36,530	10,409	3,489	37,929	88,357
Percent of total population	23.5	3.7	5.3	7.2	8.6
Minority Populations (including Hispanic or Latino ethnicity)					
Total minority population	72,112	48,927	14,653	182,540	318,232
Percent minority	46.4	17.2	22.2	34.7	30.8

Source: U.S. Census Bureau, 2006–2008 American Community Survey (USCB, 2010a).

Transient Population

Within 50 mi (80 km) of Salem and HCGS, colleges and recreational opportunities attract daily and seasonal visitors who create demand for temporary housing and services. In 2000, in the four-county ROI, 0.5 percent of all housing units were considered temporary housing for seasonal, recreational, or occasional use. Table 2-17 provides information on seasonal housing for the counties located within the Salem and HCGS ROI (USCB, 2000b). In 2008, there were 49,498 students attending colleges and universities located within 50 mi (80 km) of Salem and HCGS (NCES, 2009).

Table 2-17. Seasonal Housing in the Salem Nuclear Generating Station and Hope Creek Generating Station Region of Influence in 2000

County	Number of Housing Units	Vacant Housing Units for Seasonal, Recreational, or Occasional Use	Percent
Cumberland	52,863	826	1.6
Gloucester	95,054	274	0.3
Salem	26,158	131	0.5
New Castle	199,521	707	0.4
ROI	373,596	1,938	0.5

Source: USCB, 2000c

Migrant Farm Workers

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

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

The 2007 Census of Agriculture collected information on migrant farm and temporary labor. Table 2-18 provides information on migrant farm workers and temporary (less than 150 days) farm labor within 50 mi (80 km) of Salem and HCGS. According to the 2007 Census of Agriculture, 15,764 farm workers were hired to work for less than 150 days and were employed on 1,747 farms within 50 mi (80 km) of Salem and HCGS. The county with the largest number of temporary farm workers (4,979 persons on 118 farms) was Atlantic County, NJ (USDA, 2007). Salem County had 804 temporary farm workers on 121 farms; Cumberland County had 1,857 temporary workers on 141 farms, and Gloucester County had 1,228 on 110 farms (USDA, 2007). New Castle County reported 320 temporary workers on 52 farms.

Farm operators were asked whether any hired workers were migrant workers, defined as a farm worker whose employment required travel that prevented the migrant worker from returning to their permanent place of residence the same day. A total of 453 farms in the region (within a 50-mi [80 km] radius of Salem and HCGS) reported hiring migrant workers. Chester County, PA reported the most farms (101) with hired migrant workers. Within the four-county ROI, a total of 164 farms were reported with hired migrant farm workers, including Cumberland County with 65 farms, followed by Gloucester County with 56 and Salem County with 33. New Castle County reported a total of 10 farms with hired migrant workers (USDA, 2007).

Table 2-18. Migrant Farm Worker and Temporary Farm Labor within 50 Miles of Salem Nuclear Generating Station and Hope Creek Generating Station

County[(a)]	Farm workers working less than 150 days	Farms hiring workers for less than 150 days	Farms reporting migrant farm labor	Farms with hired farm labor
Delaware:				
Kent	728	106	22	169
New Castle	320	52	10	81
County Subtotal	**1,048**	**158**	**32**	**250**
Maryland:				
Caroline	478	121	13	153
Cecil	546	87	5	128
Hartford	266	101	12	155
Kent	245	78	8	111
Queen Anne's	317	89	13	126
County Subtotal	**1,852**	**476**	**51**	**673**
New Jersey:				
Atlantic	4,979	118	74	163
Camden	470	43	17	52
Cape May	173	38	8	46
Cumberland	1,857	141	65	192
Gloucester	1,228	110	56	163
Salem	804	121	33	172
County Subtotal	**9,511**	**571**	**253**	**788**
Pennsylvania:				
Chester	2,687	403	101	580
Delaware	106	19	2	25
Montgomery	560	115	14	155
Philadelphia	-	5	-	5
County Subtotal	**3,353**	**542**	**117**	**765**
County Total	**15,764**	**1,747**	**453**	**2,746**

(a) Includes counties with approximately more than half their area within a 50-mi radius of Salem and HCGS.

Source: USDA, 2007

2.2.8.6 Economy

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

<u>Employment and Income</u>

Between 2000 and 2007, the civilian labor force in Salem County decreased 4.4 percent to 18,193. During the same time period, the civilian labor force in Gloucester County and

Cumberland County grew 18.5 percent and 5.8 percent, respectively, to the 2007 levels of 92,154 and 48,468. In New Castle County, DE, the civilian labor force increased slightly (0.9 percent) to 284,647 between 2000 and 2007 (USCB, 2010c).

In 2008, trade, transportation, and utilities represented the largest sector of employment in the three New Jersey counties, followed by education and health services in Salem and Gloucester counties and manufacturing in Cumberland County (NJDLWD, 2010a; 2010b; 2010c). The trade, transportation, and utilities sector employed the most people in New Castle County, DE, in 2008, followed closely by the professional and business services sector (DDL, 2009). A list of some of the major employers in Salem County is provided in Table 2-19. The largest employer in the county in 2006 was PSEG with over 1,300 employees.

Table 2-19. Major Employers in Salem County in 2007

Firm	Number of Employees
PSEG	1,300+[(a)]
E.I. duPont	1,250
Mannington Mills	826
Memorial Hospital of Salem County	600
Atlantic City Electric	426
R.E. Pierson Construction	400+
Anchor Glass	361
McLane NJ	352
Elmer Hospital	350
Wal-Mart	256
Berkowitz Glass	225
Siegfried (USA)	155

Source: Salem County, 2007

(a) PSEG (2010c) reports that Salem and HCGS employ approximately 1,165 employees and share an additional 340 PSEG corporate and 109 matrixed employees, for a total of 1,614 employees.

Income information for the four-county ROI is presented in Table 2-20. Median household incomes in Gloucester and New Castle counties were each above their respective State median household income averages, while Salem and Cumberland counties had median household incomes below the State of New Jersey average. Per capita incomes in Salem, Gloucester, and Cumberland counties were each below the State of New Jersey average, while the New Castle County per capita income was above the State of Delaware average. In Salem and Cumberland counties, 9.9 and 15.1 percent of the population, respectively, was living below the official poverty level, which is greater than the percentage for the State of New Jersey as a whole (8.7 percent). Only 7.5 percent of the Gloucester County population was living below the poverty level. In Delaware, 9.9 percent of the New Castle County population was living below the poverty level, while the State average was 10.4 percent. In addition, Cumberland County has the highest percentage of families living below the poverty level in the ROI.

Table 2-20. Income Information for the Salem Nuclear Generating Station and Hope Creek Generating Station Region of Influence, 2008

	Salem County	Gloucester County	Cumberland County	New Jersey	New Castle County	Delaware
Median household income (dollars)	61,204	72,316	49,944	69,674	62,628	57,270
Per capita income (dollars)	27,785	30,893	21,316	34,899	31,400	29,124
Persons below poverty level (percent)	9.9	7.5	15.1	8.7	9.9	10.4
Families below poverty level (percent)	5.9	5.7	12.6	6.3	6.1	7.1

Source: USCB, 2010a.

Unemployment

In 2008, the annual unemployment average in Salem, Gloucester, and Cumberland counties was 7.5, 6.4, and 9.6 percent, respectively, all of which were higher than the unemployment average of 6.0 percent for the State of New Jersey. Conversely, the annual unemployment average of 5.6 for New Castle County was lower than the State of Delaware average of 6.0 percent (USCB, 2010a).

Taxes

The owners of Salem and HCGS pay annual property taxes to Lower Alloways Creek Township. From 2003 through 2009, PSEG and Exelon paid between $1,191,870 and $1,511,301 annually in property taxes to Lower Alloways Creek Township (Table 2-21). During the same time period, these tax payments represented between 54.2 and 59.3 percent of the township's total annual property tax revenue. Each year, Lower Alloways Creek Township forwards this tax money to Salem County, which provides most services to township residents. The property taxes paid annually for Salem and HCGS during 2003 through 2009 represent approximately 2.5 to 3.5 percent of Salem County's total annual property tax revenue. As a result of the payment of property taxes for Salem and HCGS to Lower Alloways Creek Township, residents of the township do not pay local municipal property taxes on residences, local school taxes, or municipal open space taxes; they pay only Salem County taxes and county open space taxes (PSEG, 2009a; 2009b).

In addition, PSEG and Exelon pay annual property taxes to the City of Salem for the Energy and Environmental Resource Center, located in Salem. From 2003 through 2009, between $177,360 and $387,353 in annual property taxes for the Center were paid to the city (Table 2-22).

Table 2-21. Salem Nuclear Generating Station and Hope Creek Generating Station Property Tax Paid and Percentage of Lower Alloways Creek Township and Salem County Tax Revenues, 2003 to 2009

				Lower Alloways Creek Township				Salem County			
	Property Tax Paid by PSEG and/or Exelon (dollars)			Total Property Tax Revenue in Township (dollars)	PSEG and/or Exelon Property Tax as Percentage of Total Property Tax Revenue (percent)			Total Property Tax Revenue in County (dollars)	PSEG and/or Exelon Property Tax as Percentage of Total Property Tax Revenue (percent)		
Year	Salem	HCGS	Total		Salem	HCGS	Total		Salem	HCGS	Total
2003	748,537	464,677	1,213,214	2,099,185	35.7	22.1	57.8	34,697,781	2.2	1.3	3.5
2004	764,379	474,512	1,238,891	2,251,474	34.0	21.1	55.0	36,320,365	2.1	1.3	3.4
2005	783,644	485,624	1,269,268	2,325,378	33.7	20.9	54.6	40,562,971	1.9	1.2	3.1
2006	734,841	457,029	1,191,870	2,195,746	33.5	20.8	54.3	43,382,037	1.7	1.1	2.7
2007	772,543	480,476	1,253,019	2,310,262	33.4	20.8	54.2	46,667,551	1.7	1.0	2.7
2008	745,081	463,397	1,208,478	2,038,467	36.6	22.7	59.3	49,058,072	1.5	0.9	2.5
2009	931,785	579,516	1,511,301	2,644,636	35.2	21.9	57.1	51,636,999	1.8	1.1	2.9

Source: PSEG, 2009a; PSEG, 2009b; PSEG, 2010e

Table 2-22. Energy and Environmental Resource Center Property Tax Paid and Percentage of City of Salem Tax Revenues, 2003 to 2009

Year	Property Tax Paid by PSEG and/or Exelon (dollars)	Total Property Tax Revenue in City of Salem (dollars)	PSEG and/or Exelon Property Tax as Percentage of Total Property Tax Revenue in City of Salem (percent)
2003	177,360	5,092,527	3.5
2004	211,755	6,049,675	3.5
2005	220,822	6,294,613	3.5
2006	228,492	6,485,947	3.5
2007	318,910	7,389,319	4.3
2008	184,445	8,423,203	2.2
2009	387,353	8,313,289	4.7

Source: PSEG, 2009a; 2009b; 2010e

This represented between 2.2 and 4.7 percent of the city's total annual property tax revenue. Ownership of the Energy and Environmental Resource Center was transferred to PSEG Power in the fourth quarter of 2008; therefore, Exelon is no longer minority owner of the center.

In 1999, the State of New Jersey deregulated its utility industry (EIA, 2008). Any changes to the tax assessment for Salem or HCGS would already have occurred and are reflected in the tax payment information provided in Table 2-21. Potential future changes to Salem and HCGS property tax rates due to deregulation would be independent of license renewal.

The continued availability of Salem and HCGS and the associated tax base is an important feature in the ability of Salem County communities to continue to invest in infrastructure and to draw industry and new residents.

2.2.9 Historic and Archaeological Resources

This section presents a brief summary of the region's cultural background and a description of known historic and archaeological resources at the Salem/HCGS site and its immediate vicinity. The information presented was collected from area repositories, the New Jersey State Historic Preservation Office (SHPO), the New Jersey State Museum (NJSM), and the applicant's ER (PSEG, 2009a; 2009b).

2.2.9.1 Cultural Background

The prehistory of New Jersey includes five major temporal divisions based on technological advancements, the stylistic evolution of the lithic tool kit, and changes in subsistence strategies related to a changing environment and resource base. These divisions are as follows:

- The Paleo-Indian Period (circa 12,000–10,000 years before present [BP])
- The Archaic Period (circa 10,000–3,000 years BP)

- The Woodland Period (circa 3,000 BP–1600 AD)
- The Contact Period (circa 1600–1700 AD)
- Historic Period (circa 1700–1700 AD)

These periods are typically broken into shorter time intervals reflecting specific adaptations and stylistic trends and are briefly discussed below.

Paleo-Indian Period

The Paleo-Indian Period began after the Wisconsin glacier retreated from the region approximately 12,000 years ago, and represents the earliest known occupation in New Jersey. The Paleo-Indian people were hunter-gatherers whose subsistence strategy may have been dependent upon hunting large game animals over a wide region of tundra-like vegetation that gradually developed into open grasslands with scattered coniferous forests (Kraft, 1982). The settlement pattern during this period likely consisted of small, temporary camps (Kraft, 1982).

Few Paleo-Indian sites have been excavated in the Mid-Atlantic Region. Within New Jersey, Paleo-Indian sites, such as the Plenge site excavated in the Musconetcong Valley in the northwestern part of the State, have largely been identified in valley and ridge zones (Marshall, 1982).

Archaic Period

The Archaic Period is marked by changes in subsistence and settlement patterns. While hunting and gathering were still the primary subsistence activities, the emphasis seems to have shifted toward hunting the smaller animals inhabiting the deciduous forests that developed during this time. Based on archaeological evidence, the settlement pattern that helps define the Archaic Period consisted of larger, more permanent habitation sites. In addition to game animals, the quantities of plant resources, as well as fish and shellfish remains that have been identified at these sites, indicate that the Archaic people were more efficiently exploiting the natural environment (Kraft, 1982).

An example of a typical Archaic Period site in southern New Jersey is the Indian Head Site, located about 35 mi (56 km) northeast of the Salem/HCGS site. The Indian Head Site is a large multi-component site with evidence of both Middle and Late Archaic Period occupations.

Woodland Period

The Woodland Period marks the introduction of ceramic manufacture, as clay vessels replaced the earlier carved soapstone vessels. Hunting and gathering subsistence activities persisted, however, the period is notable for the development of horticulture. As horticulture became of increasing importance to the subsistence economy of the Woodland people, settlement patterns were affected. Habitation sites increased in size and permanence, as a larger population size could be sustained due to the more efficient exploitation of the natural environment for subsistence (Kraft, 1982).

Examples of Woodland Period occupations in southern New Jersey are well documented in the many Riggins Complex sites recorded in the Cohansey Creek and Maurice River drainages.

Contact Period

European exploration of the Mid-Atlantic Region began in the 16th century, and by the early 17th century, maps of the area were being produced (aclink.org). The Dutch ship *Furtuyn* explored the Mullica River in 1614. The Dutch and Swedish were the first to colonize the area, though they were eventually forced to give control of lands to the British in the later part of the 17th century. These settlements mark the beginning of the Contact Period, a time of ever-increasing contact between the Native Americans of the region and the Europeans.

The native groups of the southern New Jersey region were part of the widespread Algonquin cultural and linguistic tradition (Kraft, 1982). Following initial contact, a pattern of Indian/European trade developed and the Native Americans began to acquire European-made tools, ornaments, and other goods. This pattern is reflected in the archaeological record, as the artifact assemblages from Contact Period sites contain both Native American and European cultural material.

At the time of contact, the Lenni Lenape inhabited the Salem/HCGS area. The Lenni Lenape, who eventually became known as the Delaware tribe, also occupied lands throughout New Jersey, as well as in present-day Pennsylvania and New York (Eaton, 1899). The group occupying southern New Jersey spoke the Southern Unami dialects of the Algonquin language (Kraft, 2001).

Historic Period

The first European settlement in the vicinity of the Salem/HCGS site occurred in 1638, when a Swedish fort was established along the Delaware River in the present day town of Elsinborough (CSS, 2010). This settlement was short lived, as the location was plagued with mosquitoes and was eventually deemed untenable. Later attempts to settle the area by Swedish, Finnish, and Dutch groups also met with limited success. In 1675, the Englishman John Fenwick and his group of colonists landed along the Delaware River, north of the original Swedish settlement at Elsinborough (Brown, 2007). They established “Fenwicks Colony” and the town of Salem. In 1790, the population of Salem County was 10,437. By 1880, the county’s population had more than doubled in size, reaching 24,579. Today, approximately 65,000 people inhabit Salem County (USCB, 2010c).

During the 18th and 19th century, the predominant industries in Salem County included commercial fishing, shipping of agricultural products, ship building businesses, glass manufacturing, and farming (DSC, 2010). In the latter part of the 19th century, the DuPont Company established a gunpowder manufacturing plant in Salem County. At its peak, in the early part of the 20th century, the plant employed nearly 25,000 workers. The DuPont facilities continued operation into the late 1970s. In addition to generation of electric power at the Salem and HCGS sites, furniture and glass manufacturing have been the predominate industries in Salem County in the latter part of the 20th and the early part of the 21st centuries[2].

[2] Personal communication with B. Gallo, Editor of Today’s Sunbeam, Salem County, New Jersey. March 9, 2010.

2.2.9.2 Historic and Archaeological Resources at the Salem/Hope Creek Site

Previously Identified Resources

The New Jersey State Museum (NJSM) houses the State's archaeological site files, and the New Jersey State Historical Preservation office (SHPO) houses information on historic resources such as buildings and houses, including available information concerning the National or State Register eligibility status of these resources. The NRC cultural resource team visited the NJSM and collected site files on archaeological sites and information on historic resources located within or nearby the Salem/HCGS property. Online sources were used to identify properties listed on the National Register of Historic Places (NRHP) in Salem County, NJ, and New Castle County, DE (NRHP, 2010).

A review of the NJSM files to identify archaeological resources indicated that no archaeological or historic sites have been recorded on Artificial Island. The nearest recorded prehistoric archaeological site, 35CU99, is located approximately 3.5 mi (5.6 km) southeast of the plant site, in Cumberland County. 35CU99 is an Archaic Period archeological site containing stone tools and evidence of stone tool making activity. The closest NRHP-listed site is the Joseph Ware House, which is located 6 mi (9.6 km) to the northeast, in Hancock's Bridge. To date, 6 properties within a 10-mi (16 km) radius of the Salem/HCGS site in Salem County, NJ, have been listed on the NRHP. A total of 17 NRHP-listed sites in New Castle County, DE, fall within a 10-mi radius of the Salem/HCGS site.

Potential Archaeological Resources

The Salem and HCGS sites are located on a man-made island in the Delaware River. This would suggest a very low potential for the discovery of previously undocumented prehistoric archaeological sites on the plant property. However, given the age of the artificial island upon which the generating stations were constructed, it is possible that previously undocumented historic-period resources may be present. Further research would be required to determine historic period land use patterns on the island during the 20th century.

2.3 Related Federal Project Activities

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

The Staff has determined that there are no Federal projects that would make it desirable for another Federal agency to become a cooperating agency in the preparation of the SEIS. Federal facilities and parks and wildlife areas within 50 mi (80 km) of Salem and HCGS are listed below.

- Coast Guard Training Center, Cape May (New Jersey)
- Dover Air Force Base (Delaware)
- Aberdeen Test Center (Maryland)

- United States Defense Government Supply Center, Philadelphia (Pennsylvania)
- Federal Correctional Institution, Fairton (New Jersey)
- Federal Detention Center, Philadelphia (Pennsylvania)
- New Jersey Coastal Heritage Trail
- Great Egg Harbor National Scenic and Recreational River (New Jersey)
- New Jersey Pinelands National Reserve
- Captain John Smith Chesapeake National Historic Trail (Delaware, Maryland)
- Chesapeake Bay Gateways Network (Delaware, Maryland)
- Hopewell Furnace – National Historic Site (Pennsylvania)
- Cape May National Wildlife Refuge (New Jersey)
- Supawna Meadows National Wildlife Refuge (New Jersey)
- Eastern Neck National Wildlife Refuge (Maryland)
- Bombay Hook National Wildlife Refuge (Delaware)
- Prime Hook National Wildlife Refuge (Delaware)
- Independence National Historical Park (Pennsylvania)

The USACE is involved in a project that could affect resources in the vicinity of Salem and HCGS. The USACE plans on deepening the Delaware River main navigation channel from Philadelphia to the Atlantic Ocean to a depth of 45 ft (14 m). This channel passes close to Artificial Island and the Salem and HCGS effluent discharge area. Studies determined that potential minor changes in hydrology, including salinity, would be possible. Temporary increases in turbidity would be expected during construction (USACE, 2009).

Although it is not a Federal project, the potential construction of a fourth unit at the Salem and HCGS site would require action by a Federal agency. PSEG submitted an early site permit application to the NRC regarding possible construction of one or two new reactor units at the Salem and HCGS site on Artificial Island (PSEG, 2010f).

The NRC is required under Section 102(2)(c) of the National Environmental Policy Act of 1969 (NEPA), as amended, to consult with and obtain the comments of any Federal agency that has jurisdiction by law or special expertise with respect to any environmental impact involved. The NRC consulted with the NMFS and the FWS. Federal agency consultation correspondence and comments on the SEIS are presented in Appendix D.

2.4 References

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

10 CFR Part 54. *Code of Federal Regulations*, Title 10, *Energy*, Part 51, "Requirements for Renewal of Operating Licenses for Nuclear Power Plants."

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

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

10 CFR Part 72. *Code of Federal Regulations*, Title 10, *Energy*, Part 72, "Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor-Related Greater Thank Class C Waste."

16 USC 1456. *United States Code*. Title 16, Chapter 33, Part 1456, "Coordination and Cooperation."

40 CFR Part 81. *Code of Federal Regulations*, Title 40, *Protection of the Environment*, Part 81, "Designation of Areas for Air Quality Planning Purposes."

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3.0 ENVIRONMENTAL IMPACTS OF REFURBISHMENT

License renewal actions include refurbishment actions for the extended plant life. These actions may have an impact on the environment that requires evaluation, depending on the type of action and the plant-specific design. If such actions were planned, the potential environmental effects of refurbishment actions would be identified and the analysis would be summarized within this section.

Environmental issues associated with refurbishment activities are discussed in the "Generic Environmental Impact Statement (GEIS) for License Renewal of Nuclear Plants", NUREG-1437, Vol. 1 and 2 (NRC, 1996; NRC, 1999).[1] The GEIS includes a determination of whether or not the analysis of the environmental issues can be applied to all plants and whether or not additional mitigation measures are warranted. Issues are then assigned a Category 1 or a Category 2 designation. As set forth in the GEIS, Category 1 issues are those that meet all of the following criteria:

(1) The environmental impacts associated with the issue have been determined to apply either to all plants or, for some issues, to plants having a specific type of cooling system or other specified plant or site characteristics.

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

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

For issues that meet the three Category 1 criteria, no additional plant-specific analysis is required in this supplemental environmental impact statement (SEIS) unless new and significant information is identified. Category 2 issues are those that do not meet one or more of the criteria for Category 1 and, therefore, an additional plant-specific review of these issues is required. Environmental issues associated with refurbishment, which were determined to be Category 1 and Category 2 issues, are listed in Tables 3-1 and 3-2, respectively.

Requirements for the renewal of operating licenses for nuclear power plants include the preparation of an integrated plant assessment (IPA) pursuant to Section 54.21 of Title 10 of the *Code of Federal Regulations* (CFR). The IPA must identify and list systems, structures, and components subject to an aging management review. The GEIS (NRC, 1996) provides helpful information on the scope and preparation of refurbishment activities to be evaluated. Environmental resource categories to be evaluated for impacts of refurbishment include terrestrial resources, threatened and endangered species, air quality, housing, public utilities and water supply, education, land use, transportation, and historic and archaeological resources. Items that are subject to aging and might require refurbishment include, for

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

example, the reactor vessel piping, supports, and pump casings (see 10 CFR 54.21 for details), as well as items that are not subject to periodic replacement.

PSEG Nuclear, LLC (PSEG) performed IPAs on Salem Nuclear Generating Station, Units 1 and 2 (Salem) and Hope Creek Generating Station (HCGS) pursuant to 10 CFR 54.21. This assessment did not identify the need to undertake any major refurbishment or replacement actions to maintain the functionality of important systems, structures, and components during the Salem or HCGS license renewal periods or other facility modifications associated with license renewals that would affect the environment or plant effluents (PSEG, 2009a; PSEG, 2009b); therefore, an assessment of refurbishment activities is not considered in this SEIS.

Table 3-1. Category 1 Issues for Refurbishment Evaluation

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Sections
Surface Water Quality, Hydrology, and Use (for all plants)	
Impacts of refurbishment on surface water quality	3.4.1
Impacts of refurbishment on surface water use	3.4.1
Aquatic Ecology (for all plants)	
Refurbishment	3.5
Ground Water Use and Quality	
Impacts of refurbishment on ground water use and quality	3.4.2
Land Use	
Onsite land use	3.2
Human Health	
Radiation exposures to the public during refurbishment	3.8.1
Occupational radiation exposures during refurbishment	3.8.2
Socioeconomics	
Public services: public safety, social services, and tourism and recreation	3.7.4; 3.7.4.3; 3.7.4.4; 3.7.4.6
Aesthetic impacts (refurbishment)	3.7.8

Table 3-2. Category 2 Issues for Refurbishment Evaluation

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Sections	10 CFR 51.53 (c)(3)(ii) Subparagraph
Terrestrial Resources		
Refurbishment impacts	3.6	E
Threatened or Endangered Species (for all plants)		
Threatened or endangered species	3.9	E
Air Quality		
Air quality during refurbishment (nonattainment and maintenance areas)	3.3	F
Socioeconomics		
Housing impacts	3.7.2	I
Public services: public utilities	3.7.4.5	I
Public services: education (refurbishment)	3.7.4.1	I
Offsite land use (refurbishment)	3.7.5	I
Public services, transportation	3.7.4.2	J
Historic and archaeological resources	3.7.7	K
Environmental Justice		
Environmental justice	Not addressed[a]	Not addressed[a]

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

3.1 REFERENCES

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

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

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

NRC (U.S. Nuclear Regulatory Commission). 1999. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Main Report*, "Section 6.3 – Transportation, Table 9.1, Summary of findings on NEPA issues for license renewal of nuclear power plants, Final Report."

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PSEG (PSEG Nuclear, LLC). 2009a. Salem Nuclear Generating Station, Units 1 and 2, License Renewal Application, Appendix E - Applicant's Environmental Report – Operating License Renewal Stage. Lower Alloways Creek Township, New Jersey. August, 2009. ADAMS Nos. ML092400532, ML092400531, ML092430231

PSEG (PSEG Nuclear, LLC). 2009b. Hope Creek Generating Station, License Renewal Application, Appendix E - Applicant's Environmental Report – Operating License Renewal Stage. Lower Alloways Creek Township, New Jersey. August, 2009. ADAMs No. ML092430389

4.0 ENVIRONMENTAL IMPACTS OF OPERATION

This chapter addresses potential environmental impacts related to the period of extended operation of Salem Nuclear Generating Station, Units 1 and 2 (Salem) and Hope Creek Generating Station (HCGS). These impacts are grouped and presented according to resource. Generic issues (Category 1) rely on the analysis provided in the *Generic Environmental Impact Statement for License Renewal of Nuclear Power Plants* (GEIS) prepared by the U.S. Nuclear Regulatory Commission (NRC) (NRC, 1996; 1999a) and are discussed briefly. NRC staff (the Staff) analyzed site-specific issues (Category 2) for Salem and HCGS and assigned them a significance level of SMALL, MODERATE, or LARGE. Some remaining issues are not applicable to Salem and HCGS because of site characteristics or plant features. Section 1.4 of this report explains the criteria for Category 1 and Category 2 issues and defines the impact designations of SMALL, MODERATE, and LARGE.

4.1 Land Use

Land use issues are listed in Table 4-1. The Staff did not identify any Category 2 issues for land use. The Staff also did not identify any new and significant information during the review of the applicant's environmental reports (ERs) (PSEG, 2009a; PSEG, 2009b), the site audit, or the scoping process. Therefore, there are no impacts related to these issues beyond those discussed in the GEIS. For these issues, the GEIS concludes that the impacts are SMALL.

Table 4-1. Land Use Issues. *Section 2.2.1 of this report describes the land use around Salem and HCGS.*

Issues	GEIS Section	Category
Onsite land use	4.5.3	1
Power line right-of-way	4.5.3	1

4.2 Air Quality

The air quality issue applicable to the Salem and HCGS facilities is listed in Table 4-2. The Staff did not identify any Category 2 issues for air quality. The Staff also did not identify any new and significant information during the review of the applicant's ER (PSEG, 2009a; 2009b), the site audit, or the scoping process. Therefore, there are no impacts related to this issue beyond those discussed in the GEIS. For these issues, the GEIS concludes that the impacts are SMALL.

Table 4-2. Air Quality Issue. *Section 2.2.2 of this report describes air quality in the vicinity of Salem and HCGS.*

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

4.3 Ground Water

The following sections discuss the Category 2 ground water issue applicable to Salem and HCGS, which is listed in Table 4-3.

Table 4-3. Ground Water Use and Quality Issues. *Section 2.2.3 of this report discussed ground water use and quality at Salem and HCGS.*

Issues	GEIS Section	Category
Ground Water use conflicts (potable and service water, plants using >100 gallons per minute [gpm])	4.8.1.1	2

4.3.1 Ground Water Use Conflicts (plants using >100 gpm)

NRC specifies as issue 33 in Title 10 of the Code of Federal Regulations (CFR) Part 51, Subpart A, Appendix B, Table B-1, that "Plants that use more than 100 gpm may cause groundwater use conflicts with nearby groundwater users." The NRC further states in 10 CFR 51.53(c)(3)(ii)(C), that "If the applicant's plant ... pumps more than 100 gallons (total onsite) of groundwater per minute, an assessment of the impact of the proposed action on groundwater use must be provided.." This applies to Salem and HCGS because, as discussed in section 2.1.7.1, the Salem and HCGS groundwater wells combined to produce an average of 210 million gallons per year (790,000 cubic meters [m^3] per year) from 2002 to 2008, which is a combined average of 0.58 million gallons per day (MGD; 2,200 m^3 per day), or 400 gallons per minute (gpm; 1.5 m^3/minute).

A groundwater withdrawal rate of over 100 gpm (0.38 m^3/minute) has the potential to create a cone of depression large enough to affect offsite wells and groundwater supplies, limiting the amount of groundwater available for the plant's surrounding areas. As discussed in 2.1.7.1, the facilities operate four primary production wells, including PW-5 and PW-6 at Salem, and HC-1 and HC-2 at HCGS. Three of these wells (PW-5, HC-1, and HC-2) produce groundwater from the Upper Potomac-Raritan-Magothy (PRM) Aquifer, and the fourth (PW-6) produces groundwater from the Middle PRM Aquifer. Therefore, potential impacts in both aquifers need to be considered. There are also two stand-by wells located at Salem (PW-2 and PW-3). These wells are screened in the Mount Laurel-Wenonah Aquifer. Because these wells could be used during the relicense period, potential impacts in this aquifer were evaluated.

To evaluate whether the production from the Salem and HCGS wells could affect offsite groundwater users, the Staff evaluated several lines of evidence, including measurements of onsite groundwater levels, identification of potentially-affected offsite users, comparison of water withdrawal rates to the authorized rate and rates for other authorized users, and identification of regulatory groundwater use restrictions.

In the ER, PSEG Nuclear, LLC (PSEG, the applicant) presented results of the measurement of groundwater levels in the onsite production wells (TetraTech, 2009). Water levels in many of the production wells, and some observation wells, were measured in July and/or September, 1987 (Dames & Moore, 1988), and then again measured monthly from 2000 to the present day. This data set allows an evaluation of the long-term trend in water levels in order to determine if groundwater usage is exceeding aquifer recharge in the local area. For the Mount Laurel-Wenonah Aquifer, water levels in PW-2, PW-3, and an observation well (OW-G) are all higher in elevation in 2008 than they were in 1987 and the early 2000s. This indicates no drawdown of the aquifer, as would be expected because there has been little or no production from this aquifer.

For the Middle PRM Aquifer, water levels were measured in production well PW-6 and observation well OW-6 (TetraTech, 2009). In both wells, original measurements in 1987 showed water depths of more than about 100 feet (ft; 30 meters (m)), and by the time the next measurement was made in 2000, water depths ranged from 50 to 60 ft (15 to 18 m). Water depths remained in the range of 50 to 60 ft (15 to 18 m) throughout the 2000s, with no apparent trend. While the reason for the 40 to 50 ft (15 to 18 m) rise in water levels between 1987 and 2000 is not discernible, this rise is documented only by a single measurement in each well. Because there are not trends in water levels since 2000, the production from the Middle PRM Aquifer does not appear to have had any long-term effect on water availability within the aquifer.

For the Upper PRM Aquifer, water levels were measured in production wells PW-5, HC-1, HC-2, and observation wells OW-J and OW-I (TetraTech, 2009). In each case, the water level measurements appear to show a slight, but steady, long-term decline in water level elevation. Original measurements in wells PW-5 and HC-1 in 1987 indicated water depths at approximately 72 to 76 ft (22 to 23 m). By 2000, water depths in these two wells ranged to 82 to 85 feet. By 2005 and through 2008, monthly water level measurements in these two wells occasionally reached depths of 88 to 95 ft (27 to 29 m). Water levels in well OW-I similarly declined, from 58 ft (18 m) in 1987, to 62 to 74 ft (19 to 23 m) in 2000, and 70 to 88 feet (21 to 27 m) in 2008. The same trend was observed in wells NC-2 and OW-J, although water levels in these wells were not measured in 1987. In both of these wells, water level depths started in the range of 69 to 84 ft (21 to 26 m) in 2000, and ranged from 92 to 102 ft (28 to 31) in 2008.

The reason for the declining water levels in the Upper PRM Aquifer over the last decade cannot be determined from the limited data set, but they could indicate that long-term production is resulting in dewatering of the aquifer, which could potentially cause groundwater use conflicts. The results could also be due to: continuing development of the cone of depression for the withdrawal system before it stabilizes, long-term precipitation trends that are not associated with production, or the limited duration of the monitoring period.

Because the trend in water levels in the Upper PRM Aquifer may indicate potential groundwater use limitations, the Staff identified other local users of the aquifer, and evaluated regional trends and regulatory actions to determine if groundwater use conflicts could exist. Due to the rural location of the facilities, there are no other local municipalities or industrial facilities which use groundwater from any aquifer, including the Upper PRM Aquifer. As discussed in Section 2.2.7, the closest municipal use of groundwater for potable water supply is the Artesian Water

Company's Bayview system in New Castle County, Delaware (DNREC, 2003). The Bayview system is located approximately 3.5 miles (mi; 5.6 kilometers [km]) west of the site, and supplies 132 residents from two wells in the Mount Laurel-Wenonah Aquifer. In Salem County, the City of Salem uses groundwater as a component of their water supply. The City of Salem system is located 9 mi (14 km) from the Salem and HCGS facilities, and serves approximately 9,000 persons. The two largest water supply systems in Salem County (the Pennsgrove and Pennsville systems) both produce water from the Upper PRM Aquifer (EPA, 2010; NJAW, 2010; NJDEP, 2007), but both systems are located more than 15 mi (24 km) to the north of the Salem and HCGS facilities.

In addition to being distant from potentially affected users, the water volume produced from the Upper PRM Aquifer by the Salem and HCGS wells is also small compared to municipal users in the region. The authorized water withdrawal rate for all six production wells at the Salem and HCGS facilities is 43.2 million gallons (164,000 m^3) per 30 day period (1.44 MGD [5,470 m^3/day]) (DRBC, 2000). The actual production rate is approximately 0.58 MGD (2,200 m^3/day), or about 40% of the authorized volume. The Pennsville system is authorized by DRBC to produce 1.75 MGD (6,600m^3/day) (PA Bulletin, 2005) to service approximately 13,500 residents; therefore, the volume produced by the Salem and HCGS facilities is approximately equivalent to a municipal supply system servicing less than 4,500 persons.

Additional information on groundwater use conflicts in the region is found in studies associated with the Water-Supply Critical Areas in the New Jersey Coastal Plain. Two areas (Critical Area 1 and Critical Area 2) were established in 1986 to manage withdrawals from aquifers which had water level declines that were a cause of concern (Watt, 2000). The management measures included reducing authorized withdrawals and new allocations from specific aquifers, including the Upper and Middle PRM Aquifers, and shifting water supply sources from confined aquifers to shallow unconfined aquifer and surface water sources. These measures resulted in a region-wide rise in groundwater levels. Currently, both the USGS and New Jersey Department of Environmental Protection (NJDEP) are performing additional monitoring and modeling studies in order to determine if water management strategies in the Critical Areas can be modified in response to their success in recovering groundwater levels (Voronin, 2005).

Although groundwater use conflicts were enough of a regional concern to cause designation of the Critical Areas, the Salem and HCGS facility location was not included within either of the two Critical Areas. Critical Area 2 includes a small portion of eastern Salem County, but does not include the northern portion of the county (location of the Pennsville and Pennsgrove water systems) or the western portion of the county (location of Salem and HCGS). Also, the success of the program in allowing groundwater levels to recover suggests that groundwater use conflicts in western Salem County are likely to become less of a concern, rather than greater.

Based on these lines of evidence, it appears that although groundwater production at Salem and HCGS may be contributing to a gradual reduction in groundwater availability locally, this reduction is not likely to impact other groundwater users. Therefore, the Staff concludes that impacts on nearby groundwater users would be SMALL.

4.4 Surface Water

The following sections discuss the surface water quality issues applicable to Salem and HCGS, which are listed in Table 4-4. The Staff did not identify any new and significant information during the review of the applicant's ER (PSEG, 2009a; 2009b), the site audit, or the scoping process. Therefore, no impacts are related to these issues beyond those discussed in the GEIS. For these issues, the GEIS concludes that the impacts are SMALL.

Table 4-4. Surface Water Quality Issues. *Section 2.2.4 of this report describes surface water quality conditions at Salem and HCGS.*

Issues	GEIS Section	Category
Altered current patterns at intake and discharge structures	4.2.1.2.1	1
Altered salinity gradients	4.2.1.2.2	1
Temperature effects on sediment transport capacity	4.2.1.2.3	1
Scouring caused by discharged cooling water	4.2.1.2.3	1
Eutrophication	4.2.1.2.3	1
Discharge of chlorine or other biocides	4.2.1.2.4	1
Discharge of sanitary wastes and minor chemical spills	4.2.1.2.4	1
Discharge of other metals in wastewater	4.2.1.2.4	1

4.5 Aquatic Resources

4.5.1 Categorization of Aquatic Resources Issues

The Category 1 and Category 2 issues related to aquatic resources and applicable to HCGS and Salem are listed in Table 4-5 and discussed below. Section 2.1.6 of this report describes the HCGS and Salem cooling water systems, and Section 2.2.5 describes the potentially affected aquatic resources.

Table 4-5. Aquatic Resources Issues.

Issues	GEIS Section	Category
For All Plants		
Accumulation of contaminants in sediments or biota	4.2.1.2.4	1
Entrainment of phytoplankton and zooplankton	4.2.2.1.1	1
Cold shock	4.2.2.1.5	1
Thermal plume barrier to migrating fish	4.2.2.1.6	1
Distribution of aquatic organisms	4.2.2.1.6	1
Premature emergence of aquatic insects	4.2.2.1.7	1
Gas supersaturation (gas bubble disease)	4.2.2.1.8	1
Low dissolved oxygen in the discharge	4.2.2.1.9	1
Losses from parasitism, predation, and disease among organisms exposed to sublethal stresses	4.2.2.1.10	1
Stimulation of nuisance organisms	4.2.2.1.11	1
For Plants with Cooling-Tower-Based Heat Dissipation Systems[a]		
Entrainment of fish and shellfish in early life stages	4.3.3	1
Impingement of fish and shellfish	4.3.3	1
Heat shock	4.3.3	1
For Plants with Once-Through Heat Dissipation Systems[b]		
Entrainment of fish and shellfish in early life stages	4.2.2.1.2	2
Impingement of fish and shellfish	4.2.2.1.3	2
Heat shock	4.2.2.1.4	2

[a]Applicable to HCGS.
[b]Applicable to Salem.

The Staff did not identify any new and significant information related to Category 1 aquatic resources issues during the review of the applicant's ERs for Salem (PSEG, 2009a) and HCGS (PSEG, 2009b), the site audit, or the scoping process. Consequently, there are no impacts related to the generic, Category 1 issues beyond those discussed in the GEIS.

Entrainment of fish and shellfish in early life stages, impingement of fish and shellfish, and heat shock are Category 1 issues at power plants with closed-cycle cooling systems are Category 2 issues at plants with once-through cooling systems. Hope Creek uses a closed-cycle cooling system with a cooling tower. This type of cooling system substantially reduces the volume of water withdrawn by the plant and substantially reduces entrainment, impingement, and thermal discharge effects (heat shock potential). Entrainment, impingement, and heat shock are Category 1 issues for Hope Creek and do not require further analysis to determine that their impacts during the relicensing period would be SMALL. In contrast, the cooling water system at Salem is a once-through system, and for such systems entrainment, impingement, and heat shock are Category 2 issues that require site-specific analysis. The remainder of Section 4.5 discusses these Category 2 issues for Salem.

4.5.2 Entrainment of Fish and Shellfish in Early Life Stages

Entrainment occurs when early life stages of fish and shellfish are drawn into cooling water intake systems along with the cooling water. Cooling water intake systems are designed to screen out larger organisms, but small life stages, such as eggs and larvae, can pass through the screens and be drawn into the plant condensers. Once inside, organisms may be killed or injured by heat, physical stress, or chemicals.

Regulatory Background

Section 316(b) of the Clean Water Act of 1977 (CWA) requires that the location, design, construction, and capacity of cooling water intake structures reflect the best technology available (BTA) for minimizing adverse environmental impacts (33 USC 1326). In July 2004, the U.S. Environmental Protection Agency (EPA) published the Phase II Rule implementing Section 316(b) of the CWA for Existing Facilities (69 FR 41576), which applied to large power producers that withdraw large amounts of surface water for cooling (50 MGD or more) (189,000 m^3/day or more). The rule became effective on September 7, 2004 and included numeric performance standards for reductions in impingement mortality and entrainment that would demonstrate that the cooling water intake system constitutes BTA for minimizing impingement and entrainment impacts. Existing facilities subject to the rule were required to demonstrate compliance with the rule's performance standards during the renewal process for their National Pollutant Discharge Elimination System (NPDES) permit through development of a Comprehensive Demonstration Study (CDS). As a result of a Federal court decision, EPA officially suspended the Phase II rule on July 9, 2007 (72 FR 37107) pending further rulemaking. EPA instructed permitting authorities to utilize best professional judgment in establishing permit requirements on a case-by-case basis for cooling water intake structures at Phase II facilities until it has resolved the issues raised by the court's ruling.

EPA delegated authority for NPDES permitting to NJDEP in 1984. In 1990, NJDEP issued a draft New Jersey Pollutant Discharge Elimination System (NJPDES) permit that proposed closed-cycle cooling as BTA for Salem. In 1993, NJDEP concluded that the cost of retrofitting Salem to closed-cycle cooling would be wholly disproportionate to the environmental benefits realized, and a new draft permit was issued in 1994 (PSEG, 1999a). The 1994 final NJPDES permit stated that the existing cooling water intake system was BTA for Salem, with certain conditions (NJDEP, 1994).

Conditions of the 1994 permit included improvements to the screens and Ristroph buckets, a monthly average limitation on cooling water flow of 3,024 MGD (11.4 million m^3/day), and a pilot study for the use of a sound deterrent system. In addition to technology and operational measures, the 1994 permit required restoration measures that included a wetlands restoration and enhancement program designed to increase primary production in the Delaware Estuary and fish ladders at dams along the Delaware River to restore access to traditional spawning runs for anadromous species such as blueback herring and alewife. A Biological Monitoring Work Plan (BMWP) was also required to monitor the efficacy of the technology and operational measures employed at the site and the restoration programs funded by PSEG (NJDEP, 1994). The BMWP included monitoring plans for fish utilization of restored wetlands, elimination of impediments to fish migration, bay-wide trawl survey, and beach seine survey, in addition to the entrainment and impingement abundance monitoring (PSEG, 1994). The main purpose of these studies was to monitor the success of the wetland restoration activities and screen modifications undertaken by PSEG.

The 2001 NJPDES permit required continuation of the restoration programs implemented in response to the 1994 permit, an Improved Biological Monitoring Work Plan (IBMWP), and a more detailed analysis of impingement mortality and entrainment losses at the facility (NJDEP, 2001). The 2006 NJPDES permit renewal application responded to the requirement for a detailed analysis by including a CDS as required by the Phase II rule and an assessment of alternative intake technologies (AIT). The AIT assessment includes a detailed analysis of the costs and benefits associated with the existing intake configuration and alternatives along with an analysis of the costs and benefits of the wetlands restoration program that PSEG implemented in response to the requirements of the 1994 NJPDES permit (PSEG, 2006c).

The IBMWP was submitted to NJDEP in April 2002 and approved in July 2003. A reduction in the frequency of monitoring at fish ladder sites that successfully pass river herring was submitted in December 2003 and approved was in May 2004. In 2006 PSEG submitted a revised IBMWP that proposed a reduction in sampling at the restored wetland sites. Sampling would be conducted at representative locations instead of at every restoration site (PSEG, 2006c).

Salem's 2006 NJPDES permit renewal application included a CDS because the Phase II rule was still in effect at that time. The CDS for Salem was completed in 2006 and included an analysis of impingement mortality and entrainment at the facility's cooling water intake system. According to PSEG (2006c), this analysis shows that the changes in technology and operation of the Salem cooling water intake system satisfied the performance standards of the Phase II rule and that the current configuration constitutes BTA. In 2006, NJDEP administratively continued Salem's 2001 NJPDES permit (NJ0005622), and no timeframe has been determined for issuance of the new NJPDES permit.

<u>Entrainment Studies</u>

Prior to construction of the Salem facility, baseline biological studies were begun in 1968 to characterize the biological community in the Delaware Estuary. The study area consisted of the estuary 10 mi (16 km) to the north and south of Salem. In 1969 with the passing of the National Environmental Policy Act (NEPA), the study program was expanded to include ichthyoplankton and benthos studies and to gather information on the feeding habits and life histories of the common species. In 1973 the Atomic Energy Commission (AEC) published its Final

Environmental Statement (FES) for Salem, which concluded that the effects of impingement and entrainment on the biological community of the Delaware Estuary would not be significant (PSEG, 1999a).

The Salem facility began operation in 1977, and monitoring has been performed on an annual basis since then to evaluate the impacts on the aquatic environment of the Delaware Estuary from entrainment of organisms through the cooling water system. Methods and results of these studies are summarized in several reports, including the 1984 316(b) Demonstration (PSEG, 1984), the 1999 316(b) Demonstration (PSEG, 1999a), and the 2006 316(b) Demonstration (PSEG, 2006c). In addition, biological monitoring reports were submitted to NJDEP on an annual basis from 1995 through the present (PSEG, 1996; 1997; 1998; 1999b; 2000; 2001; 2002; 2003; 2004; 2005; 2006a; 2007a; 2008a; 2009c).

The 1977 316(b) rule included a provision to select Representative Important Species (RIS) to focus the investigations, and previous demonstrations evaluated RIS as well as additional target species (PSEG, 1984; 1999a). The 2006 CDS used the term Representative Species (RS) to comprise both RIS and target species and to be consistent with the published Phase II Rule. RS were selected based on several criteria including susceptibility to impingement and entrainment at the facility, importance to the ecological community, recreational or commercial value, and threatened or endangered status (PSEG, 2006c).

The 1984 316(b) Demonstration was a five-year study from 1978 to 1983 that focused on 11 RS, including nine fish species and two macroinvertebrates. These species are weakfish (*Cynoscion regalis*), bay anchovy (*Anchoa mitchilli*), white perch (*Morone americana*), striped bass (*Morone saxatilis*), blueback herring (*Alosa aestivalis*), alewife (*Alosa pseudoharengus*), American shad (*Alosa sapidissima*), spot (*Leiostomus xanthurus*), Atlantic croaker (*Micropogonias undulatus*), opossum shrimp (*Neomysis americana*), and scud (*Gammarus* sp.) (PSEG, 1984).

In 1999 PSEG submitted a 316(b) demonstration that included the same RS fish species as the previous studies and added the blue crab (*Callinectes sapidus*). Scud and opossum shrimp were removed from the list of RS because they have high productivity, high natural mortality, and assessments completed prior to PSEG's 1999 NJPDES application concluded that Salem does not and will not have an adverse environmental impact on these macroinvertebrates (PSEG, 1999a).

The 316(b) demonstration submitted during the 2006 NJPDES renewal process included an estimation of entrainment losses for the RS developed from data collected during annual entrainment monitoring conducted in accordance with the IBMWP. A revised RS list was developed that included the nine finfish and the blue crab from previous studies and added the Atlantic silverside (*Menidia menidia*), Atlantic menhaden (*Brevoortia tyrannus*), and bluefish (*Pomotomus saltrix*) (PSEG, 2006c).

Entrainment samples typically were collected from the circulating water system intake bays 11A, 12B, or 22A or at discharge standpipes 12 or 22. From August 1977 through May 1980, intake samples were collected from the circulating water after it passed through the travelling screens and the circulating water pumps. In June 1980 the sample location was changed to the discharge pipes (PSEG, 1984). Beginning in 1994, samples were collected from either intake bay 12B or 22A (PSEG, 1996; 1997; 1998; 1999b; 2000; 2001; 2002; 2003; 2004; 2005; 2006a; 2007a; 2008a; 2009c).

Samples were collected by pumping water through a Nielsen fish pump through a 1.0 meter (m; 3.2 feet [ft]) diameter, 0.5 milimeter (mm; 0.02 inches) mesh, conical plankton net in an abundance chamber. A total sample volume of 50 to 100 m^3 (13,000 to 26,000 gallons) was filtered at a rate not to exceed 2.0 m^3/minute (500 gpm). Sample contents were rinsed into a jar and preserved for laboratory analysis. Ichthyoplankton collected was identified to the lowest practical taxon and life stage, counted, and a subset was measured (PSEG, 1984).

From August 1977 to April 1978, entrainment samples were collected monthly from September through May and twice monthly from June through August. In 1979, samples were collected once monthly in March, April, October, and November; twice monthly in May, August, and September, and four times monthly in June and July. In 1980 through 1982 additional samples were collected every fourth day from May through October. Samples were collected every 4 hours (hrs) during a 24-hr period (PSEG, 1984). In 1994 and 1995 samples were collected three times a day, once a week from January through December (PSEG, 1994; 1996). Beginning in April 1996 samples were typically collected three times a week in the summer months (April through September) and once a week throughout the remainder of the year (PSEG, 1997; 1998; 1999b; 2000; 2001; 2002; 2003; 2004; 2005; 2006a; 2007a; 2008a; 2009c). Samples were collected every 4 hrs during a 24-hr period.

Ichthyoplankton samples also were collected from June through August in 1981 and 1982 adjacent to the intake structure in five horizontal offshore strata to develop model inputs for bay anchovy and weakfish. These samples were collected with a conical plankton net 0.5 m (1.6 ft) wide with a mesh size of 0.5 mm (0.02 in; PSEG, 1984).

Entrainment survival studies were conducted from 1977 through 1982. Survival studies were conducted twice in 1977 and three times in 1978. In 1979 no samples were collected for survival studies. In 1980 sampling was conducted from April through October with 10 events. In 1981 and 1982 the sampling schedule was expanded to include four times monthly in June and July, twice monthly in May and August, and once each in September and October with 14 events occurring in May through October of 1981 and 11 events in June through September of 1982. Sampling locations for the survival studies were the same as for the abundance studies. Intake and discharge locations were sampled with a lag to account for plant transit time with duplicate sampling gear to account for sampling induced mortality (PSEG, 1984).

Samples were collected using a centrifugal fish transfer pump and a one-screen larval table until 1980. After 1980 a low velocity flume was used to allow for a larger sample volume. Specimens were taken to an onsite laboratory where their condition was recorded. Individuals were classified as live, stunned, or dead according to pre-established criteria. Live and stunned specimens were held for 12 hrs to determine latent mortality (PSEG, 1984).

In addition, tests were conducted from 1979 through 1981 to quantify mortality caused by the collection equipment. Tests were conducted with alewife, blueback herring, white perch, weakfish, spot, *N. americana*, and *Gammarus* spp. Mortality rates due to the larval table, the low velocity flume, and the fish pump combined with the larval table were estimated separately. Entrainment simulation tests also were conducted from 1974 through 1982 to quantify the effects of pressure and temperature changes on entrained organisms (PSEG, 1984).

For the 1984 316(b) Demonstration, weekly entrainment densities (numbers of organisms per volume of water) were estimated based on densities in both the intake and the estuary. These projected densities then were used along with estimated weekly mortality rates to project annual entrainment losses due to the facility. Weekly mortality rates were estimated from the results of the onsite studies, simulation studies conducted in the laboratory, and literature values. Mortality rates were calculated for the effects of mechanical and chemical stresses separately from thermal stresses. Total entrainment mortality was estimated under the assumption that the thermal and nonthermal mortality rates are independent of one another as shown in the following equation (PSEG, 1984).

$$M_T = 1 - (1 - M_n) \times (1 - M_t)$$

where

M_T = total entrainment mortality rate

M_n = nonthermal mortality rate

M_n = thermal mortality rate

Projected entrainment losses for each species were calculated on a daily basis using the following equation. Daily entrainment losses were then summed on a weekly basis and projected based on plant operating schedules (PSEG, 1984).

Daily entrainment loss = $CWS1_i + SWS1_i + CWS2_i + SWS2_i$

$CWS1_i$ = K1 x Density $_i$ x (F_i - R x F_i) / (1 - R + R x F_i)

$SWS1_i$ = K2 x Density $_i$ x (1 – R)

where

$CWS1_i$ = entrainment loss at Unit No. 1 circulating waters system (CWS) on the i th day

$SWS1_i$ = entrainment loss at Unit No. 1 service water system (SWS) on the i th day

$CWS2_i$ = entrainment loss at Unit No. 2 CWS on the i th day

$SWS2_i$ = entrainment loss at Unit No. 2 SWS on the i th day

K1 = plant withdrawal at Unit No. 1 CWS on the i th day
= 11.672 m^3/sec x 86,400 seconds x the number of CWS pumps operating in Unit No. 1

K2 = plant withdrawal at Unit No. 1 SWS on the i th day
= 0.686 m^3/sec x 86,400 seconds x the number of CWS pumps operating in Unit No. 1

Density $_i$ = estimated entrainment density on the i th day

F_i = estimated total entrainment density on the i th day

R = recirculation factor

The 1999 316(b) Demonstration (PSEG, 1999a) used data from entrainment monitoring that was conducted annually from 1995 through 1998 in accordance with the BMWP. PSEG calculated total entrainment loss by species and life stage by summing the individual occurrences in samples taken at the intakes for both the circulating water system (CWS) and the service water system (SWS) for Units 1 and 2; using correction factors for collection efficiency, recirculation (re-entrainment), and mortality; and then scaling for plant flow. The equation used for this calculation of entrainment loss follows (PSEG, 1999a).

$$E = \sum_{i=1}^{K} \sum_{j=1}^{365} D_y \cdot C^{-1} \cdot \left(\frac{f_{y\_} R f_{ij}}{1 - R + R f_{ij}} \right) \cdot Q_y$$

where

E = entrainment (number of organisms)

i = i^{th} water system, i.e., Unit 1 CWS, Unit 1 SWS, Unit 2 CWS, and Unit 2 SWS

j = j^{th} day of the year

D_y = average concentration (number per m^3 of intake water)

C = collection efficiency

F_{ij} = daily through-plant mortality

R = recirculation factor

Q_y = average daily plant flow for i^{th} water system (m^3)

PSEG (1999a) used the results of these calculations to estimate densities for each week of the year, which then were scaled up based on weekly flow through the facility to estimate total entrainment losses for each year by species (Table 4-6). The years 1978 through 1981 were a transitional period between the beginning of commercial operation of Salem Unit 1 in 1978 and Unit 2 in 1982 (PSEG, 1999a).

In the 2006 316(b) Demonstration, PSEG estimated annual entrainment losses for the years 2002 through 2004 by using entrainment density data from sampling conducted at the intakes and scaling for total water withdrawal volume using the same methodology as described above for the 1999 316(b) study (Table 4-7). Entrainment losses were calculated by assuming an entrainment mortality rate of 100 percent (PSEG, 2006c). From 1978 through 1998 (Table 4-6) and 2002 through 2004 (Table 4-7), bay anchovy was the species with the greatest entrainment losses for all life stages (PSEG, 1999a; 2006c).

Results of the annual entrainment monitoring for the RS at Salem from 1995 through 2008 were reported in annual biological monitoring reports for 1995 through 2008 (PSEG, 1996; 1997; 1998; 1999b; 2000; 2001; 2002; 2003; 2004; 2005; 2006a; 2007a; 2008a; 2009c). Total annual entrainment was reported by species and life stage based on mean density expressed as number of organisms per 100 cubic meters (n/100 m^3) of water withdrawn through the intake screens (Table 4-8).

Table 4-9 provides a list of species collected during the annual entrainment monitoring conducted at Salem from 1995 through 2008 and their average densities in cooling water during that period. On average, the RS constituted approximately 75 percent of total entrainment abundance based on average densities for these species from 1995 through 2008, and bay anchovy alone made up approximately 50 percent of total entrainment during this period.

Entrainment Reductions

Due to the potential for entrainment to have adverse effects on the aquatic environment in the vicinity of Salem, and in response to the requirements of the 1994 NJPDES permit, PSEG has employed technological and operational changes to reduce entrainment and impingement and mitigate their effects on the Delaware Estuary. While improvements to the cooling water intake system were targeted mainly toward reducing impingement mortality, improvement in entrainment rates also has resulted. In response to the requirements of the 1994 NJPDES permit, PSEG made modifications to the trash racks, intake screens, and fish return system (PSEG, 1999a).

Improved intake screen panels were installed that use a thinner wire in the mesh (14 gage instead of 12 gage), which in combination with smaller screen openings allowed for a 20 percent decrease in through-screen velocity. Lower velocities through the screens allow more small fish to be able to swim away from the screens and escape entrainment. Screen openings also were reduced in size from 10 mm (3/8 inch) square mesh to 6 mm (1/4 inch) wide by 13 mm (1/2 inch) high rectangular mesh. The smaller screen openings reduce the size of organisms that can be drawn through the screens, thus reducing entrainment. The smaller screen mesh excludes more organisms, which then may be impinged and could be returned to the estuary alive (PSEG, 1999a). While impingement mortality rates for these smaller organisms generally are higher than for larger organisms, they are lower than estimated entrainment mortality rates (PSEG, 1999a).

Table 4-6. Estimated Annual Entrainment Losses for Representative Species (RS) at Salem, 1978 to 1998

Year	Estimated Annual Entrainment Losses (in Millions)										
	Alewife	American shad	Atlantic croaker	Bay anchovy	Blueback herring	Striped bass	Spot	Weakfish	White perch	Atlantic menhaden	Silversides[(1)]
1978	0.008	0.004	0.784	7,962.1	0.775	0.026	5.096	399.818	0.000	0.000	79.935
1979	0.050	0	14.515	3,535.1	0.019	0.020	1.095	23.193	0.625	0.072	18.083
1980	0.860	0.015	0.756	15,155.9	2.813	0	10.296	256.708	27.514	4.277	145.109
1981	2.002	0	8.157	11,714.1	11.853	0	5.418	45.765	0.969	9.207	113.240
1982	0	0	0	3,712.9	0.017	0	29.963	74.457	18.857	4.157	22.201
1985	0.163	0.126	0.933	29,463.7	1.151	0	0.184	63.616	0.447	0	0
1986	0.348	0.059	0.492	45,248.6	1.594	0	0.858	110.397	0.654	0	0
1987	0	0.062	0.000	40,172.4	0.082	0	0.055	61.267	0.628	0	0
1988	0.749	0	1.710	22,331.5	2.988	0	73.502	57.063	8.968	0	0
1989	0.541	0	56.341	10,163.5	2.395	47.946	1.027	3.026	192.131	0	0
1990	0.101	0	123.375	7,678.4	0.260	1.313	4.395	6.685	2.626	0	0
1991	0	0	131.798	19,506.6	0	0.778	1.096	72.478	1.108	0	0
1992	0.319	0	71.352	1,570.5	0.864	1.728	0.000	10.375	3.393	0	0
1993	0.676	0	75.030	11,774.2	2.340	108.065	0.585	122.672	37.635	0	0
1994	0.697	0	24.783	1,120.3	2.623	7.490	46.859	88.781	66.927	0	0
1995	0.477	0.014	31.454	1,404.5	0.082	0.579	0.071	335.083	2.039	177.221	31.019
1996	0.083	0.028	4.385	70.6	0.425	7.289	0.025	14.258	16.800	3.039	1.227
1997	0.053	0.747	71.819	1,811.8	0.318	6.505	0.007	12.601	7.865	16.668	6.919
1998	14.480	0	132.130	2,003.7	59.282	448.563	0.020	76.343	412.839	480.557	51.528

[(1)] Silversides were not identified to species.

Source: NJPDES Application (PSEG, 1999a).

Table 4-7. Estimated Annual Entrainment and Annual Entrainment Losses for Representative Species (RS) at Salem, 2002-2004

	Total Entrained (in millions)			Entrainment Losses (in millions)		
Taxon	**2002**	**2003**	**2004**	**2002**	**2003**	**2004**
Alewife	9.8	5.2	2.5	9.4	4.5	2.4
American shad	0	0	0	0	0	0
Atlantic croaker	448.0	211.5	213.2	182.5	86.4	87.9
Bay anchovy	946.4	366.4	2,343.2	946.4	366.4	2,343.2
Blueback herring	1.1	1.7	1.1	1.0	1.6	0.934
Spot	2.3	0.047	0	0.454	0.009	0
Striped bass	403.6	120.3	35.7	159.5	37.6	14.3
Weakfish	29.2	11.9	46.8	19.2	8.5	32.8
White perch	18.7	19.5	25.8	18.0	13.9	23.9
Atlantic silverside	44.8	3.6	10.1	44.8	3.6	10.1
Atlantic menhaden	190.3	4.9	6.8	190.3	4.9	6.8

Source: Comprehensive Demonstration Study (PSEG, 2006c).

Table 4-8. Entrainment Densities for Representative Species (RS) at Salem, 1995-2008

	Density (n/100 m^3)													
Taxon	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Alewife	0.01	–	–	–	–	–	0.05	<0.01	0.11	0.02	<0.01	0.02	0.05	<0.01
American shad	–	0.01	0.01	–	–	0.00	–	–	–	–	–	–	–	–
Atlantic croaker	3.03	1.60	8.19	9.48	15.45	6.70	4.17	12.52	2.62	5.05	5.56	10.51	5.88	7.74
Atlantic menhaden	2.91	0.38	0.46	1.68	2.23	1.34	1.04	4.92	0.20	0.47	1.06	5.01	1.47	16.21
Atlantic silverside	0.13	0.29	0.69	0.22	2.20	0.36	0.09	0.95	0.15	0.47	0.55	0.29	0.12	0.10
Bay anchovy	66.55	17.43	42.95	61.88	292.14	12.72	8.86	24.18	13.15	100.52	54.57	101.45	174.66	41.87
Blueback herring	–	0.02	–	0.00	0.01	0.09	0.03	0.01	<0.01	0.02	<0.01	<0.01	0.01	<0.01
Blueback herring/alewife	0.01	0.12	–	2.06	0.02	0.05	0.01	0.11	0.07	0.07	0.05	–	0.03	0.72
Bluefish	0.01	–	–	–	–	0.00	–	–	–	–	–	–	–	<0.01
Spot	0.01	–	–	0.00	0.09	0.09	0.01	0.10	<0.01	–	0.25	<0.01	0.03	0.14
Striped bass	0.03	1.55	0.02	11.50	0.03	13.97	9.07	7.20	5.07	1.84	4.03	0.55	42.34	1.72
Weakfish	11.86	3.69	0.76	1.99	6.61	2.48	2.25	0.64	0.43	1.10	2.09	0.70	1.44	0.52
White perch	0.02	0.88	–	4.49	0.11	6.15	0.06	0.10	0.44	0.64	0.24	0.55	1.19	0.01
White perch/striped bass	0.06	1.10	–	3.63	0.00	–	–	<0.01	0.87	0.44	0.40	0.11	10.69	0.02
Eggs	47.54	0.51	21.41	41.84	278.18	0.35	2.97	8.42	2.06	74.22	28.56	78.20	149.59	23.82
Larvae	48.46	26.52	31.66	78.64	97.93	47.13	29.13	67.53	46.10	51.12	62.67	82.92	103.57	39.65
Juveniles	11.84	7.87	19.15	13.11	21.17	11.10	7.27	16.74	5.67	7.84	9.46	15.99	10.79	21.86
Adults	0.14	0.07	0.20	0.23	0.29	0.18	0.13	0.15	0.15	0.20	0.27	0.26	0.25	0.19

Note: Blank spaces (–) indicate the species was not identified in entrainment samples that year.

Source: Biological Monitoring Program Annual Reports (PSEG, 1996; 1997; 1998; 1999b; 2000; 2001; 2002; 2003; 2004; 2005; 2006a; 2007a; 2008a; 2009c).

Table 4-9. Species Entrained at Salem During Annual Entrainment Monitoring, 1995-2008

Common Name	Scientific Name	Average Density (n/100 m^3)
Bay anchovy	***Anchoa mitchilli***	**72.35**
Naked goby	*Gobiosoma bosc*	27.58
Striped bass	***Morone saxatilis***	**7.07**
Atlantic croaker	***Micropogonias undulatus***	**7.04**
Atlantic menhaden	***Brevoortia tyrannus***	**6.91**
Weakfish	***Cynoscion regalis***	**2.81**
Goby	Gobiidae	2.61
White perch/striped bass	***Morone* spp.**	**1.57**
White perch	***Morone americana***	**1.15**
Atlantic silverside	***Menidia menidia***	**0.66**
Unidentifiable silverside	Antherinidae	0.47
Blueback herring/alewife	***Alosa spp.***	**0.37**
Silversides	*Menidia* spp.	0.22
Northern pipefish	*Syngnathus fuscus*	0.18
American eel	*Anguilla rostrata*	0.13
Unidentifiable fish		0.13
Summer flounder	*Paralichthys dentatus*	0.12
Hogchoker	*Trinectes maculatus*	0.10
Spot	***Leiostomus xanthurus***	**0.09**
Inland silverside	*Menidia beryllina*	0.08
Herrings	Clupeidae	0.08
Black drum	*Pogonias cromis*	0.07
Carps and minnows	Cyprinidae	0.06
Gizzard shad	*Dorosoma cepedianum*	0.06
Unidentifiable larvae		0.06
Atlantic herring	*Clupea harengus*	0.06
Alewife	***Alosa pseudoharengus***	**0.05**
Smallmouth flounder	*Etropus microstomus*	0.04
Rough silverside	*Membras martinica*	0.03
Blueback herring	***Alosa aestivalis***	**0.03**
Yellow perch	*Perca flavescens*	0.03
Spotted hake	*Urophycis regia*	0.02
Killifishes	*Fundulus* spp.	0.02
Mummichog	*Fundulus heteroclitus*	0.01
Northern searobin	*Prionotus carolinus*	0.01
Quillback	*Carpiodes cyprinus*	0.01
Unidentifiable eggs		0.01
Silver perch	*Bairdiella chrysoura*	0.01
Winter flounder	*Pseudopleuronectes americanus*	0.01

Common Name	Scientific Name	Average Density (n/100 m^3)
Threespine stickleback	*Gasterosteus aculeatus*	0.01
Atlantic needlefish	*Strongylura marina*	0.01
Unidentifiable		0.01
Blackcheek tonguefish	*Symphurus plagiusa*	0.01
Oyster toadfish	*Opsanus tau*	0.01
Common carp	*Cyprinus carpio*	0.01
American shad	***Alosa sapidissima***	**0.01**
Striped cusk-eel	*Ophidion marginatum*	0.01
Windowpane	*Scophthalmus aquosus*	0.004
Green goby	*Microgobius thalassinus*	0.004
Northern puffer	*Sphoeroides maculatus*	0.004
Feather blenny	*Hypsoblennius hentz*	0.004
American sand lance	*Ammodytes americanus*	0.004
Bluefish	***Pomatomus salatrix***	**0.003**
Unidentifiable juvenile		0.003
Striped searobin	*Prionotus evolans*	0.003
Conger eel	*Conger oceanicus*	0.003
Inshore lizardfish	*Synodus foetens*	0.003
Unidentifiable drum	Sciaenidae	0.003
Eastern silvery minnow	*Hybognathus regius*	0.003
Perches	Percidae	0.003
Northern kingfish	*Menticirrhus saxatilis*	0.003
Bluegill	*Lepomis macrochirus*	0.002
Banded killifish	*Fundulus diaphanus*	0.002
Unidentifiable sucker	Catostomidae	0.002
Striped anchovy	*Anchoa hepsetus*	0.002
Northern stargazer	*Astroscopus guttatus*	0.002
White crappie	*Pomoxis annularis*	0.002
Tautog	*Tautoga onitis*	0.002
Unidentifiable porgy	Sparidae	0.001
Spanish mackerel	*Scomberomorus maculatus*	0.001
Black sea bass	*Centropristis striata*	0.001
Sheepshead minnow	*Cyprinodon variegauts*	0.001
Striped killifish	*Fundulus majalis*	0.001
Unidentifiable sunfish	Centrarchidae	0.001
White sucker	*Catostomus commersoni*	0.001
Channel catfish	*Ictalurus punctatus*	0.001

(1) Species in **bold** are RS at Salem.

(2) Average density expressed as number of organisms entrained (n) per 100 cubic meters (m^3) of water withdrawn through the intake screens.

Source: Biological Monitoring Program Annual Reports (PSEG, 1996; 1997; 1998; 1999b; 2000; 2001; 2002; 2003; 2004; 2005; 2006a; 2007a; 2008a; 2009c).

Table 4-10. Entrainment Densities for Representative Species (RS) at Salem, 1978-2008

	Density (n/100 m^3)														
Taxon	**1978**	**1979**	**1980**	**1981**	**1982**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**
Alewife	–	–	0.03	–	–	–	0.01	–	0.01	–	–	–	–	–	–
Alosa sp.	–	–	–	–	–	–	–	–	–	0.14	0.01	–	0.02	0.15	0.11
American shad	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Atlantic croaker	0.10	0.02	0.02	1.24	–	0.02	0.07	–	0.07	2.76	0.72	3.47	2.51	2.71	1.19
Atlantic menhaden	–	0.02	0.25	1.13	0.27	–	–	–	–	–	–	–	–	–	–
Atlantic silverside	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Bay anchovy	349.64	1848.55	845.68	706.22	148.12	1799.26	2527.17	2094.53	618.68	314.27	243.26	416.78	111.59	416.25	27.22
Blueback herring	0.06	–	0.07	0.12	–	0.03	–	–	0.04	–	–	–	–	–	–
Blueback herring/alewife	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Morone sp.	–	–	–	–	–	–	–	–	–	0.21	0.01	–	0.03	0.90	0.01
Bluefish	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Silversides	6.32	15.33	4.77	4.04	0.86	–	–	–	–	–	–	–	–	–	–
Spot	0.07	0.10	1.53	0.86	3.69	0.04	0.01	–	1.64	0.02	0.16	0.09	–	0.01	1.17
Striped bass	0.05	–	–	–	–	–	–	–	–	1.87	0.01	0.03	0.06	3.63	0.29
Weakfish	16.31	3.35	5.15	1.20	2.63	1.77	4.50	3.09	1.11	0.08	0.28	1.43	0.25	1.91	2.46
White perch	–	–	0.09	–	0.26	–	0.01	0.01	0.10	4.16	0.03	0.01	0.07	0.46	0.81
White perch/striped bass	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Taxon	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Alewife	0.01	–	–	–	–	–	0.05	< 0.01	0.11	0.02	< 0.01	0.02	0.05	< 0.01
Alosa sp.	0.01	0.13	–	1.58	–	–	–	–	–	–	–	–	–	–
American shad	0.01	–	–	–	–	0.00	–	–	–	–	–	–	–	–
Atlantic croaker	3.07	1.64	12.48	8.52	15.45	6.70	4.17	12.52	2.62	5.05	5.56	10.51	5.88	7.74
Atlantic menhaden	2.90	0.37	0.86	3.19	2.23	1.34	1.04	4.92	0.20	0.47	1.06	5.01	1.47	16.21
Atlantic silverside	–	–	–	–	2.20	0.36	0.09	0.95	0.15	0.47	0.55	0.29	0.12	0.10
Bay anchovy	64.18	17.63	52.89	53.31	292.14	12.72	8.86	24.18	13.15	100.52	54.57	101.45	174.66	41.87
Blueback herring	–	0.02	–	0.10	0.01	0.09	0.03	0.01	< 0.01	0.02	< 0.01	< 0.01	0.01	< 0.01
Blueback herring/alewife	–	–	–	–	0.02	0.05	0.01	0.11	0.07	0.07	0.05	–	0.03	0.72
Morone sp.	0.06	1.11	–	2.92	–	–	–	–	–	–	–	–	–	0.02
Bluefish	–	–	–	–	–	0.00	–	–	–	–	–	–	–	< 0.01
Silversides	0.99	0.30	0.96	0.87	–	–	–	–	–	–	–	–	–	–
Spot	0.01	0.03	–	0.00	0.09	0.09	0.01	0.10	< 0.01	–	0.25	< 0.01	0.03	0.14
Striped bass	0.03	1.58	0.03	9.92	0.03	13.97	9.07	7.20	5.07	1.84	4.03	0.55	42.34	1.72
Weakfish	11.78	3.75	0.77	1.80	6.61	2.48	2.25	0.64	0.43	1.10	2.09	0.70	1.44	0.52
White perch	0.02	0.90	–	3.73	0.11	6.15	0.06	0.10	0.44	0.64	0.24	0.55	1.19	0.01
White perch/striped bass	–	–	–	–	0.00	–	–	< 0.01	0.87	0.44	0.40	0.11	10.69	–

Note: Blank spaces (–) indicate the species was not identified in entrainment samples that year.
Source: Biological Monitoring Program Annual Reports (PSEG, 2000; 2001; 2002; 2003; 2004; 2005; 2006a; 2007a; 2008a; 2009c)

4.5.3 Impingement of Fish and Shellfish

Impingement occurs when fish and shellfish are held against the intake screens by the force of the water being drawn into the cooling system. Impingement mortality can occur directly as a result of the force of the water, or indirectly due to stresses from the time spent on the screens or as a result of being washed off the screens.

Regulatory Background

EPA regulates impingement and entrainment under Section 316(b) of the CWA through the NPDES permit renewal process. A history of NPDES permitting at Salem can be found in Section 4.5.2 under the heading Regulatory Background.

Impingement Studies

PSEG has performed annual impingement monitoring at the Salem plant since 1977 in order to determine the impacts that impingement at Salem might have on the aquatic environment of the Delaware Estuary. The monitoring program described in the early 316(b) demonstration focused on seven target fish species. The two macroinvertebrates included in the entrainment study program are too small to be impinged and, therefore, were not included in the impingement study program. The fish species are weakfish, bay anchovy, white perch, striped bass, blueback herring, alewife, American shad, spot, and Atlantic croaker (PSEG, 1984).

Impingement abundance samples were collected at the CWS and SWS intakes from May 1977 through December 1982. CWS samples were collected at least four times per day at six-hour intervals three days a week from May 1977 through September 1978. In September 1978 sampling frequency was increased to a minimum of 10 samples per day six days a week. In the spring of 1980, sampling frequency was reduced to four times a day, but remained at six days a week (PSEG, 1984).

Impinged organisms are washed off the CWS intake screens and returned to the Delaware Estuary through a fish return system. Impingement samples were collected in fish counting pools constructed for this purpose that are located adjacent to the fish return system discharge troughs at both the northern and southern ends of the CWS intake structure. Screen-wash water was diverted into the counting pools for an average sample duration of 3 minutes (min; depending on debris load, sampling time varied from 1 to 15 min). Water then was drained from the pools, and organisms were sorted by species, counted, measured, and weighed (PSEG, 1984).

Impingement abundance samples were collected from the SWS intake screens by a high-pressure spray wash into collection baskets through a trough. Screen washes were conducted at either 12 hr or 24 hr intervals depending on debris loads. Samples were collected from the SWS three times a week from April 1977 through September 1979. Organisms were sorted, counted, and weighed (PSEG, 1984).

Special impingement-related studies in addition to impingement monitoring studies also were performed. Studies were conducted from 1979 through February 1982 to quantify impingement collection efficiency. Studies of blueback herring, bay anchovy, white perch, weakfish, spot, and Atlantic croaker were conducted to determine the percentage of different size classes of fish that would not be collected by the screen washing and fish collection procedures (PSEG, 1984).

Because individual organisms that are impinged on the intake screens are washed off and returned to the estuary, studies of impingement mortality rates also were conducted from May 1977 through December 1982. Studies were conducted to estimate the percentage of impinged individuals that do not survive being impinged and washed from the intake screens (initial mortality) and the percentage that exhibit delayed mortality and do not survive for a longer period of at least two days (extended or latent mortality). Studies of initial mortality were conducted at a rate of three times per week until October 1978, after which samples were collected six times per week if impingement levels for target species exceeded predetermined levels. Initial mortality studies were conducted using the same counting pools as the abundance samples. Screen-wash water was diverted into the counting pool, samples were held for five min, the water was drained from the pool, and organisms were sorted as live, damaged, or dead. Each subset was identified to species and the total number and weight, maximum and minimum lengths, and length frequency distribution were recorded. Studies of latent mortality were conducted using the organisms classified as live or damaged in the studies of initial mortality. At the beginning of the latent mortality studies, only organisms classified as live were used, but damaged fish also were evaluated after November 1978. Two-day latent mortality studies were conducted at least weekly and entailed holding impinged organisms in aerated tanks for 48 hrs. Organisms were monitored continuously for the first 30 min, at hour intervals for the next four hrs, and then at approximately 24-hr intervals. Control specimens also were collected with a seine and subjected to the same survival study (PSEG, 1984).

Impingement mortality was found to be seasonally variable and dependent on several environmental factors, including temperature and salinity. Initial and latent mortality rates were estimated on a monthly basis and summed to provide a total mortality rate (PSEG, 1984). Estimated impingement mortality rates by species evaluated are summarized in Table 4-11.

Table 4-11. Estimated Impingement Mortality Rates by Species at Salem, 1977-1982

Taxon	Estimated Impingement Mortality (percent)
Spot	30.2 – 67.7
Blueback herring	71.9 - 100
Alewife	72.6 – 100
American shad	20.8 – 100
Atlantic croaker	38.8 – 87.9
Striped bass	10.0 – 84.8
White perch	29.4 – 52.9
Bay anchovy	77.0 – 95.1
Weakfish	71.2 – 78.3

Source: PSEG, 1984.

PSEG submitted a 316(b) demonstration in 1999 as part of the application for NJPDES permit renewal (PSEG, 1999a). This demonstration assessed the effects of Salem's cooling water intake structure on the biological community of the Delaware Estuary (PSEG, 1999a). It focused on the same RS fish species as the earlier studies and added the blue crab (*Callinectes sapidus*). Impingement losses at Salem were estimated using impingement density (the number of impinged individuals collected divided by the total volume sampled, expressed as number/m^3) and adjusting for impingement survival, collection efficiency, and recirculation factor. This result was then scaled by month using the water withdrawal rates and summed for the year to provide annual impingement losses for the facility. Estimated annual impingement losses for the RS at Salem from 1978 through 1998 are summarized in Table 4-12. Bay anchovy was the species most frequently lost to impingement from 1978 to 1998, constituting 46 percent of the RS impingement loss. Weakfish was the next most frequently lost species, making up 20 percent of the RS impingement losses (PSEG, 1999a).

Impingement monitoring was conducted annually in accordance with the BMWP from 1995 through 2002. In 2002, the IBMWP was developed to include improvements to the BMWP. These monitoring plans include provisions to quantify impingement and entrainment losses at Salem, as well as fish populations in the Delaware Estuary and the positive effects of the restoration program (PSEG, 2006c).

Table 4-12. Estimated Annual Impingement Losses for Representative Species (RS) at Salem, 1978 to 1998

	Estimated Annual Impingement Losses									
Year	Alewife	American Shad	Atlantic croaker	Bay anchovy	Blueback herring	Blue crab	Spot	Striped bass	Weakfish	White perch
1978	17,057	4,549	125,822	2,623,694	438,248	111,627	84,519	3,213	6,391,256	254,688
1979	11,513	2,144	8,494	1,321,105	651,005	97,434	292,471	9,625	580,628	541,715
1980	11,301	6,382	93,232	11,046,658	460,638	501,000	146,794	4,350	1,821,462	403,453
1981	647,832	8,820	14,996	11,264,933	364,803	347,436	857,167	1,895	1,818,578	344,726
1982	46,951	9,406	2,975	3,846,612	418,130	122,032	979,961	542	967,867	261,912
1983	19,584	5,359	2,326	3,784,994	224,303	100,953	681,704	924	1,038,356	143,904
1984	128,002	3,266	853	2,444,847	1,335,665	87,890	316,579	430	357,125	300,333
1985	4,676	11,033	275,670	3,771,190	162,478	1,011,790	183,679	193	1,263,119	582,528
1986	20,788	11,007	233,915	2,011,567	467,361	1,228,076	52,445	2,875	756,956	1,033,048
1987	74,461	24,120	1,245,098	3,346,956	157,496	834,857	2,204	6,673	1,095,105	715,912
1988	31,082	35,182	4,046	4,657,784	357,896	1,247,649	1,917,236	10,450	427,218	646,825
1989	137,998	65,138	24,168	781,653	891,085	344,310	119,381	26,006	184,538	760,842
1990	50,074	15,393	5,787	1,373,446	168,555	178,511	120,833	28,003	170,778	768,431
1991	21,275	22,874	45,535	1,719,784	137,107	307,591	134,807	10,089	575,349	688,724
1992	23,847	64,807	55,267	1,286,667	120,649	370,591	2,999	20,966	841,319	1,158,199
1993	23,267	22,087	176,279	596,243	100,999	387,190	16,869	74,100	723,366	1,043,913
1994	22,946	6,315	31,538	178,764	31,835	491,199	247,677	23,612	2,130,349	1,266,489
1995	14,745	7,940	610,261	363,601	143,846	1,012,348	27,435	10,812	890,341	321,359
1996	1,321	829	21,010	18,802	5,548	83,457	7,281	9,191	130,459	75,006
1997	5,899	819	266,558	309,018	50,879	475,443	30,245	12,779	1,582,441	228,996
1998	8,037	2,214	2,370,135	1,104,126	57,267	280,741	2,654	10,660	1,572,811	124,351

Source: PSEG, 1999a.

The 316(b) demonstration submitted during the 2006 NJPDES renewal process (PSEG, 2006c) included the CDS as required by the Phase II rule and a demonstration that the plant satisfies the impingement mortality and entrainment reductions required by the rule. The CDS included an estimation of impingement losses for the RS developed from data collected during annual impingement monitoring conducted in accordance with the IBMWP. A revised RS list was developed for the IBMWP and subsequently used in the 2006 CDS that included the nine finfish and the blue crab from previous studies and added the Atlantic silverside (*Menidia menidia*), Atlantic menhaden (*Brevoortia tyrannus*), and bluefish (*Pomotomus saltrix*) (PSEG, 2006c).

Estimated annual impingement and impingement losses for the study period 2002 to 2004 are summarized in Table 4-13. Atlantic croaker was the species most impinged in 2002 and the RS most often lost to impingement that year. White perch was the RS most impinged in 2003 and 2004, while weakfish was the species most often lost to impingement in those years.

Table 4-13. Estimated Annual Impingement and Annual Impingement Losses for Representative Species (RS) at Salem, 2002-2004

	Total Impingement			Impingement Losses		
Taxon	**2002**	**2003**	**2004**	**2002**	**2003**	**2004**
Alewife	87,001	31,275	134,149	10,996	16,360	63,492
American shad	5,879	31,584	227,103	1,672	15,354	72,486
Atlantic croaker	21,313,809	620,754	3,260,494	6,332,522	143,298	332,644
Bay anchovy	424,168	475,799	544,177	197,496	326,839	341,135
Blueback herring	184,095	133,328	1,110,952	28,113	50,790	265,866
Spot	1,131	2,714	366	253	721	133
Striped bass	101,208	776,934	505,340	5,351	167,332	66,007
Weakfish	722,090	3,129,152	3,531,713	428,300	1,953,299	2,118,736
White perch	2,044,207	9,424,768	11,181,299	163,505	773,818	970,462
Atlantic silverside	509,142	220,114	156,495	138,270	44,951	48,609
Atlantic menhaden	534,646	31,211	20,420	360,931	21,769	15,724
Blue crab	2,739,118	356,983	831,320	172,725	27,483	57,931
Bluefish	45,292	31,311	44,533	3,884	7,592	17,433

Source: PSEG, 2006c.

Table 4-14 provides a summary of annual impingement densities based on monitoring results for RS at Salem from the annual monitoring reports for the period 1995 through 2007. Impingement densities were calculated by relating impingement abundance to the circulating water flow and extrapolating to the number of organisms impinged per million m^3 for every week of each year (PSEG, 1999a). The four most commonly impinged species were Atlantic croaker (23 percent), blue crab (21 percent), white perch (19 percent), and weakfish (14 percent). Table 4-15 provides a list of species collected and average densities impinged during this period.

Table 4-14. Impingement Densities for Representative Species (RS) at Salem, 1995-2008

	Density (n/10^6 m^3)													
Taxon	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Blue crab	1901.05	620.48	2033.08	824.27	636.84	393.89	606.88	502.13	76.41	171.28	1895.82	694.73	797.66	640.45
Alewife	3.09	5.47	10.8	12.09	15.78	27.41	20.55	13.91	4.84	25.99	8.19	2.41	7.66	0.66
American shad	3.1	2.63	1.00	3.39	14.5	3.82	0.57	0.79	6.43	43.24	10.11	4.01	16.98	1.7
Atlantic croaker	887.71	112.71	623.81	1489.08	625.94	403.53	412.56	3820.65	101.22	626.74	845.57	1405.31	951.09	545.25
Atlantic menhaden	14.72	9.9	38.36	78.79	15.78	20.5	25.55	88.9	6.26	4.82	22.22	44	27.49	57.85
Atlantic silverside	44.15	12.61	40.7	43.54	111.15	49.67	42.28	78.46	35.67	25.71	24.08	46.89	44.52	56.28
Bay anchovy	136.82	66.52	229.13	367	127.83	122.62	84.1	74.09	89.5	93.89	49.33	202.44	132.62	72.27
Blueback herring	30.78	8.64	126.62	107.8	110.7	73.14	81.06	31.05	23.27	156.55	19.75	25.37	17.76	7.34
Bluefish	2.69	8.88	6.41	4.79	2.55	6.00	1.14	7.89	8.14	11.67	2.06	7.44	2.95	5.7
Spot	10.28	3.38	88.74	3.94	0.53	7.28	0.05	0.34	0.8	0.14	55.11	10.38	3.73	23.65
Striped bass	64.89	82.05	62.91	28.61	52.83	102.49	54.62	20.04	159.93	110.86	29.72	10.22	47.88	32.56
White perch	641.12	543.08	1625.16	425.98	384.33	273.32	263.56	427.71	1771.18	2113.19	1042.62	360.51	429.81	662.14
Weakfish	1071.27	441.89	1370.74	528.95	228.01	369.57	524.64	172.98	530.71	725.72	930.88	343.81	379.65	304.8

Source: Biological Monitoring Program Annual Reports (PSEG, 1996; 1997; 1998; 1999b; 2000; 2001; 2002; 2003; 2004; 2005; 2006a; 2007a; 2008a; 2009c).

Table 4-15. Species Impinged at Salem and Average Impingement Densities, Based on Annual Impingement Monitoring for 1995-2008

Common Name[(1)]	Scientific Name[(1)]	Average Density ($n/10^6$ m^3) [(2)]
Atlantic croaker	***Micropogonias undulatus***	**917.94**
Blue crab	***Callinectes sapidus***	**842.50**
White perch	***Morone americana***	**783.12**
Weakfish	***Cynoscion regalis***	**565.97**
Hogchoker	*Trinectes maculatus*	231.95
Spotted hake	*Urophycis regia*	135.03
Bay anchovy	***Anchoa mitchilli***	**132.01**
Striped bass	***Morone saxatilis***	**61.40**
Blueback herring	***Alosa aestivalis***	**58.56**
Atlantic silverside	***Menidia menidia***	**46.84**
Gizzard shad	*Dorosoma cepedianum*	42.11
Atlantic menhaden	***Brevoortia tyrannus***	**32.51**
Threespine stickleback	*Gasterosteus aculeatus*	27.64
Striped cusk-eel	*Ophidion marginatum*	20.78
Spot	***Leiostomus xanthurus***	**14.88**
Alewife	***Alosa pseudoharengus***	**11.35**
Northern searobin	*Prionotus carolinus*	10.53
American shad	***Alosa sapidissima***	**8.02**
Yellow perch	*Perca flavescens*	7.71
Black drum	*Pogonias cromis*	6.29
Atlantic herring	*Clupea harengus*	6.05
Eastern silvery minnow	*Hybognathus regius*	5.60
Bluefish	*Pomatomus saltatrix*	5.59
American eel	*Anguilla rostrata*	5.32
Channel catfish	*Ictalurus punctatus*	4.90
Silver perch	*Bairdiella chrysoura*	4.62
Summer flounder	*Paralichthys dentatus*	4.48
Northern kingfish	*Menticirrhus saxatilis*	4.29
Oyster toadfish	*Opsanus tau*	3.68
Northern pipefish	*Syngnathus fuscus*	3.59
Red hake	*Urophycis chuss*	3.26
Naked goby	*Gobiosoma bosc*	3.25
Winter flounder	*Pseudopleuronectes americanus*	2.59
Windowpane	*Scophthalmus aquosus*	2.41
Mummichog	*Fundulus heteroclitus*	2.13
Smallmouth flounder	*Etropus microstomus*	2.00
Bluegill	*Lepomis macrochirus*	1.89
Striped searobin	*Prionotus evolans*	1.81
Scup	*Stenotomus chrysops*	1.38
Harvestfish	*Peprilus alepidotus*	1.01
Striped killifish	*Fundulus majalis*	1.00
Butterfish	*Peprilus triacanthus*	0.87
Black sea bass	*Centropristis striata*	0.83
Brown bullhead	*Ameiurus nebulosus*	0.76
River herring	*Alosa* spp.	0.75
Unknown spp.	Unknown spp.	0.52

Common Name[1]	Scientific Name[1]	Average Density (n/10^6 m^3) [2]
Sea lamprey	*Petromyzon marinus*	0.52
Skilletfish	*Gobiesox strumosus*	0.51
Rainbow smelt	*Osmerus punctatus*	0.48
Northern stargazer	*Astroscopus guttatus*	0.45
Fourspine stickleback	*Apeltes quadracus*	0.44
Conger eel	*Conger oceanicus*	0.43
Striped mullet	*Mugil cephalus*	0.43
Temperate bass	*Morone* sp.	0.38
Rough silverside	*Membras martinica*	0.36
Striped anchovy	*Anchoa hepsetus*	0.36
Inland silverside	*Menidia beryllina*	0.33
White mullet	*Mugil curema*	0.32
Spotfin butterflyfish	*Chaetodon ocellatus*	0.28
Atlantic needlefish	*Strongylura marina*	0.27
Yellow bullhead	*Ameiurus natalis*	0.26
Crevalle jack	*Caranx hippos*	0.25
Black crappie	*Pomoxis nigromaculatus*	0.24
Banded killifish	*Fundulus diaphanus*	0.24
Silver hake	*Merluccius bilinearis*	0.23
Lookdown	*Selene vomer*	0.20
Blackcheek tonguefish	*Symphurus plagiusa*	0.20
Permit	*Trachinotus falcatus*	0.16
Common carp	*Cyprinus carpio*	0.14
Sheepshead minnow	*Cyprinodon variegatus*	0.14
Pumpkinseed	*Lepomis gibbosus*	0.14
Northern puffer	*Sphoeroides maculatus*	0.14
Sheepshead	*Archosargus probatocephalus*	0.13
Florida pompano	*Trachinotus carolinus*	0.13
Fourspot flounder	*Paralichthys oblongus*	0.12
Smooth dogfish	*Mustelus canis*	0.12
Tessellated darter	*Etheostoma olmstedi*	0.12
Lined seahorse	*Hippocampus erectus*	0.11
Inshore lizardfish	*Synodus foetens*	0.11
Pinfish	*Lagodon rhomboides*	0.11
Golden shiner	*Notemigonus crysoleucas*	0.11
Atlantic spadefish	*Chaetodipterus faber*	0.10
White crappie	*Pomoxis annularis*	0.10
Unidentifiable Fish	Unidentifiable fish	0.10
White catfish	*Ameiurus catus*	0.10
White sucker	*Catostomus commersoni*	0.09
Spotfin killifish	*Fundulus luciae*	0.09
Pigfish	*Orthopristis chrysoptera*	0.09
Feather blenny	*Hypsoblennius hentz*	0.09
Spanish mackerel	*Scomberomorus maculatus*	0.09
Bluespotted cornetfish	*Fistularia tabacaria*	0.09
Spottail shiner	*Notropis hudsonius*	0.08
Goosefish	*Lophius americanus*	0.08
Atlantic thread herring	*Opisthonema oglinum*	0.07
Green sunfish	*Lepomis cyanellus*	0.07

Common Name[(1)]	Scientific Name[(1)]	Average Density ($n/10^6$ m^3)[(2)]
Redfin pickerel	*Esox americanus*	0.07
Spotfin mojarra	*Eucinostomus argenteus*	0.07
Redeared sunfish	*Lepomis microlophus*	0.07
Tautog	*Tautoga onitis*	0.06
Fat sleeper	*Dormitator maculatus*	0.06
Largemouth bass	*Micropterus salmoides*	0.06
Cownose	*Rhinoptera bonasus*	0.06
Satinfin shiner	*Cyprinella analostana*	0.06
Rainbow trout	*Oncorhynchus mykiss*	0.06
Redbreast sunfish	*Lepomis auritus*	0.06
Green goby	*Microgobius thalassinus*	0.06
Eastern mudminnow	*Umbra pygmaea*	0.06
Mud sunfish	*Acantharchus pomotis*	0.05
Atlantc sturgeon	*Acipenser oxyrhynchus*	0.05
Atlantic cutlassfish	*Trichiurus lepturus*	0.05
Southern kingfish	*Menticirrhus americanus*	0.05

(1) Species in **bold** are RS at Salem.

(2) Average density expressed as number of fish impinged (n) per million (10^6) cubic meters (m^3) of water withdrawn through the intake screens.

Source: Biological Monitoring Program Annual Reports (PSEG, 1996; 1997; 1998; 1999b; 2000; 2001; 2002; 2003; 2004; 2005; 2006a; 2007a; 2008a; 2009c).

Due to the differences in methods used during the more than 30 years since Salem Unit 1 began commercial operation in 1978, it is difficult to compare impingement estimates across studies. The NRC staff used impingement density as a metric to evaluate trends in impingement and abundance of RS in water withdrawn at the Salem intake over the operational period 1978 through 2008 (Table 4-16). NRC staff plotted impingement density by year to provide an indication of trends in the abundance of RS species at the Salem intake. The annual average densities of most of the 13 RS were highly variable from year to year, but trends were discernable for all but three species (Atlantic silverside, bay anchovy, and bluefish). Spot was the only species with an apparent overall trend of declining densities. In contrast, the densities of Atlantic menhaden appear to show a slight increasing trend, and the densities of eight species (alewife, American shad, Atlantic croaker, blue crab, blueback herring, striped bass, weakfish, and white perch) show apparent increasing trends, with most beginning notable increases in densities around 1993 to 1998. Overall, impingement densities of 12 of the 13 RS generally have been stable or increasing over the decades during which Salem has operated. The trend of declining densities of spot appears to reflect a widespread reduction in abundance in the species range well beyond Delaware Bay (ASFMC, 2008) and, thus, does not appear to be associated with Salem. Overall, these apparent trends do not suggest impacts on most fish populations in the estuary in the vicinity of the intake over the period of Salem operation.

Table 4-16. Impingement Densities for Representative Species (RS) at Salem, 1978-2008

	Density (n/10^6 m^3)															
Taxon	**1978**	**1979**	**1980**	**1981**	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**
Alewife	0.26	0.95	0.89	26.35	2.02	0.75	3.81	0.13	0.75	2.04	0.94	3.70	1.33	0.75	0.89	0.91
American shad	0.12	0.39	0.41	0.38	0.69	0.38	0.20	0.48	0.64	1.04	1.57	2.78	0.70	1.14	4.04	0.95
Atlantic croaker	7.04	0.42	5.89	0.70	0.15	0.30	0.09	9.36	7.23	43.97	0.42	1.66	0.25	3.21	7.55	11.22
Atlantic menhaden	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Atlantic silverside	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Bay anchovy	228.56	204.95	459.35	406.60	97.15	142.69	106.59	81.99	55.35	78.23	94.96	19.52	36.61	40.94	17.09	16.44
Blue crab	56.97	44.45	151.83	66.59	16.33	16.24	19.73	141.62	181.63	109.58	160.39	47.22	38.04	45.42	75.99	65.48
Blueback herring	28.28	27.13	17.98	14.93	17.79	10.80	54.15	4.54	10.04	4.40	7.90	27.43	4.70	6.19	5.27	2.77
Bluefish	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Spot	15.42	52.60	17.58	45.34	60.92	47.50	32.48	4.37	3.85	0.09	96.29	7.08	5.43	5.38	0.12	0.98
Striped bass	0.83	2.58	0.64	0.18	0.09	0.04	0.08	0.13	0.39	1.95	1.62	3.84	3.84	2.08	3.59	15.85
Weakfish	910.81	149.03	105.78	78.91	43.69	49.78	30.34	55.38	36.60	52.25	18.39	7.27	10.70	25.20	48.07	40.86
White perch	32.27	69.78	33.33	33.24	25.47	20.91	23.30	25.69	75.29	49.20	38.93	52.33	57.08	52.80	55.23	123.43

	Density (n/10^6 m^3)														
Taxon	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Alewife	0.65	3.09	5.47	10.8	12.09	15.78	27.41	20.55	13.91	4.84	25.99	8.19	2.41	7.66	0.66
American shad	0.32	3.1	2.63	1	3.39	14.5	3.82	0.57	0.79	6.43	43.24	10.11	4.01	16.98	1.7
Atlantic croaker	3.59	887.71	112.71	623.81	1489.08	625.94	403.53	412.56	3820.65	101.22	626.74	845.57	1405.31	951.09	545.25
Atlantic menhaden	—	14.72	9.9	38.36	78.79	15.78	20.5	25.55	88.9	6.26	4.82	22.22	44	27.49	57.85
Atlantic silverside	—	44.15	12.61	40.7	43.54	111.15	49.67	42.28	78.46	35.67	25.71	24.08	46.89	44.52	56.28
Bay anchovy	5.11	136.82	66.52	229.13	367	127.83	122.62	84.1	74.09	89.5	93.89	49.33	202.44	132.62	72.27
Blue crab	88.60	1901.05	620.48	2033.08	824.27	636.84	393.89	606.88	502.13	76.41	171.28	1895.82	694.73	797.66	640.45
Blueback herring	1.30	30.78	8.64	126.62	107.8	110.7	73.14	81.06	31.05	23.27	156.55	19.75	25.37	17.76	7.34
Bluefish	—	2.69	8.88	6.41	4.79	2.55	6	1.14	7.89	8.14	11.67	2.06	7.44	2.95	5.7
Spot	26.78	10.28	3.38	88.74	3.94	0.53	7.28	0.05	0.34	0.8	0.14	55.11	10.38	3.73	23.65
Striped bass	0.73	64.89	82.05	62.91	28.61	52.83	102.49	54.62	20.04	159.93	110.86	29.72	10.22	47.88	32.56
Weakfish	132.51	1071.27	441.89	1370.74	528.95	228.01	369.57	524.64	172.98	530.71	725.72	930.88	343.81	379.65	304.8
White perch	96.26	641.12	543.08	1625.16	425.98	384.33	273.32	263.56	427.71	1771.18	2113.19	1042.62	360.51	429.81	662.14

Note: Blank spaces (–) indicate the species was not identified in impingement samples that year.
Source: Biological Monitoring Program Annual Reports (PSEG, 1996; 1997; 1998; 1999b; 2000; 2001; 2002; 2003; 2004; 2005; 2006a; 2007a; 2008a; 2009c).

<u>Reductions in Impingement Mortality</u>

Due to the potential for impingement to have adverse effects on the aquatic environment in the vicinity of Salem and requirements of the 1994 NJPDES permit, PSEG has taken steps to reduce impingement mortality and its effects in the Delaware Estuary. PSEG has made many improvements to the cooling water intake system at Salem over the years, including modifications to the intake screens and fish return system (PSEG, 1999a).

Improved intake screen panels have a smooth mesh surface to allow impinged fish to more easily slide across the panels. The Ristroph buckets and screen-wash system were modified to increase survival of impinged organisms. The new buckets are constructed from smooth, non-metallic materials and have several design elements that minimize turbulence inside the bucket, including a reshaped lower lip, mounting hardware located behind the screen mesh, a flow spoiler inside the bucket, and flap seals to prevent fish and debris from bypassing their respective troughs (PSEG, 1999a). The screen wash system was redesigned to provide an optimal spray pattern using low-pressure nozzles to more gently remove organisms from the screens prior to use of high pressure nozzles that remove debris. In addition, the maximum screen rotation speed was increased from 17.5 feet per minute (fpm) (5.3 m/min) to 35 fpm (11 m/min) to reduce the differential pressure across the screens during times of high debris loading. The screens are continuously rotated, and the rotation speed automatically adjusts as the pressure differential increases. The fish return trough was redesigned from the original rectangular trough to incorporate a custom formed fiberglass trough with radius rounded corners. The fish return system has a bi-directional flow that is coordinated with the tidal cycle to minimize re-impingement. The flow from the trough discharges to the downstream side of the cooling water intake system on the ebb tide and to the upstream side on the flood tide (PSEG, 1999a).

PSEG (199a) reports estimates of impingement mortality with the modified screens were compared to estimates of mortality with the original screens to assess the reduction in impingement mortality due to the screen modifications. The assessment relied on data from impingement studies conducted in 1995, 1997, and 1998 and compared to data collected in 1978 through 1982 when impingement survival studies were conducted for the original screen configuration. A side-by-side comparison also was conducted in 1995 when only one of the units had the modified intake system. Table 4-17 showing data from PSEG (1999a) provides a comparison of estimated impingement mortality rates for the original screens versus the modified screens.

PSEG (1999a) concluded that results from the comparison of 1997 and 1998 data for the modified screens to data from 1978 to 1982 for the original screens indicate that the modified intake system generally provides reductions in impingement mortality. The study found that white perch, bay anchovy, Atlantic croaker, spot, and *Alosa* species (blueback herring, alewife, and American shad combined) had lower mortality rates for all months studied during the 1997 and 1998 studies compared to those estimated for the 1978 to 1982 study of the original screens. In contrast, weakfish had higher mortality rates for the modified screens in June and July, but lower in August and September. Those authors speculated that this difference may result from the much smaller size of the weakfish impinged in June and July – impingement mortality rates for smaller fish generally are higher than for larger fish (however, they are lower than estimated entrainment mortality rates, and the modifications to improve impingement survival increase this difference). PSEG (1999a) found that the 1995 side-by-side study showed higher survival rate estimates for weakfish with the modified screens.

Table 4-17. Comparison of Impingement Mortality Rates (percent) for Original Screens (1978-1982 and 1995 Studies) and Modified Screens (1995 and 1997-1998 Studies)

		Original Screens		Modified Screens	
Taxon	**Month**	**1978-1982**	**1995**	**1995**	**1997-1998**
Weakfish	June	39	33	17	79
	July	51	31	18	82
	August	52	51	25	38
	September	40	-	-	12
	October	53	-	-	-
White perch	January	13	-	-	-
	February	16	-	-	-
	March	12	-	-	-
	April	15	-	-	7
	October	21	-	-	-
	November	16	-	-	7
	December	8	-	-	2
Bay anchovy	April	-	-	-	54
	May	81	-	-	55
	June	89	-	-	78
	July	90	-	-	80
	August	85	-	-	-
	September	72	-	-	-
	October	65	-	-	35
	November	32	-	-	28
Atlantic croaker	April	-	-	-	42
	May	-	-	-	34
	June	-	-	-	28
	July	-	-	-	35
	October	-	-	-	5
	November	-	-	-	2
	Dec-Jan	49	-	-	15
Spot	June	31	-	-	-

	July	48	-	-	-
	August	47	-	-	-
		Original Screens		**Modified Screens**	
	October	38	-	-	-
	November	19	-	-	7
	December	29	-	-	-
Alosa species	Mar-Apr	89	-	-	18
	Oct - Dec	31	-	-	22

Note: Mortality rate estimates for *Alosa* species for original screens are based on blueback herring only while estimates for modified screens are based on *Alosa* species (blueback herring, alewife, and American shad combined). Estimates include initial and 48-hr latent mortalities.
Blank spaces (-) indicate months in which the species was not identified in sufficient numbers in the impingement survival studies to allow reliable estimates of impingement mortality rates.
Source: PSEG, 1999a.

4.5.4 Heat Shock

NRC uses the term heat shock to refer to the acute thermal stress caused by exposure to a sudden elevation of water temperature that adversely affects the metabolism and behavior of fish and can lead to death. Heat shock can occur at power plants when the cooling water discharge elevates the temperature of the surrounding water.

The NRC considers heat shock to be a generic (Category 1) issue at power plants with closed-cycle cooling systems. HCGS uses closed-cycle cooling and if NRC finds no new and significant information, site-specific evaluation is not required to determine that impacts to fish and shellfish from heat shock associated with the continued operation of HCGS during the renewal term would be SMALL. In contrast, heat shock is a Category 2 issue at power plants with once-through cooling systems. Salem has a once-through cooling system; therefore, heat shock is considered a site-specific (Category 2) issue for Salem, and a site-specific analysis is required to determine the level of impact that heat shock may have on the aquatic environment. The potential for heat shock at Salem is discussed below.

Regulatory Background

The Delaware River Basin Commission (DRBC) is a federal interstate compact agency charged with managing the water resources of the Delaware River Basin without regard to political boundaries. It regulates water quality in the Delaware River and Delaware Estuary through DRBC Water Quality Regulations, including temperature standards. The temperature standards for Water Quality Zone 5 of the Delaware Estuary, where the Salem discharge is located, state that the temperature in the river outside of designated heat dissipation areas (HDAs) may not be raised above ambient by more than 4 degrees Fahrenheit (°F; 2.2 degrees Celsius [°C]) during non-summer months (September through May) or 1.5°F (0.8°C) during the summer (June through August), and a maximum temperature of 86°F (30.0°C) in the river cannot be exceeded year-round (18 CFR 410; DRBC, 2001). HDAs are zones outside of which the DRBC temperature-increase standards shall not be exceeded. HDAs are established on a case-by-case basis. The thermal mixing zone requirements and HDAs that had been in effect for Salem since it initiated operations in 1977 were modified by the DRBC in 1995 and again in 2001

(DRBC, 2001), and the 2001 requirements were included in the 2001 NJPDES permit. The HDAs at Salem are seasonal. In the summer period (June through August), the Salem HDA extends 25,300 ft (7,710 m) upstream and 21,100 ft (6,430 m) downstream of the discharge and does not extend closer than 1,320 ft (402 m) from the eastern edge of the shipping channel. In the non-summer period (September through May), the HDA extends 3,300 ft (1,000 m) upstream and 6,000 ft (1,800 m) downstream of the discharge and does not extend closer than 3,200 ft (970 m) from the eastern edge of the shipping channel (DRBC, 2001).

Section 316(a) of the CWA regulates thermal discharges from power plants. This regulation includes a process by which a discharger can obtain a variance from thermal discharge limits when it can be demonstrated that the limits are more stringent than necessary to protect aquatic life (33 USC 1326). PSEG submitted a comprehensive Section 316(a) study for Salem in 1974, filed three supplements through 1979, and provided further review and analysis in 1991 and 1993. In 1994, NJDEP granted PSEG's request for a thermal variance and concluded that the continued operation of Salem in accordance with the terms of the NJPDES permit "would ensure the continued protection and propagation of the balanced indigenous population of aquatic life" in the Delaware Estuary (NJDEP, 1994). The 1994 permit continued the same thermal limitations that had been imposed by the prior NJPDES permits for Salem. This variance has been continued through the current NJPDES permit. PSEG subsequently provided comprehensive Section 316(a) Demonstrations in the 1999 and 2006 NJPDES permit renewal applications for Salem. NJDEP reissued the Section 316(a) variance in the 2001 NJPDES Permit (NJDEP, 2001).

The Section 316(a) variance for Salem limits the temperature of the discharge, the difference in temperature (ΔT) between the thermal plume and the ambient water, and the rate of water withdrawal from the Delaware Estuary (NJDEP, 2001). During the summer period the maximum permissible discharge temperature is 115°F (46.1°C). In non-summer months, the maximum permissible discharge temperature is 110°F (43.3°C). The maximum permissible temperature differential year round is 27.5°F (15.3°C). The permit also limits the amount of water that Salem withdraws to a monthly average of 3,024 MGD (11 million m^3/day) (NJDEP, 2001).

In 2006, PSEG submitted an NJPDES permit renewal application (PSEG, 2006c) with a request for renewal of the Section 316(a) variance. The variance renewal request summarizes studies that have been conducted at the Salem plant, including the 1999 Section 316(a) Demonstration, and evaluates the changes in the thermal discharge characteristics, facility operations, and aquatic environment since the time of the 1999 Section 316(a) Demonstration. PSEG concluded that Salem's thermal discharge had not changed significantly since the 1999 application and that the thermal variance should be continued. In 2006, NJDEP administratively continued Salem's NJPDES permit (NJ0005622), including the Section 316(a) variance. No timeframe for issuance of the new NJPDES permit has been determined.

Characteristics of the Thermal Plume

Cooling water from Salem is discharged through six adjacent 10 ft (3 m) diameter pipes spaced 15 ft (4.6 m) apart on center that extend approximately 500 ft (150 m) from the shore (PSEG, 1999c). The discharge pipes are buried for most of their length until they discharge horizontally into the water of the estuary at a depth at mean tidal level of about 31 ft (9.5 m). The discharge is approximately perpendicular to the prevailing currents. Figure 4-1 provides a plan view of the Salem discharge, and Figure 4-2 is a section view. At full power, Salem is designed to discharge approximately 3,200 MGD (12 million m^3/day) at a velocity of about 10 fps (3 m/s). The location of the discharge and its general design characteristics have remained essentially the same over the period of operation of the Salem facility (PSEG, 1999c).

The thermal plume at Salem can be defined by the regulatory thresholds contained in the DRBC water quality regulations, consisting of the 1.5°F (0.83°C) isopleth of ΔT during the summer period and the 4°F (2.2°C) isopleth of ΔT during non-summer months. Thermal modeling, to characterize the thermal plume, has been conducted numerous times over the period of operation of Salem. Since Unit 2 began operation in 1981, operations at Salem have been essentially the same and studies have indicated that the characteristics of the thermal plume have remained relatively constant (PSEG, 1999c).

The most recent thermal modeling was conducted during the 1999 Section 316(a) Demonstration. Three linked models were used to characterize the size and shape of the thermal plume: an ambient temperature model, a far-field model (RMA-10), and a near-field model (CORMIX). The plume is narrow and approximately follows the contour of the shoreline at the discharge. The width of the plume varies from about 4,000 ft (1,200 m) on the flood tide to about 10,000 ft (3,000 m) on the ebb tide. The maximum plume length extends to approximately 43,000 ft (13,000 m) upstream and 36,000 ft (11,000 m) downstream (PSEG, 1999c). Figures 4-3 through 4-6 depict the expansion and contraction of the surface and bottom plumes through the tidal cycle. Table 4-18 includes the surface area occupied by the plume within each ΔT isopleth through the tidal cycle.

The thermal plume consists of a near-field region, a transition region, and a far-field region. The near-field region, also referred to as the zone of initial mixing, is the region closest to the outlet of the discharge pipes where the mixing of the discharge with the waters of the Delaware Estuary is induced by the velocity of the discharge itself. The length of the near-field region is approximately 300 ft (90 m) during ebb and flood tides and 1,000 ft (300 m) during slack tide. The transition region is the area where the plume spreads horizontally and stratifies vertically due to the buoyancy of the warmer waters. The length of the transition region is approximately 700 ft (200 m). In the far-field region, mixing is controlled by the ambient currents induced mainly by the tidal nature of the receiving water. The ebb tide draws the discharge downstream, and the flood tide draws it upstream. The boundary of the far-field region is delineated by a line of constant ΔT (PSEG, 1999c).

1 **Table 4-18. Surface Area within Each ΔT Contour through the Tidal Cycle**

	Ebb: 6/2/1998 at 0830 hrs		End of Ebb: 6/2/1998 at 0000 hrs		Flood: 6/4/1998 at 1630 hrs		End of Flood: 5/31/1998 at 1600 hrs	
ΔT (°F)	Surface Area (Acres)	Percent of Estuary Area	Surface Area (Acres)	Percent of Estuary Area	Surface Area (Acres)	Percent of Estuary Area	Surface Area (Acres)	Percent of Estuary Area
>13	0.08	0.00002	0.00	0.00000	0.00	0.00000	0.00	0.00000
>12	0.46	0.00010	0.47	0.00010	0.21	0.00004	0.00	0.00000
>11	0.98	0.00020	2.15	0.00045	0.61	0.00013	0.00	0.00000
>10	1.66	0.00034	2.15	0.00045	1.15	0.00024	0.85	0.00018
>9	2.22	0.00046	2.15	0.00045	1.82	0.00038	1.93	0.00040
>8	3.19	0.00066	2.15	0.00045	2.64	0.00055	1.93	0.00040
>7	4.32	0.00090	5.10	0.00106	3.59	0.00075	1.93	0.00040
>6	5.61	0.00116	11.32	0.00235	4.68	0.00097	1.93	0.00040
>5	36.60	0.00760	21.43	0.00445	56.58	0.01174	2.14	0.00044
>4	150.08	0.03115	45.11	0.00936	245.94	0.05105	205.37	0.04263
>3	631.42	0.13106	739.88	0.15357	585.78	0.12158	920.75	0.19111
>2	1947.91	0.40430	2519.94	0.52303	2212.75	0.45927	2093.04	0.43442
>1.5	3156.56	0.65517	3725.19	0.77319	3703.61	0.76871	3596.95	0.74657

Notes:
Plant Conditions: Low flow (140,000 gpm/pump), high ΔT (18.6°F).
Total surface area of the estuary is 481,796 acres.
To convert acres to hectares, multiply by 0.4047.
Reasonable worst-case tide phases were selected based on analysis of time-temperature curves.
Running tides (e.g., ebb and flood) include area approximation of the intermediate field.
Source: PSEG, 1999c.

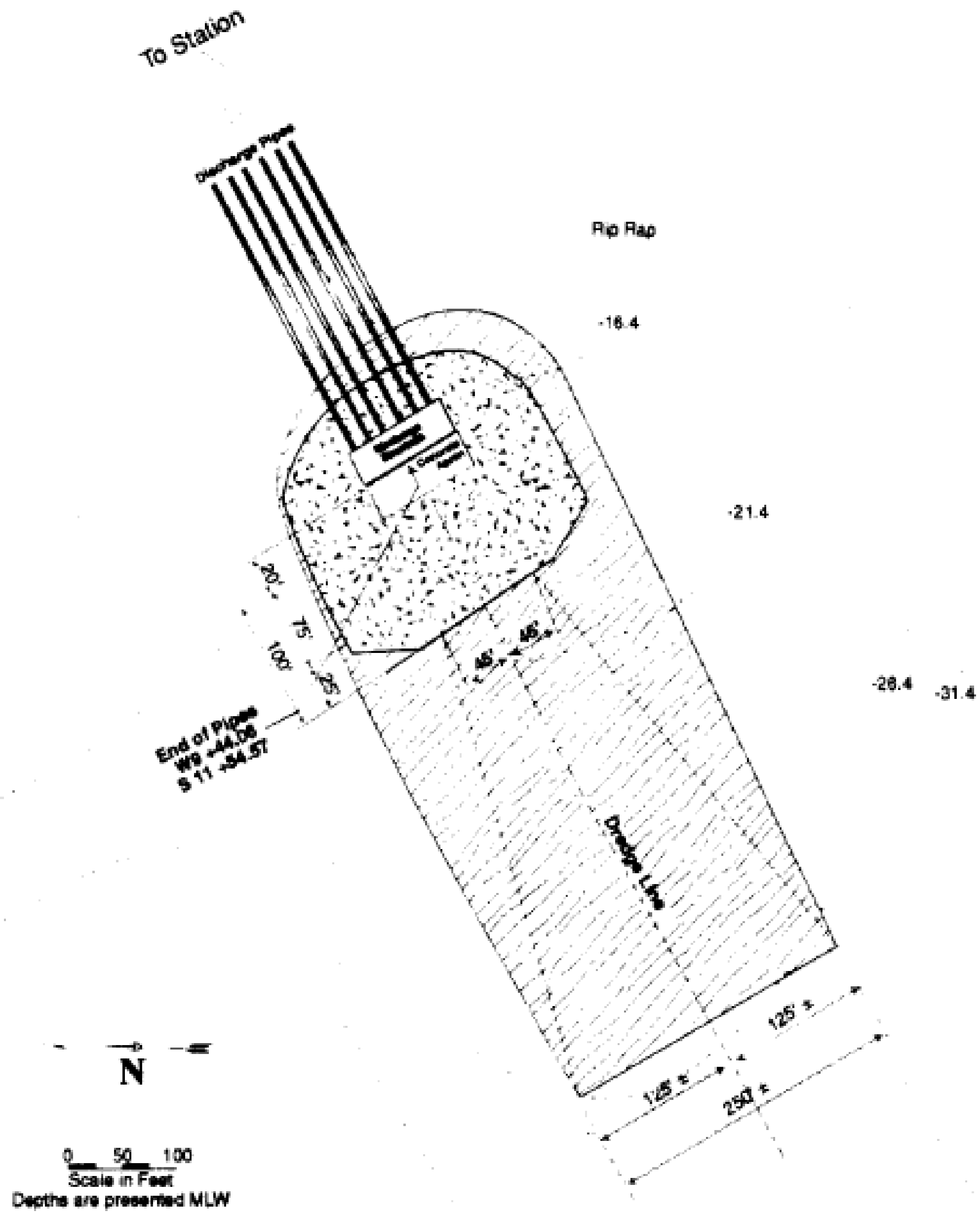


Figure 4-1. Plan View of Salem discharge pipes (Source: PSEG, 1999c).

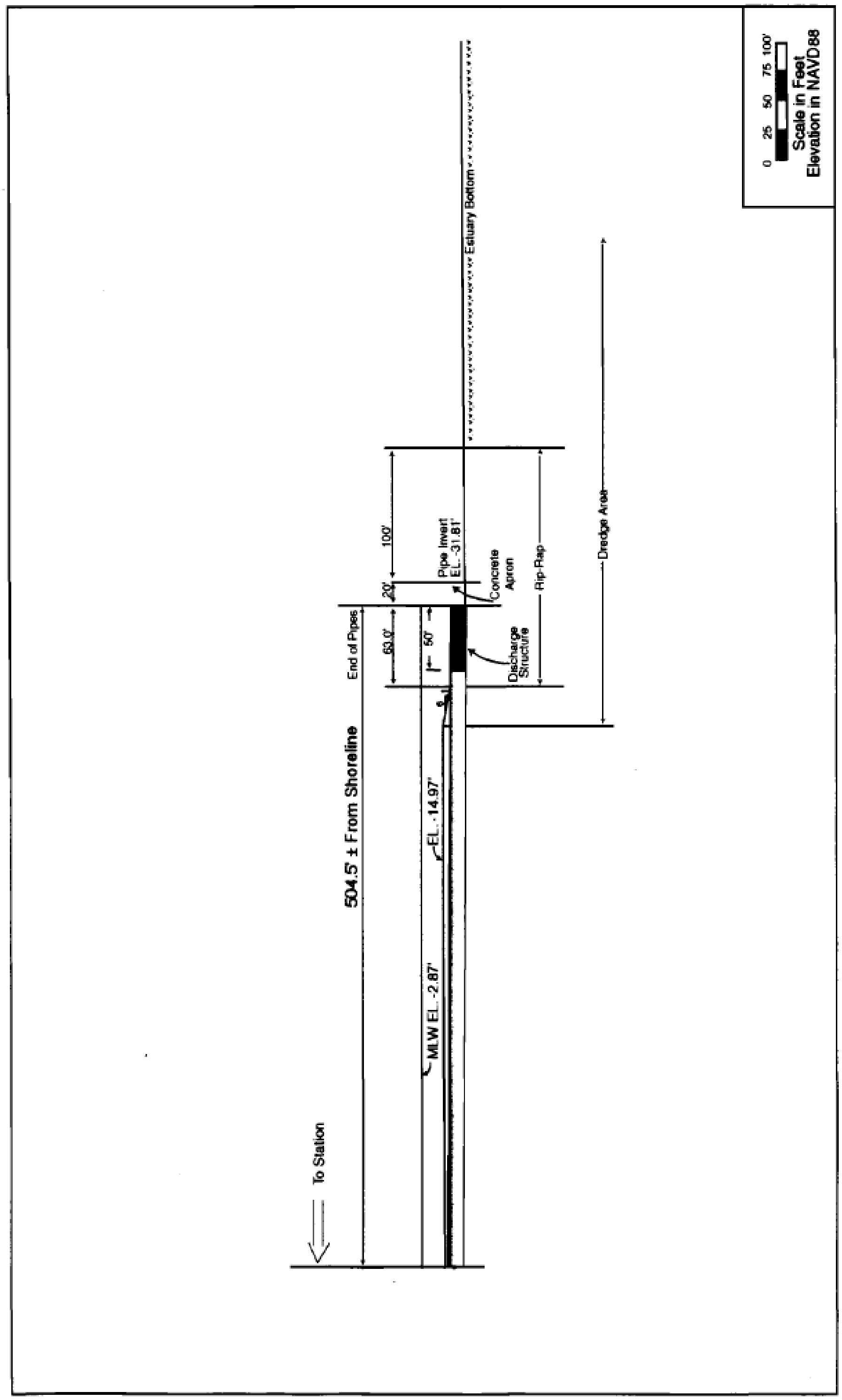
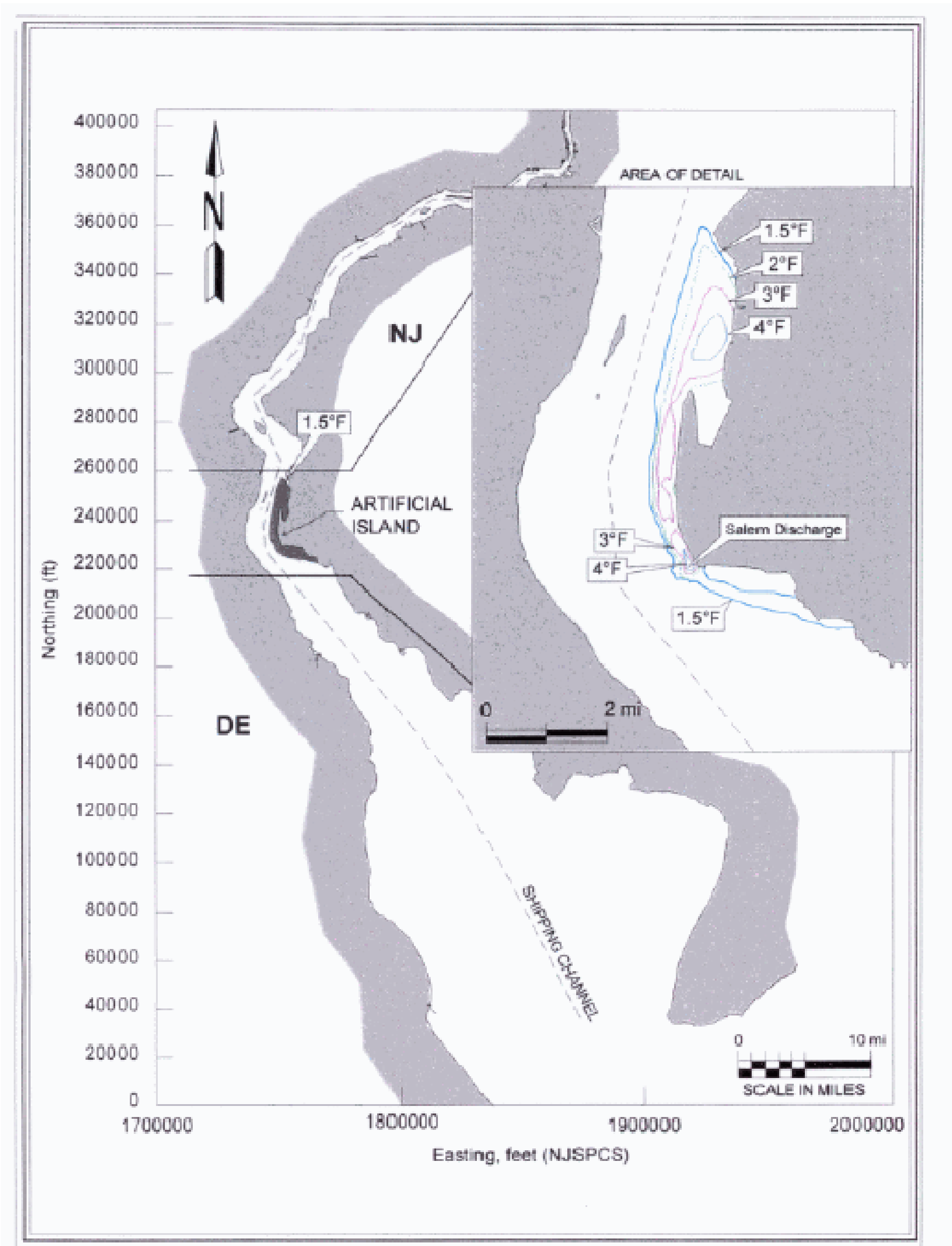
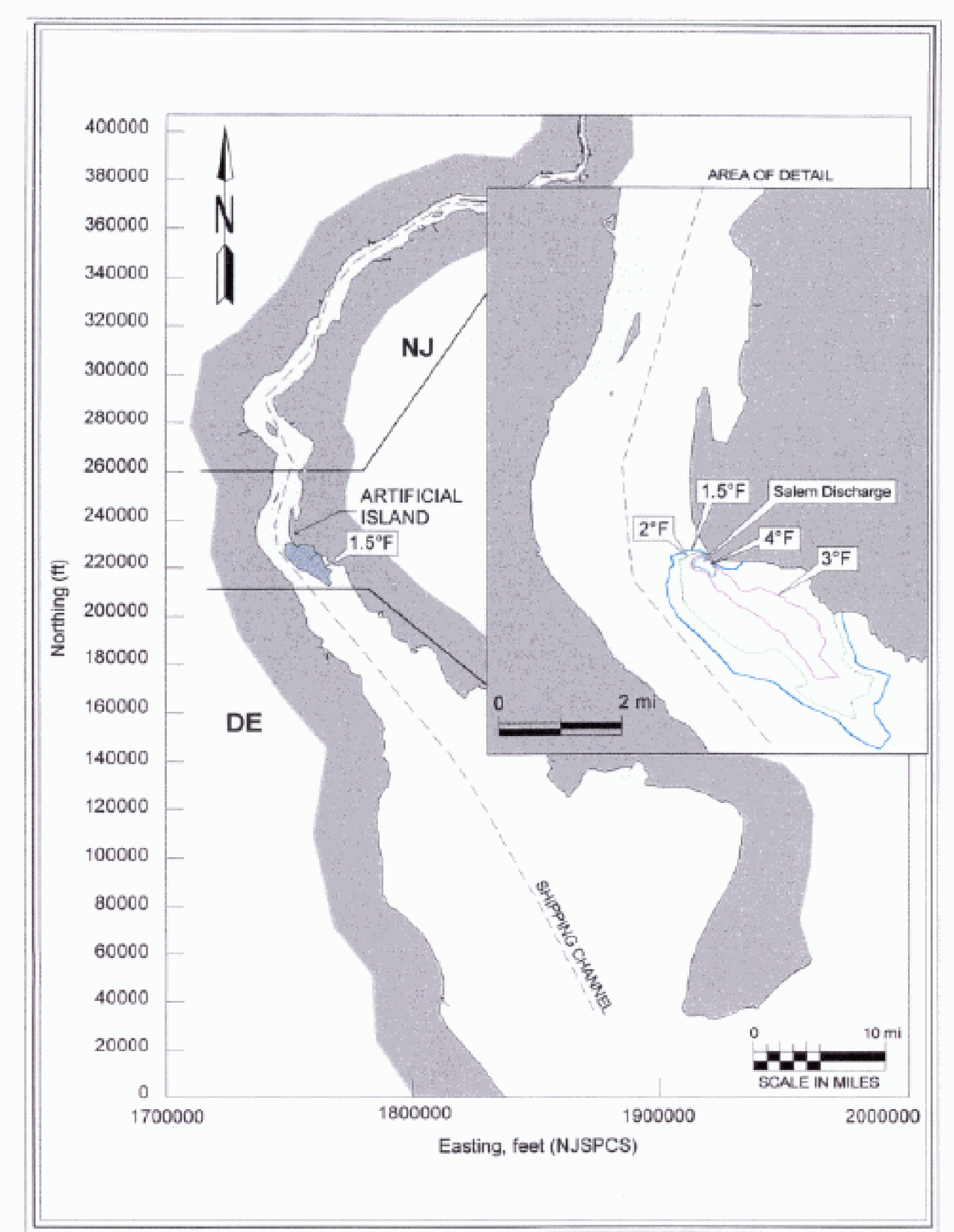


Figure 4-2. Section View of Salem discharge pipes (Source: PSEG, 1999c).



1
2 **Figure 4-3. Surface ΔT isotherms for Salem's longest plume at the end of flood on May**
3 **31, 1998 (Source: PSEG, 1999c).**



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2 **Figure 4-4. Surface ΔT isotherms for Salem at the end of ebb on June 2, 1998 (Source:**
3 **PSEG, 1999c).**

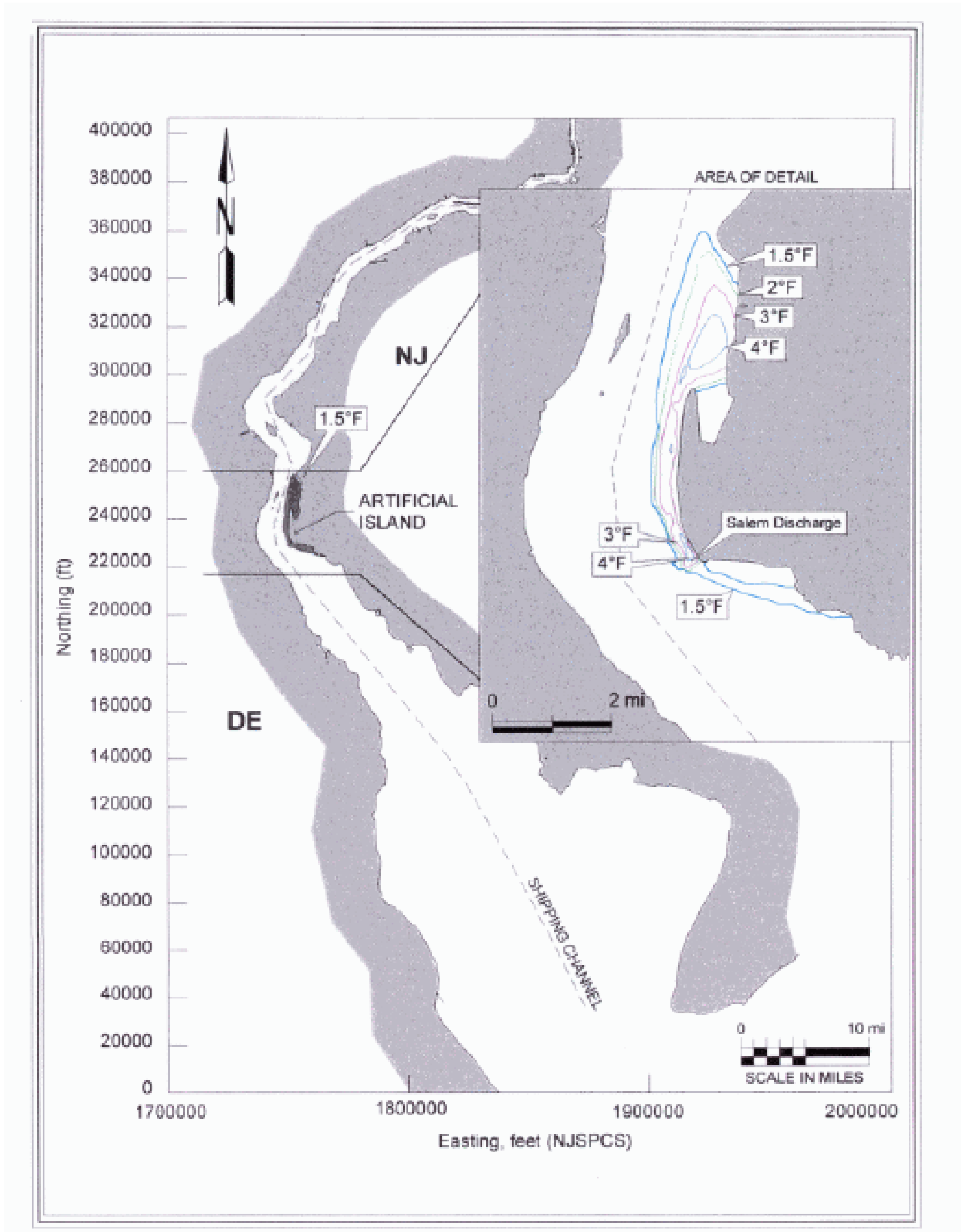


Figure 4-5. Bottom ΔT isotherms for Salem's longest plume at the end of the flood on May 31, 1998 (Source: PSEG, 1999c).

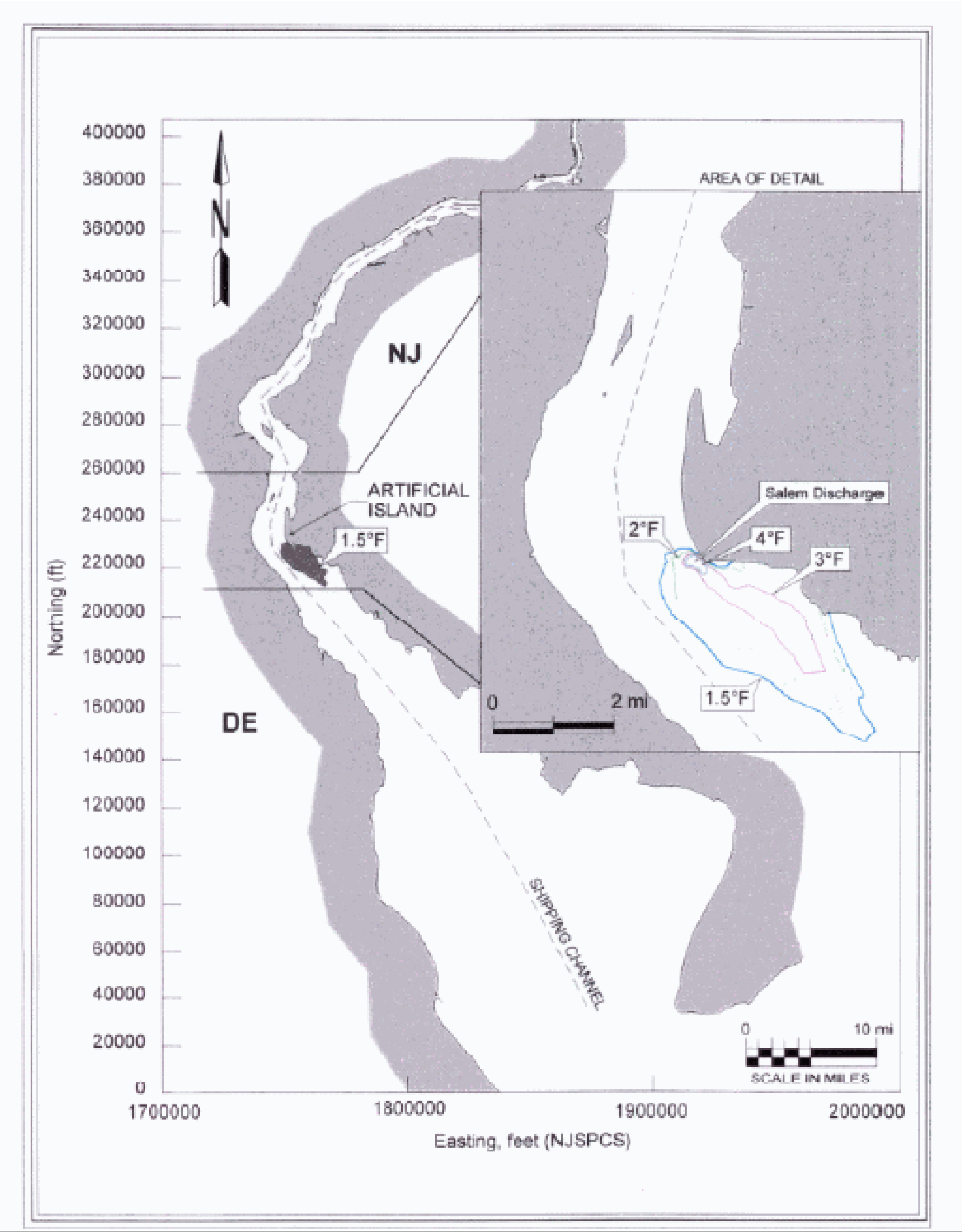


Figure 4-6. Bottom ΔT isotherms for Salem at the end of the ebb on June 2, 1998 (Source: PSEG, 1999c).

Thermal Discharge Studies

Extensive studies were conducted at Salem between 1968 and 1999 to determine the effects of the thermal plume on the biological community of the Delaware Estuary. Initial studies were conducted in 1968 to determine the location and design for the outfall that would best minimize the potential for adverse environmental effects. Several hydrothermal and biothermal studies subsequently have been conducted in support of requests for variance from thermal discharge limitations pursuant to Section 316(a). The Section 316(a) Demonstrations from 1974 through 1979 evaluated information on the life history, geographical distribution, and thermal tolerances of the RIS compared to the characteristics of the projected thermal plume. Supplements included information on the potential for Salem's thermal plume to promote the presence of undesirable organisms; use of the area in the vicinity of the Salem facility as spawning and nursery habitat; attraction of fish to the thermal plume and the potential for cold shock; effects of thermal plume entrainment on ichthyoplankton and zooplankton; effects of the plume on migration of anadromous fishes; and effects of the thermal plume on macroinvertebrates, such as blue crabs, oysters (*Crassostrea virginica*), and shipworms (Teredinidae), and other benthos (PSEG, 1975).

In 1995, PSEG applied to the DRBC for revision of the Salem Docket to provide seasonal HDAs to assure compliance with DRBC's water quality regulations. PSEG used mathematical modeling and statistical analyses to characterize the maximum size of the summer thermal plume (June through August) and non-summer thermal plume (September through May) in terms of the 24-hr average ΔT between the thermal plume and ambient water temperatures. PSEG also updated the information collected on the thermal tolerances, preferences, and avoidances of the RIS and conducted an evaluation of the potential for the thermal plume to have adverse effects on these species. The assessment indicated that Salem's thermal plume and the proposed HDAs would not have the potential to adversely affect aquatic life or recreational uses in the Delaware Estuary, and the DRBC granted the requested HDAs (PSEG, 1999c).

In 1999 PSEG submitted an application to renew the NJPDES permit for Salem, and the Section 316(a) Demonstration included provided another thermal plume characterization, biothermal assessment, and detailed analysis of the potential effects of Salem's thermal plume on the aquatic community. NJDEP reviewed this Section 316(a) Demonstration, determined that a "thermal discharge at the Station, which does not exceed a maximum of 115 ºF, is expected to assure the protection and propagation of the balanced indigenous population," and included a Section 316(a) variance in Salem's 2001 NJPDES permit (NJDEP, 2001).

The 1999 Section 316(a) Demonstration includes the most detailed and most recent evaluation of the potential effects of the thermal discharge on the aquatic environment near Salem. This evaluation includes a four-part assessment of the potential for the discharge to negatively affect the balanced indigenous community of the Delaware Estuary, including consideration of the following factors: (1) the vulnerability of the aquatic community to thermal effects; (2) the potential for the survival, growth, and reproduction of the RIS to be affected; (3) the potential for effects of other pollutants to be increased by heat; and (4) evidence of prior appreciable harm from the thermal discharge (PSEG, 1999c).

PSEG (1999d) concluded that the vulnerablity analysis indicates that the location and design of Salem's discharge minimize the potential for adverse environmental effects. They report that the high exit velocity produces rapid dilution, which limits high temperatures to relatively small areas in the zone of initial mixing in the immediate vicinity of the discharge. Fish and other nektonic organisms are essentially excluded from these areas due to high velocities and turbulence. PSEG (1999c) found that the offshore location and rapid dilution of the thermal discharge also places the highest temperature plumes in an area of the Estuary where productivity is lowest.

The RIS evaluation in the 1999 Section 316(a) Demonstration (PSEG, 1999c) included an assessment of the potential for the thermal plume to adversely affect survival, growth, and reproduction of the selected RIS. The RIS included alewife (*Alosa pseudoharengus*), American shad (*Alosa sapidissima*), Atlantic croaker (*Micropogonias undulatus*), bay anchovy (*Anchoa mitchilli*), blueback herring (*Alosa aestivalis*), spot (*Leiostomus xanthurus*), striped bass (*Morone saxatilis*), weakfish (*Cynoscion regalis*), white perch (*Morone americana*), blue crab (*Callinectes sapidus*), opossum shrimp (*Neomysis americana*), and scud (*Gammarus daiberi, G. fasciatus, G. tigrinus*). For each of the RIS, temperature requirements and preferences as well as thermal limits were identified and compared to temperatures in the thermal plume to which these species may be exposed (PSEG, 1999c).

This biothermal assessment (PSEG, 1999c) concluded that Salem's thermal plume would not have substantial effects on the survival, growth, or reproduction of the selected species from heat-induced mortality. Scud, blue crab, and juvenile and adult American shad, alewife, blueback herring, white perch, striped bass, Atlantic croaker, and spot have higher thermal tolerances than the temperature of the plume in areas where their swimming ability would allow them to be exposed. PSEG (1999c) concluded that juvenile and adult weakfish and bay anchovy could come into contact with plume waters that exceed their thermal tolerances during the warmer months, but the mobility of these organisms should allow them to avoid contact with these temperatures

The biothermal assessment also concluded that less-mobile organisms, such as scud, juvenile blue crab, and fish eggs, would not be likely to experience mortality from being transported through the plume. American shad, alewife, blueback herring, white perch, striped bass, Atlantic croaker, spot, and weakfish are not likely to spawn in the vicinity of the discharge. Scud, juvenile blue crab, and eggs and larvae that do occur in the vicinity of the discharge have higher temperature tolerances than the maximum temperature of the centerline of the plume in average years. PSEG (1999c) concluded that opossum shrimp, weakfish, and bay anchovy may experience some mortality during peak summer water temperatures in warm years (approximately 1 to 3 percent of the time).

Interactions of heat with other pollutants were also evaluated in the 1999 Section 316(a) Demonstration. The assessment concluded that the thermal plume has no observable effects on the dissolved oxygen level near the Salem discharge. In addition, the assessment indicates that there is no potential for plume interaction with other contaminants in the Estuary from other industrial, municipal, or agricultural sources such as polycarbonated biphenyols (PCBs), dichlorodiphenyltrichloroethane (DDT), dieldrin, polycyclic aromatic hydrocarbons (PAHs), tetrachloroethene (PCE), dichloroethene (DCE), and copper due to the low concentrations of such contaminants in the vicinity of Salem (PSEG, 1999c).

As part of the 1999 Section 316(a) Demonstration, an analysis of the biological community in the Delaware Estuary was conducted to determine whether there has been evidence of changes within the community that could be attributable to the thermal discharge at Salem. PSEG (1999c) concluded that observed changes in the species composition or overall abundance in organisms in the estuary since Salem began operation are within the range expected to occur as a result of natural variation or changes in water quality. PSEG found no indications of increases in populations of nuisance species or stress-tolerant species, and it found statistically significant increases in the abundance of juveniles for almost all species of RIS evaluated. PSEG (1999c) concluded that a declining trend for blueback herring was a coast-wide trend and not related to Salem's operation.

4.5.5 Restoration Activities

In addition to the changes in technology and operations of the Salem facility, PSEG has implemented restoration activities that enhance the fish and shellfish populations in the Delaware Estuary. In compliance with Salem's 1994 and 2001 NJPDES permits, PSEG implemented the Estuary Enhancement Program (EEP), which has preserved and/or restored more than 20,000 acres (ac; 8,000 hectares [ha]) of wetland and adjoining upland buffers (PSEG, 2009a).

In particular, the program restored 4,400 ac (1,800 ha) of formerly diked salt hay farms to reestablish conditions suitable for the growth of low marsh vegetation such as saltmarsh cord grass (*Spartina alterniflora*) and provide for tidal exchange with the estuary. These restored wetlands increase the production of fish and shellfish by increasing primary production in the detritus-based food web of the Delaware Estuary. Both primary and secondary consumers benefit from this increase in production, including many of the RS at Salem and federally managed species with essential fish habitat (EFH) in the estuary. PSEG (2006c) estimated the increase in production of secondary consumers due to this restoration to be at least 18.6 million lbs/yr (8.44 million kg/yr). These secondary consumers include species of fish and shellfish affected by impingement and entrainment at Salem, as well as other species.

The EEP also included the installation of 13 fish ladders at impoundments in New Jersey and Delaware (PSEG, 2009a). The fish ladders eliminate blockages to spawning areas for anadromous fish species such as alewife and blueback herring (both RS at Salem). Fish ladders were constructed in New Jersey at Sunset Lake, Stewart Lake (two ladders), Newton Lake and Cooper River Lake, and in Delaware at Noxontown Pond, Silver Lake (Dover), Silver Lake (Milford), McGinnis Pond, Coursey Pond, McColley Pond, Garrisons Lake, and Moore's Lake (PSEG, 2009a). Most anadromous fish exhibit spawning site fidelity, returning to the same areas where they hatched to spawn. Therefore, PSEG undertook a stocking program that transplanted gravid adults into the newly accessible impoundments to induce future spawning runs (PSEG, 2009a).

Along with the active restoration programs described above, PSEG has provided funding through the EEP for many other programs in the area, including some managed by NJDEP and the Delaware Department of Natural Resources and Environmental Control (DNREC). Examples of these funded programs are restoration of three areas in Delaware dominated by common reed (*Phragmites australis*), State-managed artificial reef programs, revitalization of 150 ac (61 ha) of State-managed oyster habitat, and restoration of 964 ac (390 ha) of degraded wetlands at the Augustine Creek impoundment (PSEG, 2009a).

A requirement of the 2001 NJPDES permit for Salem was for PSEG to evaluate and quantify the increased production associated with its restoration activities and compare it to the production lost due to entrainment and impingement at the facility. These restoration production estimates were provided in Section 7 of the 2006 NJPDES permit renewal application (PSEG, 2006c). The assessment included estimates of increased production associated with the restoration of the three salt hay farms and 12 fish ladder sites. It did not include production associated with the restoration of marshes dominated by common reed, upland buffer areas, and artificial reefs (PSEG, 2006c).

PSEG (2006c) used an Aggregated Food Chain Model (AFCM) to estimate the annual production (lbs wet weight/yr) of secondary consumers attributable to the restoration of the salt hay farm sites. This method used data for the biomass of above-ground vegetation collected during the annual monitoring from 2002 through 2004 to estimate primary production (production of above-ground marsh vegetation). This primary production was then converted to production of secondary consumers through three trophic transfers: vegetation to detrital complex (dissolved and particulate organic matter, bacteria, fungi, protozoa, nematodes, rotifers, copepods, and other microscopic organisms) to primary consumers (zooplankton and macroinvertebrates) to secondary consumers (age-0 fish). PSEG also used two independent methods, an ecosystem model and a fish abundance model, to corroborate the AFCM estimates.

PSEG (2006c) calculated the production of secondary consumers attributable to the restoration of the salt hay marsh sites to be 11,228,415 lbs wet weight/yr (5,093,209 kg wet weight/yr). PSEG (2006c) concluded that the methods used were likely to have underestimated total production attributable to the salt hay marsh restoration because they did not include production associated with below-ground plant parts (roots and rhizomes), benthic algae, or other primary producers such as photosynthetic bacteria. PSEG (2006c) estimated the increase in production attributable to restoration of the salt hay farms to be 2.3 times the annual production lost from impingement and entrainment at Salem.

PSEG (2006c) estimated the annual production of river herring (blueback herring and alewife) attributable to the installation of fish ladders at 12 impoundments in New Jersey and Delaware using results from surveys of juvenile fish in the impoundments, which were then converted to weight using an age-1 average weight. PSEG (2006c) calculated the production of river herring due to the fish ladders to be 944 lbs wet weight/yr (428 kg wet weight/yr), which it estimated was equivalent to about 1/6 of the production of river herring lost to impingement and entrainment at the facility.

4.5.6 Conclusions

Entrainment, impingement, heat shock, and the restoration programs simultaneously affect the aquatic resources of the Delaware Estuary. PSEG has conducted extensive studies of the effects of entrainment (Section 4.5.2) and impingement (Section 4.5.3) at Salem over the more than 30-yr period during which it has been operating. PSEG also has conducted extensive studies of the thermal plume at Salem (Section 4.5.4) that have shown that the thermal discharge from operation of the Salem facility has not had a noticeable adverse effect on the balanced indigenous community of the Delaware Estuary in the vicinity of the outfall. Thus, PSEG was granted a thermal variance in accordance with Section 316(a) of the CWA in 1994, and this variance remains a part of the current NJPDES permit issued to PSEG in 2001 and was administratively continued in 2006. Multiple long-term, large-scale studies of the estuary by PSEG and State and Federal agencies have documented the ecological condition of the estuary through time and allowed the analysis of long-term trends in populations of RS. The results of the studies indicate that the processes of entrainment, impingement, and thermal discharge collectively have not had a noticeable adverse effect on the balanced indigenous community of the Delaware Estuary in the vicinity of Salem.

The Staff considered these results and reviewed the available information, including that provided by the applicant, the Staff's site visit, the States of New Jersey and Delaware, the NJPDES permits and applications, and other public sources. The NJDEP, not the NRC, is responsible for issuing and enforcing NPDES permits. NRC assumes that NJDEP will continue to apply the best information available to the evaluation and approval of future NJPDES permits. The Staff concludes that impacts to fish and shellfish from the collective effects of entrainment, impingement, and heat shock at Salem during the renewal term would be SMALL.

The Staff identified a variety of measures that could mitigate potential impacts resulting from continued operation of the Salem cooling water system, although it should be noted that the NRC cannot impose mitigation requirements on the applicant. The Atomic Safety and Licensing Appeal Board in the "Yellow Creek" case determined that EPA has sole jurisdiction over the regulation of water quality with respect to the withdrawal and discharge of waters for nuclear power stations and that the NRC is prohibited from placing any restrictions or requirements upon the licensees of those facilities with regards to water quality (Tennessee Valley Authority [Yellow Creek Nuclear Plant, Units 1 and 2], ALAB-515, 8 NRC 702, 712-13 [1978]).

A few mitigation measures for the effects of the cooling water system on aquatic organisms include conversion to a closed cycle cooling water system, scheduling plant outages during historic peak impingement and entrainment periods, installing variable speed drive controllers on the pump motors to allow flow reductions during months of high biological activity, the use of dual-flow fine-mesh screens, and the use of a sound deterrent system for fish. These mitigation measures could reduce impacts by reducing the flow rate of water drawn into the facility, resulting in a commensurate decrease in impingement and entrainment, or by excluding organisms from the intake or deterring them from entering the area.

PSEG performed a cost-benefit analysis of these mitigation measures as part of its CDS for the 2006 NPDES permit renewal application (PSEG, 2006c). EPA's evaluation of the Salem NPDES permit renewal application would likely address any applicable site-specific mitigation measures that may reduce entrainment and impingement impacts. EPA's Phase II Rule has been suspended, and compliance with CWA Section 316(b) is presently based on EPA's best professional judgment.

4.6 Terrestrial Resources

The Category 1 issues related to terrestrial resources and applicable to Salem and HCGS are listed in Table 4-19. There are no Category 2 issues related to terrestrial resources. Section 2.2.6 provides a description of the terrestrial resources at the site of the Salem and HCGS facilities and in the surrounding area.

Table 4-19. Terrestrial Resources Issues Applicable to Salem and/or HCGS.

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

[(a)]Applicable only to HCGS.
[(b)]Applicable to Salem and HCGS.

The Staff did not identify any new and significant information during the review of the Salem and HCGS ER documents (PSEG, 2009a; 2009b), the Staff's site audit, the scoping process, or the evaluation of other available information (including bird mortality surveys conducted for the HCGS cooling tower from 1984 to 1986). Therefore, the NRC staff concludes that there would be no impacts related to these issues beyond those discussed in the GEIS (NRC, 1996). Regarding these issues, the GEIS concluded that the impacts are SMALL, and additional site-specific mitigation measures are not likely to be sufficiently beneficial to warrant implementation.

4.7 Threatened or Endangered Species

Potential impacts to threatened or endangered species are listed as a site-specific or Category 2 issue in 10 CFR Part 51, Subpart A, Appendix B, Table B-1. The GEIS section and category for this issue are listed in Table 4-20.

Table 4-20. Category 2 Issues Applicable to Threatened or Endangered Species During the Renewal Term

Issue	GEIS Section	Category
Threatened or endangered species	4.1	2

This site-specific issue requires consultation with appropriate agencies to determine whether threatened or endangered species are present and whether they would be adversely affected by continued operation of the nuclear facility during the license renewal term. The characteristics and habitats of threatened or endangered species in the vicinity of the site of the Salem and

HCGS facilities is discussed in Sections 2.2.7.1 and 2.2.7.2. The NRC contacted the National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (FWS) on December 23, 2010 to request information on the occurrence of threatened, endangered, or other protected species in the vicinity of the site and the potential for impacts on those species from license renewal (NRC, 2009a; 2009b). On February 11, 2010, NMFS, identified the endangered shortnose sturgeon (*Acipenser brevirostrum*), and the Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) as having the potential to be affected by the proposed action (NMFS, 2010). The Atlantic sturgeon is currently a candidate species be considered for being listed as an endangered species. Additionally, NMFS identified four Federally listed sea turtle species: the loggerhead (*Caretta caretta*), Kemp's ridley (*Lepidochelys kempi*), green turtle (*Chelonia mydas*), and leatherback turtle (*Dermochelys coriacea*), as having the potential to be adversely affected by the proposed action. These six species, their habitats, and their life histories, are described in Section 2.2.7.1.

The FWS (2010) responded on June 29, 2010, and indicated that there are no Federally listed species known to occur in the vicinity of the Salem and HCGS sites. Potential habitat for the bog turtle (*Clemmys muhlenbergil)* and swamp pink (*Helonias bullata)* exist along the New Freedom North and New Freedom South transmission line ROWs; however, the FWS concluded that the continued operation of Salem and HCGS is unlikely to adversely affect these species (FWS, 2010).

4.7.1 Aquatic Threatened or Endangered Species of the Delaware Estuary

Pursuant to consultation requirements under Section 7 of the Endangered Species Act of 1973, the Staff sent a letter to NMFS dated December 23, 2009 (NRC, 2009a) requesting information on Federally listed endangered or threatened species and proposed or candidate species. In its response on February 11, 2010, NMFS stated that the shortnose sturgeon, the Atlantic sturgeon, and four sea turtle species are known to occur in the Delaware River and estuary in the vicinity of Salem and HCGS, and that no critical habitat is currently designated by NMFS near these facilities (NMFS, 2010).

At Salem, NMFS considers takes to include mortalities as well as turtles that are impinged but removed alive and released. In 1991, NMFS issued a Biological Opinion that found that continued operation of Salem and HCGS would affect threatened or endangered sea turtles but was not likely to jeopardize any populations, and it issued an Incidental Take Statement (ITS) for Kemp's ridley, green, and loggerhead turtles and shortnose sturgeon. The number of turtles impinged in 1991 was unexpectedly high, exceeding the incidental take allowed and resulting in additional consultation. An opinion issued in 1992 revised the ITS. The impingement of sea turtles exceeded the allowable take in 1992 as well, prompting additional consultation between NRC and NMFS (NMFS, 1999). A 1993 Biological Opinion (NMFS 1993) required that PSEG track all loggerhead sea turtles taken alive at the cooling water intake structure (CWIS) and released. Also in 1993, PSEG implemented a policy of removing the ice barriers from the trash racks on the intake structure during the period between May 1 and October 24, which resulted in substantially lower turtle impingement rates at Salem.

In 1999, NRC requested that the studies of released turtles be eliminated due to the reduction in the number of turtles impinged after the 1993 change in procedure regarding the removal of ice barriers. NMFS responded in 1999 with a letter and an incidental take statement stating that these studies could be discontinued because it appeared that the reason for the relatively high impingement numbers previously was the ice barriers that had been left on the intake structure during the warmer months (NMFS, 1999). This letter allowed an annual incidental take of 5 shortnose sturgeon, 30 loggerhead sea turtles, 5 green sea turtles, and 5 Kemp's ridley sea turtles. In addition, the statement required ice barrier removal by May 1 and replacement after October 24, and it required that in the warmer months the trash racks must be cleaned weekly and inspected every other hour, and in the winter they should be cleaned every other week. The statement requires that if a turtle is killed, the racks must be inspected every hour for the rest of the warm season. Dead shortnose sturgeon are required to be inspected for tags, and live sturgeon are to be tagged and released (NMFS, 1999). No sea turtles have been captured at Salem since 2001 (NMFS, 2009).

No shortnose sturgeon or sea turtles have been impinged at the HCGS intake structure (NMFS, 2009), and NMFS has not required monitoring at HCGS beyond normal cleaning of the intake structure (NMFS, 1993).

The Staff discusses the potential effects of entrainment, impingement, and thermal discharges on these and other important species in Sections 4.5.2, 4.5.3, and 4.5.4. Based on examination by the Staff of entrainment data provided by PSEG, there is no evidence that the eggs or larvae of either sturgeon species are commonly entrained at Salem and HCGS. Neither of the sturgeon species is on the list of species that has been identified in annual entrainment monitoring during the 1978 – 2008 period (Table 4.21). The life histories of these sturgeon, described in Section 2.2.7.1, suggest that entrainment of their eggs or larvae is unlikely. Shortnose sturgeon spawn upstream in freshwater reaches of the Delaware River and are most abundant between Philadelphia and Trenton. Their eggs are demersal and adhere to the substrate, and juvenile stages tend to remain in freshwater or fresher areas of the estuary for 3 to 5 years before moving to more saline areas such as the nearshore ocean. Thus, shortnose sturgeon eggs or larvae are unlikely to be present in the water column at the Salem or HCGS intakes well downstream of the spawning areas. Similarly, the life history of the Atlantic sturgeon makes entrainment of its eggs or larvae very unlikely.

Table 4-21. Impingement data for shortnose sturgeon and three sea turtle species with recorded impingements at Salem intakes, 1978-2008.

Year	Number Impinged[(1)]			
	Shortnose sturgeon	Kemp's ridley sea turtle	Green sea turtle	Loggerhead sea turtle
1978	2 (2)	0	0	0
1979	0	0	0	0
1980	0	1	1	2 (2)
1981	1 (1)	1 (1)	0	3 (2)
1982	0	0	0	1 (1)
1983	0	1 (1)	0	2 (2)
1984	0	1	0	2 (2)
1985	0	2 (1)	0	6 (5)
1986	0	1 (1)	0	0
1987	0	3 (1)	0	3
1988	0	2 (1)	0	8 (6)
1989	0	6 (2)	0	2
1990	0	0	0	0
1991	3 (3)	1	1	23 (1)
1992	2 (2)	4 (2)	1 (1)	10
1993	0	1	0	0
1994	2 (2)	0	0	1
1995	0	0	0	1 (1)
1996	0	0	0	0
1997	0	0	0	0
1998	3 (1)	0	0	1 (1)
1999	1	0	0	0
2000	1 (1)	0	0	2 (1)
2001	0	0	0	1 (1)
2002	0	0	0	0
2003	1 (1)	0	0	0
2004	2 (1)	0	0	1
2005	0	0	0	0
2006	0	0	0	0
2007	1 (1)	0	0	0
2008	1 (1)	0	0	0
2009	0	0	0	0
Total	20 (16)	24 (10)	3 (1)	69 (25)

(1) Numbers in parentheses indicate the number of individuals out of the yearly total shown that were either dead when found at the intakes or died afterward. Impingements of Atlantic sturgeon or leatherback sea turtles were not reported in the data on which this table was based.

Source: PSEG, 2010d.

Both sturgeon species and three of the four turtle species have been impinged at Salem. Atlantic sturgeon were collected in impingement studies in a single year, 2006 (PSEG, 2006a). From 1978 through 2009, 20 shortnose sturgeon were impinged at the Salem intakes, of which 16 died. Between 1978 and 2008, 24 Kemp's ridley sea turtles were impinged, of which ten died. Three green turtles (one died) and 69 loggerhead turtles (25 died) also were impinged. Impingement of the turtles was greatest in 1991 and 1992 (Table 4.21). After PSEG modified its use of the ice barriers in 1993, turtle impingement numbers returned to levels much lower than in 1991. From 1994 through 2009, Salem impinged seven sea turtles (all loggerheads), and four of these died. Also during this 16-yr period, 12 shortnose sturgeon were impinged, of which eight died. Sea turtles have not been impinged at Salem since 2004 (NMFS, 2009).

Section 4.5.4 discusses potential impacts of thermal discharges on the aquatic biota of the Delaware Estuary, and the Staff expects that impacts on fish and invertebrates, including those preyed upon by sturgeon and sea turtles, to be minimal. The high exit velocity of the discharge produces rapid dilution, which limits high temperatures to relatively small areas in the zone of initial mixing in the immediate vicinity of the discharge. Fish and many other organisms are largely excluded from these areas due to high velocities and turbulence. Shortnose and Atlantic sturgeon and the four sea turtle species have little potential to experience adverse effects from exposure to the temperatures at the discharge because of their life history characteristics and their mobility. Sturgeon spawning and nursery areas do not occur in the area of the discharge in the estuary, and adult sturgeon forage on the bottom while the buoyant thermal plume rises toward the surface. Sea turtles prefer warmer water temperatures, occur in the region only during warm months, and are unlikely to be sensitive to the localized area of elevated temperatures at the discharge. NMFS (1993) considered the possibility that the warm water near the discharge could cause sea turtles to remain in the area until surrounding waters are too cold for their safe departure in the fall, but it concluded that this scenario was not supported by any existing data.

The Staff reviewed information from the site audit, the applicant's ERs for Salem and HCGS, biological monitoring reports, other reports, and coordination with NMFS, FWS, and State regulatory agencies in New Jersey and Delaware regarding listed species. The Staff concludes that the impacts on Federally listed threatened or endangered aquatic species of the Delaware Estuary during an additional 20 years of operation of the Salem and HCGS facilities would be SMALL. NRC provides a Biological Assessment of the potential effects from the proposed license renewal for the Salem and HCGS facilities on Federally listed endangered or threatened species under NMFS jurisdiction in Appendix D.

4.7.2 Terrestrial and Freshwater Aquatic Threatened or Endangered Species

The FWS (2010) indicated that no Federally listed terrestrial species are known to occur on or in the vicinity of the Salem and HCGS sites. The FWS (2010) noted that areas of potential habitat and/or known occurrences of the bog turtle and swamp pink exist along the New Freedom North and New Freedom South transmission line ROWs, but that the continued operation of Salem and HCGS are unlikely to adversely affect either species because PSEG had previously committed to adopting FWS-recommended conservation measures along the transmission line ROWS. The Staff reviewed information from the site audit, ERs for Salem and HCGS, other reports, and coordinated with FWS and State regulatory agencies in New Jersey and Delaware regarding listed species. The NRC staff concludes that the impacts on Federally listed terrestrial and freshwater aquatic species from an additional 20 years of operation and maintenance of the Salem and HCGS facilities and associated transmission line ROWs would be SMALL.

4.8 Human Health

The human health issues applicable to Salem and HCGS are discussed below and listed in Table 4-22 for Category 1, Category 2, and uncategorized issues.

Table 4-22. Human Health Issues. *Table B-1 of Appendix B to Subpart A of 10 CFR Part 51 contains more information on these issues.*

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

[a] - Issues apply to refurbishment, an activity that neither Salem nor HCGS plan to undertake.
[b] - Issue applies to plant features such as cooling lakes or cooling towers that discharge to small rivers. Neither Salem nor HCGS have applicable features.

4.8.1 Generic Human Health Issues

The Staff did not identify any new and significant information related to human health issues or radiation exposures during its review of the PSEG environmental reports, the site audit, or the scoping process. Therefore, there are no impacts related to these issues beyond those discussed in the GEIS. For these issues, the GEIS concluded that the impacts are SMALL, and additional site-specific mitigation measures are not likely to be sufficiently beneficial to be warranted (Category 1 issues). These impacts will remain SMALL through the license renewal term.

4.8.2 Radiological Impacts of Normal Operations

Category 1 issues in 10 CFR Part 51, Subpart A, Appendix B, Table B-1, applicable to Salem and HCGS in regard to radiological impacts are listed in Table 4-22. PSEG stated in its ER that it was not aware of any new radiological issues associated with the renewal of the Salem and HCGS operating licenses. The Staff has not identified any new and significant information, during its independent review of PSEG's ER, the site audit, the scoping process, or its evaluation of other available information. Therefore, the Staff concludes that there would be no impact from radiation exposures to the public or to workers during the renewal term beyond those discussed in the GEIS.

According to the GEIS, the impacts to human health are SMALL, and additional plant-specific mitigation measures are not likely to be sufficiently beneficial to be warranted

- Radiation exposures to public (license renewal term). Based on information in the GEIS, the Commission found the following:

  Radiation doses to the public will continue at current levels associated with normal operations.

- Occupational exposures (license renewal term). Based on information in the GEIS, the Commission found the following:

  Projected maximum occupational doses during the license renewal term are within the range of doses experienced during normal operations and normal maintenance outages, and would be well below regulatory limits.

Therefore, the Staff expects that there would be no impacts during the renewal term beyond those discussed in the GEIS.

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

The information presented below is a discussion of selected radiological programs conducted at Salem and HCGS.

Radiological Environmental Monitoring Program

PSEG conducts a radiological environmental monitoring program (REMP) to assess the radiological impact, if any, to its employees, the public, and the environment around the plant site. The REMP provides measurements of radiation and of radioactive materials for the exposure pathways and the radionuclides which lead to the highest potential radiation exposures to the public. The REMP supplements the radioactive effluent monitoring program by verifying that any measurable concentrations of radioactive materials and levels of radiation in the environment are not higher than those calculated using the radioactive effluent release measurements and transport models.

The objectives of the REMP are as follows:

- To fulfill the requirements of the radiological surveillance sections of the Plants' Technical Specifications and the Offsite Dose Calculation Manual.
- To determine whether any significant increase occurred in the concentration of radionuclides in critical pathways for the transfer of radionuclides through the environment to man.
- To determine if operation of the plants caused an increase in the radioactive inventory of long-lived radionuclides in the environment.
- To detect any change in ambient gamma radiation levels.

- To verify that operation of the plants have no detrimental effects on the health and safety of the public or on the environment.

An annual radiological environmental operating report is issued, which contains a discussion of the results of the monitoring program. The report contains data on the monitoring performed for the most recent year as well as graphs containing historical information. The REMP collects samples of environmental media in order to measure the radioactivity levels that may be present. The media samples are representative of the radiation exposure pathways that may impact the public. The REMP measures the aquatic, terrestrial, and atmospheric environment for radioactivity, as well as the ambient radiation. Ambient radiation pathways include radiation from radioactive material inside buildings and plant structures and airborne material that may be released from the plant. In addition, the REMP measures background radiation (i.e., cosmic sources, global fallout, and naturally occurring radioactive material, including radon). Thermoluminescent dosimeters (TLDs) are used to measure ambient radiation. The atmospheric environmental monitoring consists of sampling and analyzing the air for particulates and radioiodine. Terrestrial environmental monitoring consists of analyzing samples of locally grown vegetables and fodder crops, drinking water, groundwater, meat, and milk. The aquatic environmental monitoring consists of analyzing samples of surface water, fish, crabs, and sediment. An annual land use census is conducted to determine if the REMP needs to be revised to reflect changes in the environment or population that might alter the radiation exposure pathways. Salem and HCGS has an onsite groundwater protection program designed to monitor the onsite plant environment for early detection of leaks from plant systems and pipes containing radioactive liquid (PSEG, 2009a; 2009b; 2010c). Additional information on the groundwater protection program is contained later in this section and in the Ground Water Quality section in Chapter 2 of this document.

The Staff reviewed the Salem and HCGS annual radiological environmental operating reports for 2005 through 2009 to look for any significant impacts to the environment or any unusual trends in the data (PSEG, 2006b; 2007b; 2008c; 2009f; 2010c). A five year period provides a representative data set that covers a broad range of activities that occur at a nuclear power plant such as refueling outages, non-refueling outage years, routine operation, and years where there may be significant maintenance activities. Based on the Staff's review, no unusual trends were observed and the data showed that there was no significant radiological impact to the environment from operations at Salem and HCGS. Small amounts of radioactive material (i.e., tritium, cesium-137, and manganese-54) were detected below NRC's reporting values for radionuclides in environmental samples. Overall, the results, with the exception of the on-site groundwater contaminated with tritium, were comparable to the results obtained during the preoperational phase of the REMP and with historical results obtained since commercial operation.

The NJDEP's Bureau of Nuclear Engineering performs an independent Environmental Surveillance and Monitoring Program (ESMP) in the environment around the Salem and Hope Creek Nuclear Generating Stations. The ESMP provides a comprehensive monitoring strategy that ensures that New Jersey citizens are aware of and, if necessary, protected from harmful exposure to radioactive effluent discharges from New Jersey's nuclear power plants during normal or accident operations.

The specific objectives of the ESMP are to monitor pathways for entry of radioactivity into the environment in order to identify potential exposures to the population from routine and accidental releases of radioactive effluent, and to provide a summary and interpretation of this information to members of the public and government agencies.

The Staff reviewed the NJDEP's 2008 report (the most recent report available to the Staff at the time this draft SEIS was prepared) which contains information on the environmental sampling conducted during the time period of January 1, 2008 through December 31, 2008. The State reported the following: "Overall, the data collected by the NJDEP's ESMP throughout 2008 indicate that residents living in the area around Oyster Creek and Salem/Hope Creek nuclear power plants have not received measurable exposures of radiation above normal background" (NJDEP, 2009).

Radiological Groundwater Protection Program

In response to an identified radioactive liquid release from the Salem Unit 1 spent fuel pool in 2002, PSEG implemented a Remedial Action Work Plan (RAWP) and developed a voluntary Radiological Groundwater Protection Program (RGPP) in 2006 that added additional groundwater sampling locations, outside the scope of the REMP. The RAWP, which was reviewed by the NRC and approved by the NJDEP, is a program designed to remediate the site's groundwater to remove the tritiated groundwater and control the tritium plume from reaching the site boundary and impacting the off-site environment. The results of the RGPP groundwater monitoring program have been reported in the annual radiological environmental operating report since 2006.

The radiological monitoring data for 2009 showed a wide range of tritium concentrations in the on-site groundwater. For HCGS, the results show that tritium was detected at concentrations that ranged from the lower limit of detection value of 200 pico Curies per liter (pCi/L) to a maximum of 7,778 pCi/L. As a result of the positive indications of tritium, the applicant increased the sampling frequency for the monitoring wells. Subsequent sampling did not reproduce the highest levels observed; however, variations in the levels were observed throughout 2009. As a result, the applicant continues to track the concentrations of tritium in the groundwater to determine if a trend can be observed. For the Salem units, the results show that tritium was detected in on-site groundwater in concentrations that ranged from the lower limit of detection value of 200 pCi/L to a maximum of 2,259 pCi/L. The applicant is tracking the tritium concentration levels to determine if a trend can be observed (PSEG, 2010c). The Staff notes that no groundwater samples reached the NRC's reporting level of 20,000 pCi/L for tritium in environmental samples.

As part of the applicant's investigation for new and significant information that is relevant to its license renewal application, the issue of tritium in the groundwater was evaluated. The applicant's evaluation concludes that changes in tritium-related groundwater quality are not significant at Salem and would not preclude current or future uses of the groundwater for the following reasons:

- Although tritium concentrations are elevated in the shallow aquifer beneath Salem, PSEG has been performing remedial actions since 2004, and concentrations continue to decrease.
- Tritium concentrations in groundwater are due to an historic incident; the source (spend fuel pool water leak) has been eliminated.
- No tritium concentrations above either the EPA Drinking Water Standard or the NJDEP

Ground Water Quality Criterion have migrated to the property boundary or into geologic formations deeper than the shallow aquifer. Offsite tritium concentrations are below regulatory limits.

- There is no human exposure pathway and, therefore, no threat to public or employee health or safety.

Radioactive Effluent Release Program

All nuclear plants were licensed with the expectation that they would release radioactive material to both the air and water during normal operation. However, NRC regulations require that radioactive gaseous and liquid releases from nuclear power plants must meet radiation dose-based limits specified in 10 CFR Part 20, and as low as is reasonably achievable (ALARA) criteria in Appendix I to 10 CFR Part 50. The regulatory limits protect plant workers and members of the public from radioactive material released by a nuclear power plant. In addition, nuclear power plants are required to file an annual report to the NRC which lists the types and quantities of radioactive effluents released into the environment. The radioactive effluent release and radiological environmental monitoring reports are available for review by the public through the NRC's ADAMS electronic reading room on the NRC website.

The Staff reviewed the annual radioactive effluent release reports for 2005 through 2009 (PSEG, 2006d; 2007c; 2008b; 2008e; 2010b). The review focused on the calculated doses to a member of the public from radioactive effluents released from Salem and HCGS. The doses were compared to the radiation protection standards in 10 CFR 20.1301 and the ALARA dose design objectives in Appendix I to 10 CFR Part 50.

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

Salem Units 1 and 2

- The total-body dose to an offsite member of the public from radioactive liquid effluents from Salem Unit 1 was 3.22×10^{-05} millirem (mrem; 3.22×10^{-05} millisieverts [mSv]) and 2.72×10^{-05} mrem (2.72×10^{-07} mSv) for Unit 2, which is well below the 3 mrem (0.03 mSv) dose criterion for an individual reactor unit in Appendix I to 10 CFR Part 50.

- The maximum dose to any organ (i.e., skin, thyroid, liver, G.I. tract, etc.) of an offsite member of the public from radioactive liquid effluents from Salem Unit 1 was 8.60×10^{-05} mrem (8.60×10^{-07} mSv) and 8.89×10^{-05} (8.89×10^{-07} mSv) for Unit 2, which is well below the 10 mrem (0.1 mSv) dose criterion for an individual reactor unit in Appendix I to 10 CFR Part 50.

- The air dose at the site boundary from gamma radiation in gaseous effluents from Salem Unit 1 was 1.28×10^{-04} millirad (mrad; 1.28×10^{-06} megagray [mGy]), and 2.74×10^{-05} mrad (2.74×10^{-07} mGy) for Unit 2, which is well below the 10 mrad (0.1 mGy) dose criterion for an individual reactor unit in Appendix I to 10 CFR Part 50.

- The air dose at the site boundary from beta radiation in gaseous effluents from Salem Unit 1 was 3.14×10^{-04} mrad ($3.14\ 10^{-06}$ mGy) and 1.46×10^{-05} mrad (1.46×10^{-07} mGy) for Unit 2, which is well below the 20 mrad (0.2 mGy) dose criterion for an individual reactor unit in Appendix I to 10 CFR Part 50.
- The maximum dose to any organ (i.e., skin, thyroid, liver, G.I. tract, etc.) of a member of the public at the site boundary from radioactive iodine, tritium, and radioactive particulate matter from Unit 1 was 2.70×10^{-03} mrem (2.70×10^{-05} mSv) and 1.65×10^{-03} mrem (1.65 E-05 mSv) for Unit 2, which is well below the 15 mrem (0.15 mSv) dose criterion for an individual reactor unit in Appendix I to 10 CFR Part 50.

<u>Hope Creek Generating Station</u>

- The total-body dose to an offsite member of the public from radioactive liquid effluents from HCGS was 8.32×10^{-05} mrem (8.32×10^{-07} mSv), which is well below the 3 mrem (0.03 mSv) dose criterion for an individual reactor unit in Appendix I to 10 CFR Part 50.
- The maximum dose to any organ (i.e., skin, thyroid, liver, G.I. tract, etc.) of an offsite member of the public from radioactive liquid effluents from HCGS was 3.05×10^{-04} mrem (3.05×10^{-06} mSv), which is well below the 10 mrem (0.1 mSv) dose criterion for an individual reactor unit in Appendix I to 10 CFR Part 50.
- The air dose at the site boundary from gamma radiation in gaseous effluents from HCGS was 7.29×10^{-04} mrad (7.29×10^{-06} mGy), which is well below the 10 mrad (0.1 mGy) dose criterion for an individual reactor unit in Appendix I to 10 CFR Part 50.
- The air dose at the site boundary from beta radiation in gaseous effluents from HCGS was 7.34×10^{-04} mrad (7.34×10^{-06} mGy), which is well below the 20 mrad (0.2 mGy) dose criterion for an individual reactor unit in Appendix I to 10 CFR Part 50.
- The maximum dose to any organ (i.e., skin, thyroid, liver, G.I. tract, etc.) of a member of the public at the site boundary from radioactive iodine, tritium, and radioactive particulate matter from HCGS was 1.97×10^{-02} mrem (1.97×10^{-04} mSv), which is well below the 15 mrem (0.15 mSv) dose criterion for an individual reactor unit in Appendix I to 10 CFR Part 50.

<u>Salem – Hope Creek Site Total</u>

- The total-body dose to an offsite member of the public from the combined radioactive effluents from all three reactor units was 7.26×10^{-03} mrem (7.26×10^{-05} mSv), which is well below the 25 mrem (0.25 mSv) dose criterion in 40 CFR Part 190.
- The dose to any organ (i.e., skin, thyroid, liver, G.I. tract, etc.) of an offsite member of the public from the combined radioactive effluents from all three reactor units was 2.54 E-02 mrem (2.54×10^{-04} mSv), which is well below the 25 mrem (0.25 mSv) dose criterion in 40 CFR Part 190.
- The thyroid dose to an offsite member of the public from the combined radioactive effluents from all three reactor units was 2.41×10^{-02} mrem (2.41×10^{-04} mSv), which is well below the 75 mrem (0.75 mSv) dose criterion in 40 CFR Part 190.

Based on the Staff's review of the Salem and HCGS radioactive waste system's performance in controlling radioactive effluents and the resultant doses to members of the public in conformance with the ALARA criteria in Appendix I to 10 CFR Part 50, the Staff found that the 2009 radiological effluent data for Salem and HCGS are consistent, within reasonable variation attributable to operating conditions and outages, with the historical data. The results demonstrate that Salem and HCGS are operating in compliance with Federal radiation protection standards contained in Appendix I to 10 CFR Part 50, 10 CFR Part 20, and 40 CFR Part 190.

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

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

4.8.3 Microbiological Organisms – Public Health

Both Salem and HCGS have thermal discharges to the Delaware Estuary, a large brackish, tidally-influenced water body that allows their thermal plumes to disperse quickly. There are no other facilities that release thermal discharges to the Estuary in the vicinity of Salem and HCGS.

Table B-1 of Appendix B to Subpart A of 10 CFR Part 51 and Table 4-22 list the effects of thermophilic microbiological organisms on human health as a Category 2 issue and requires the conduct of a plant-specific evaluation before license renewal. This issue applies to plant features such as cooling lakes or cooling towers that discharge to small rivers. NRC has determined that Salem and HCGS discharge to an estuary (NRC, 1996). Neither Salem nor HCGS use cooling ponds, cooling lakes, cooling canals, or discharge to a small river. Therefore, this issue does not apply and the effects of plant discharges on microbiological organisms do not need to be addressed for license renewal.

4.8.4 Electromagnetic Fields – Acute Effects

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

In the GEIS (NRC, 1996), the Staff found that without a review of the conformance of each nuclear plant transmission line with National Electrical Safety Code (NESC) criteria, it was not possible to determine the significance of the electric shock potential (IEEE, 2007). Evaluation of individual plant transmission lines is necessary because the issue of electric shock safety was not addressed in the licensing process for some plants. For other plants, land use in the vicinity of transmission lines may have changed, or power distribution companies may have chosen to upgrade line voltage. To comply with 10 CFR 51.53(c)(3)(ii)(H), the applicant must provide an assessment of the impact of the proposed action on the potential shock hazard from the transmission lines if the transmission lines that were constructed for the specific purpose of connecting the plant to the transmission system do not meet the recommendations of the NESC for preventing electric shock from induced currents.

As described in Section 2.1.1.6, four 500-kilovolt (kV) transmission lines were specifically constructed to distribute power to the electrical grid from the Salem and HCGS. One 500-kV line, the HCGS-New Freedom line, was originally constructed to connect HCGS to the transmission system. Two additional lines, Salem-New Freedom North and Salem-Keeney (via Red Lion substation), were originally built for Salem but have since been connected to HCGS. The fourth line, Salem-New Freedom South, originates at Salem (PSEG, 2009a; 2009b).

PSEG conducted an analysis of the Salem HCGS transmission lines using a computer model of induced current under the line and the results were field verified. PSEG calculated electric field strength and induced current using a computer code called ACDCLINE, produced by the Electric Power Research Institute. The analysis determined that there are no locations under the transmission lines that have the capacity to induce more than 5 milliamperes (mA) in a vehicle parked beneath the line. Therefore, the lines meet the NESC 5 mA criterion. The maximum induced current calculated for the power lines was 4.2 mA for the Salem-New Freedom South line (PSEG, 2009a; 2009b).

PSEG also conducts regular aerial and ground surveillance and maintenance to ensure that design ground clearances do not change. The aerial patrols of all corridors include checks for encroachments, broken conductors, broken or leaning structures, and signs of burnt trees, any of which would be evidence of clearance problems. Ground inspections include examination for clearance at questionable locations, examination for integrity of structures, and surveillance for dead or diseased trees that might fall on the transmission line. Problems noted during any inspection are brought to the attention of the appropriate organizations for corrective action (PSEG, 2009a; 2009b).

The Staff has reviewed the available information, including the applicant's evaluation and computational results for the potential impacts of electric shock resulting from operation of Salem and HCGS and their associated transmission lines. The staff concludes that the potential impacts of electric shock during the renewal term would be SMALL.

4.8.5 Electromagnetic Fields – Chronic Effects

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

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

The report by NIEHS (NIEHS, 1999) contains the following conclusion:

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

> United States uses electricity and therefore is routinely exposed to ELF-EMF, passive regulatory action is warranted such as continued emphasis on educating both the public and the regulated community on means aimed at reducing exposures. The NIEHS does not believe that other cancers or non-cancer health outcomes provide sufficient evidence of a risk to currently warrant concern.

This statement is not sufficient to cause the Staff to change its position with respect to the chronic effects of electromagnetic fields. The NRC staff considers the GEIS finding of "not applicable" still appropriate and will continue to follow developments on this issue.

4.9 Socioeconomics

The socioeconomic issues applicable to Salem and HCGS during the license renewal term are listed in Table 4-23, including applicable GEIS section and category (Category 1, Category 2, or uncategorized).

Table 4-23. Socioeconomic Issues. *Section 2.2.8 of this report describes the socioeconomic conditions near Salem and HCGS.*

Issue	GEIS Section	Category
Housing impacts	4.7.1	2
Public services: public safety, social services, and tourism and recreation	4.7.3; 4.7.3.3; 4.7.3.4; 4.7.3.6	1
Public services: public utilities	4.7.3.5	2
Public services: education (license renewal term)	4.7.3.1	1
Offsite land use (license renewal term)	4.7.4	2
Public services: transportation	4.7.3.2	2
Historic and archaeological resources	4.7.7	2
Aesthetic impacts (license renewal term)	4.7.6	1
Aesthetic impacts of transmission lines (license renewal term)	4.5.8	1
Environmental justice	Not addressed (a)	Uncategorized (a)

(a) Guidance related to environmental justice was not in place at the time the GEIS and the associated revisions to 10 CFR Part 51 were prepared. Therefore, environmental justice must be addressed in plant-specific reviews.

4.9.1 Generic Socioeconomic Issues

The NRC reviewed and evaluated the Salem and HCGS ERs (PSEG, 2009a; 2009b), scoping comments, and other available information, and visited the Salem and HCGS sites and did not identify any new and significant information that would change the conclusions presented in the

GEIS. Therefore, there would be no impacts related to the Category 1 issues during the period of extended operation beyond those discussed in the GEIS. For Salem and HCGS, the GEIS conclusions for Category 1 issues are incorporated by reference. Impacts for Category 2 and uncategorized issues are discussed in the following sections.

4.9.2 Housing Impacts

According to the 2000 Census, approximately 501,820 people lived within 20 mi (32 km) of Salem and HCGS, which equates to a population density of 450 persons per square mile (PSEG, 2009a; 2009b). This density translates to GEIS Category 4 – least sparse (greater than or equal to 120 persons per square mile within 20 mi [32km]). Approximately 5,201,842 people live within 50 mi (80 km) of Salem and HCGS (PSEG, 2009a; 2009b). This equates to a population density of 771 persons per square mile. Applying the GEIS proximity measures, this value translates to a Category 4 – in close proximity (greater than or equal to 190 persons per square mile within 50 mi [80 km]). Therefore, according to the sparseness and proximity matrix presented in the GEIS, the sparseness Category 4 and proximity Category 4 indicate that Salem and HCGS are located in a high population area.

Table B-1 of Appendix B to Subpart A of 10 CFR Part 51 states that impacts on housing availability are expected to be of small significance in high-density population areas where growth control measures are not in effect. Since Salem and HCGS are located in a high population area, and Cumberland, Gloucester, Salem, and New Castle Counties are not subject to growth control measures that would limit housing development, any changes in employment at Salem and HCGS would have little noticeable effect on housing availability in these counties. Since PSEG has no plans to add non-outage employees during the license renewal period, employment levels at Salem and HCGS would remain relatively constant with no additional demand for permanent housing during the license renewal term. In addition, the number of available housing units has kept pace with or exceeded the growth in the area population. Based on this information, there would be no additional impact on housing during the license renewal term beyond what has already been experienced.

4.9.3 Public Services: Public Utilities

As discussed in Section 4.7.4 of the GEIS, impacts on public utility services (e.g., water, sewer) are considered SMALL if the public utility has the ability to respond to changes in demand and would have no need to add or modify facilities. Impacts are considered MODERATE if service capabilities are overtaxed during periods of peak demand. Impacts are considered LARGE if additional system capacity is needed to meet ongoing demand.

Analysis of impacts on the public water and sewer systems considered both facility demand and facility-related population growth. As previously discussed in Section 2.1.7, Salem and HCGS obtain their potable water supply directly from groundwater sources. The facility does not purchase water from a public water system. Water usage by Salem and HCGS has not stressed the supply source capacity (usage is approximately 41 percent of the permitted withdrawal [DRBC, 2000; NJDEP, 2004b]) and is not currently an issue. PSEG has no plans to increase Salem and HCGS staffing due to refurbishment or new construction activities, and has identified no operational changes during the license renewal term that would increase potable water use by the facilities.

Since PSEG has no plans to add non-outage employees during the license renewal period, employment levels at Salem and HCGS would remain relatively unchanged with no additional demand for public water services. Public water systems in the region are adequate to meet the demand of residential and industrial customers in the area. Therefore, there would be no additional impact to public water services during the license renewal term beyond what is currently being experienced.

4.9.4 Offsite Land Use – License Renewal Period

Off-site land use during the license renewal term is a Category 2 issue. Table B-1 of Appendix B to Subpart A of 10 CFR Part 51 notes that “significant changes in land use may be associated with population and tax revenue changes resulting from license renewal.” In Section 4.7.4 of the GEIS, the magnitude of land-use changes as a result of plant operation during the period of extended operation is defined as follows:

> SMALL - Little new development and minimal changes to an area's land-use pattern.
>
> MODERATE - Considerable new development and some changes to the land-use pattern.
>
> LARGE - Large-scale new development and major changes in the land-use pattern.

Tax revenue can affect land use because it enables local jurisdictions to provide the public services (e.g., transportation and utilities) necessary to support development. Section 4.7.4.1 of the GEIS states that the assessment of tax-driven land-use impacts during the license renewal term should consider (1) the size of the plant’s payments relative to the community’s total revenues, (2) the nature of the community’s existing land-use pattern, and (3) the extent to which the community already has public services in place to support and guide development. If the plant’s tax payments are projected to be small relative to the community’s total revenue, tax-driven land-use changes during the plant’s license renewal term would be SMALL, especially where the community has pre-established patterns of development and has provided adequate public services to support and guide development. Section 4.7.2.1 of the GEIS states that if tax payments by the plant owner are less than 10 percent of the taxing jurisdiction’s revenue, the significance level would be SMALL. If the plant’s tax payments are projected to be medium to large relative to the community’s total revenue, new tax-driven land-use changes would be MODERATE. If the plant’s tax payments are projected to be a dominant source of the community’s total revenue, new tax-driven land-use changes would be LARGE. This would be especially true where the community has no pre-established pattern of development or has not provided adequate public services to support and guide development.

<u>Population-Related Impacts</u>

Since PSEG has no plans to add non-outage employees during the license renewal period, there would be no noticeable change in land use conditions in the vicinity of the Salem and HCGS. Therefore, there would be no population-related land use impacts during the license renewal term beyond those already being experienced.

Tax Revenue-Related Impacts

As previously discussed in Section 2.2.8.6, PSEG and the Salem site's minority owner Exelon pay annual real estate taxes to Lower Alloways Creek Township. From 2003 through 2009, the owners paid between $1.2 and $1.5 million annually in property taxes to Lower Alloways Creek Township. This represented between 54 and 59 percent of the township's total annual property tax revenue. Each year, Lower Alloways Creek Township forwards this tax money to Salem County, which provides most services to township residents. The property taxes paid annually for Salem and HCGS during 2003 through 2009 represent approximately 2.5 to 3.5 percent of Salem County's total annual property tax revenues during that time period. PSEG pays annual property taxes to the City of Salem for the Energy and Environmental Resource Center, located in Salem. However, the tax payments for the Center would continue even if the licenses for Salem and HCGS were not renewed; therefore, these tax payments are not considered in the evaluation of tax revenue-related impacts during the license renewal term.

Since PSEG started making payments to the local jurisdiction, population levels and land use conditions in Lower Alloways Creek Township and Salem County have not changed significantly, which might indicate that these tax revenues have had little or no effect on land use activities within the township or county.

Since PSEG has no plans to add non-outage employees during the license renewal period, employment levels at Salem and HCGS would remain relatively unchanged. There would be no increase in the assessed value of Salem and HCGS, and annual property tax payments to Lower Alloways Creek Township would be expected to remain relatively constant throughout the license renewal period. Based on this information, there would be no tax revenue-related land-use impacts during the license renewal term beyond those already being experienced.

4.9.5 Public Services: Transportation Impacts

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

Since PSEG has no plans to add non-outage employees during the license renewal period, traffic volume and levels of service on roadways in the vicinity of Salem and HCGS would not change. Therefore, there would be no transportation impacts during the license renewal term beyond those already being experienced.

4.9.6 Historic and Archaeological Resources

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

A review of the New Jersey State Museum (NJSM) files shows that there are no previously recorded archaeological or above ground historic architectural resources identified on the Salem/Hope Creek property. As noted in Section 2.2.9.1, literature review and background research of the plant property was conducted as part of the applicant's ER; however, no systematic pedestrian or subsurface archaeological surveys have been conducted at the Salem/Hope Creek site to date. Background research identified 23 National Register of Historic Places listed resources within a 10 mi (16 km) radius of the facility; however, none are located within the boundaries of the Salem/Hope Creek property.

There is little potential for historic and archaeological resources to be present on most of the Salem/Hope Creek property. As noted in Section 2.2.9.2, due to the fact that the Salem and Hope Creek generating stations are located on a manmade island, there is little potential for prehistoric archaeological resources to be present. However, because the creation of the island dates to the historic period, there is potential for historic-period archaeological resources to be present in areas not previously disturbed by construction activities.

No new facilities, service roads, or transmission lines are proposed for the Salem/Hope Creek site as a part of this operating license renewal, nor are refurbishment activities proposed. Therefore, the potential for National Register eligible historic or archaeological resources to be impacted by renewal of this operating license is SMALL. Based on this conclusion there would be no need to review mitigation measures.

4.9.7 Environmental Justice

Under Executive Order (EO) 12898 (59 FR 7629), Federal agencies are responsible for identifying and addressing, as appropriate, potential disproportionately high and adverse human health and environmental impacts on minority and low-income populations. In 2004, the Commission issued a *Policy Statement on the Treatment of Environmental Justice Matters in NRC Regulatory and Licensing Actions* (69 FR 52040), which states, "The Commission is committed to the general goals set forth in EO 12898, and strives to meet those goals as part of its NEPA review process."

The Council of Environmental Quality (CEQ) provides the following information in *Environmental Justice: Guidance Under the National Environmental Policy Act* (CEQ, 1997):

> **Disproportionately High and Adverse Human Health Effects.**
>
> Adverse health effects are measured in risks and rates that could result in latent cancer fatalities, as well as other fatal or nonfatal adverse impacts on human health. Adverse health effects may include bodily impairment, infirmity, illness, or death. Disproportionately high and adverse human health effects occur when the risk or rate of exposure to an environmental hazard for a minority or low-income population is significant (as employed by NEPA) and appreciably exceeds the risk or exposure rate for the general population or for another appropriate comparison group (CEQ, 1997).

Disproportionately High and Adverse Environmental Effects.

> A disproportionately high environmental impact that is significant (as defined by NEPA) refers to an impact or risk of an impact on the natural or physical environment in a low-income or minority community that appreciably exceeds the environmental impact on the larger community. Such effects may include ecological, cultural, human health, economic, or social impacts. An adverse environmental impact is an impact that is determined to be both harmful and significant (as employed by NEPA). In assessing cultural and aesthetic environmental impacts, impacts that uniquely affect geographically dislocated or dispersed minority or low-income populations or American Indian tribes are considered (CEQ, 1997).

The environmental justice analysis assesses the potential for disproportionately high and adverse human health or environmental effects on minority and low-income populations that could result from the operation of Salem and HCGS during the renewal term. In assessing the impacts, the following definitions of minority individuals and populations and low-income population were used (CEQ, 1997):

Minority individuals

> Individuals who identify themselves as members of the following population groups: Hispanic or Latino, American Indian or Alaska Native, Asian, Black or African American, Native Hawaiian or Other Pacific Islander, or two or more races, meaning individuals who identified themselves on a Census form as being a member of two or more races, for example, Hispanic and Asian.

Minority populations

> Minority populations are identified when (1) the minority population of an affected area exceeds 50 percent or (2) the minority population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographic analysis.

Low-income population

> Low-income populations in an affected area are identified with the annual statistical poverty thresholds from the Census Bureau's Current Population Reports, Series P60, on Income and Poverty.

<u>Minority Population in 2000</u>

There are a total of 23 counties in the 50-mi (80-km) radius surrounding Salem and HCGS. Of these, seven are in New Jersey (Salem, Cumberland, Cape May, Atlantic, Gloucester, Camden and Burlington), three are in Delaware (New Castle, Kent and Sussex), six are in Pennsylvania (Philadelphia, Montgomery, Delaware, Chester, Lancaster, and York) and seven are in Maryland (Harford, Cecil, Baltimore, Kent, Queen Anne’s, Caroline and Talbot).

According to 2000 Census data, 35.1 percent of the population (1,872,783 persons) residing within a 80-km (50-mi) radius of Salem and HCGS identified themselves as minority individuals. The largest minority group was Black or African American (1,213,122 persons or 19.5 percent), followed by Asian (190,983 persons or 3.1 percent). A total of 341,886 persons (5.5 percent) identified themselves as Hispanic or Latino ethnicity (USCB, 2003).

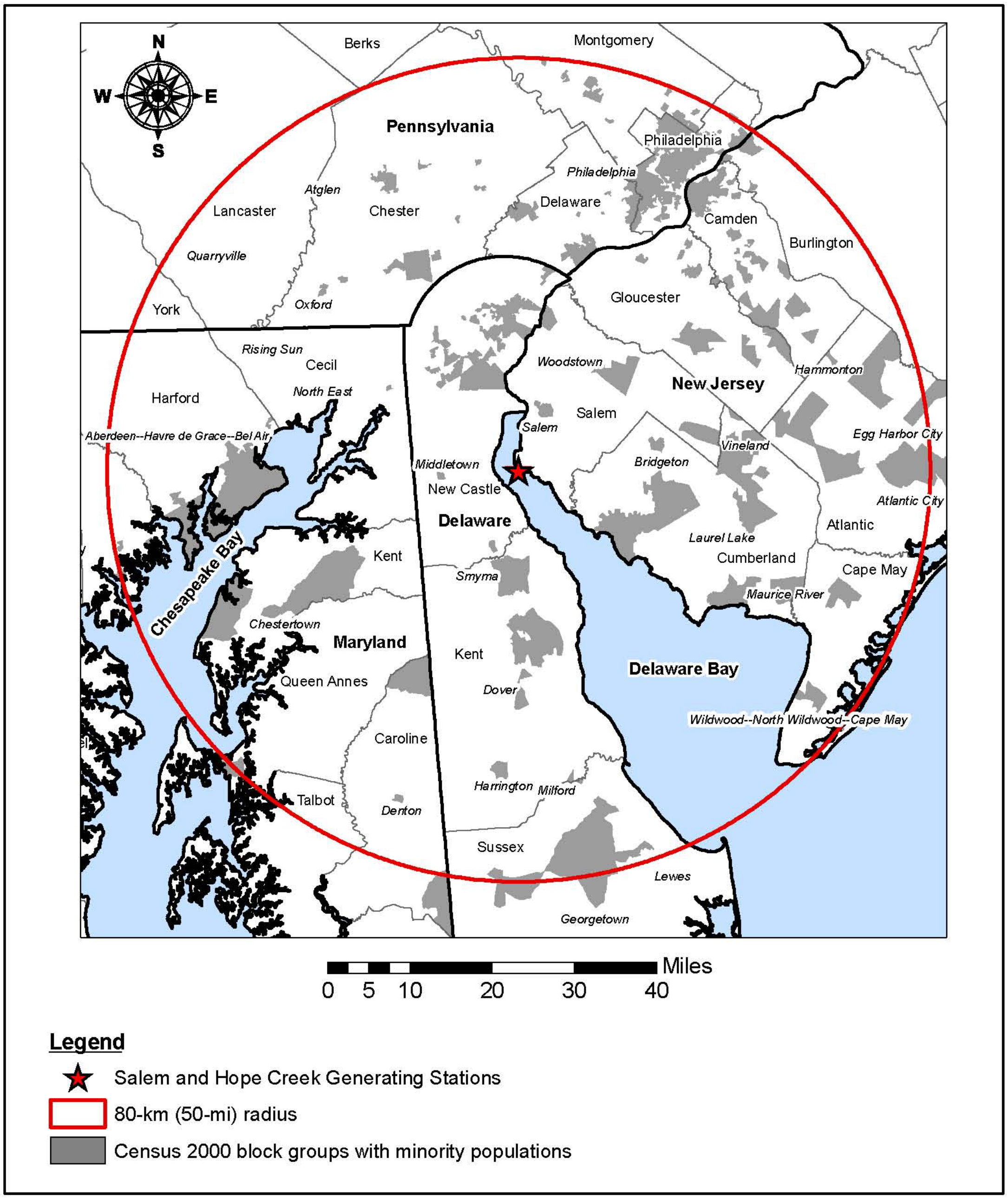
Of the 4,579 census block groups located wholly or partly within the 50-mi radius of Salem and HCGS, 1,860 block groups were determined to have minority population percentages that exceeded the 50-mi (80-km) radius percentage (USCB, 2000a). The largest minority group was Black or African American, with 1,284 block groups that exceed the 50-mi (80-km) radius percentage. These block groups are primarily located in Philadelphia County, Pennsylvania. There were 24 block groups with Asian, 94 block groups with Some Other Race, and 1 block group with Two or More Races minority classifications that exceeded the 50-mi (80-km) radius percentage. A total of 202 block groups exceeded the 80-km (50-mi) radius percentage for Hispanic or Latino ethnicity. The minority population nearest to Salem and HCGS is located in the City of Salem, New Jersey.

Based on 2000 Census data, Figure 4-7 shows minority block groups within an 50-mi (80-km) radius of Salem and HCGS.

<u>Low-Income Population in 2000</u>

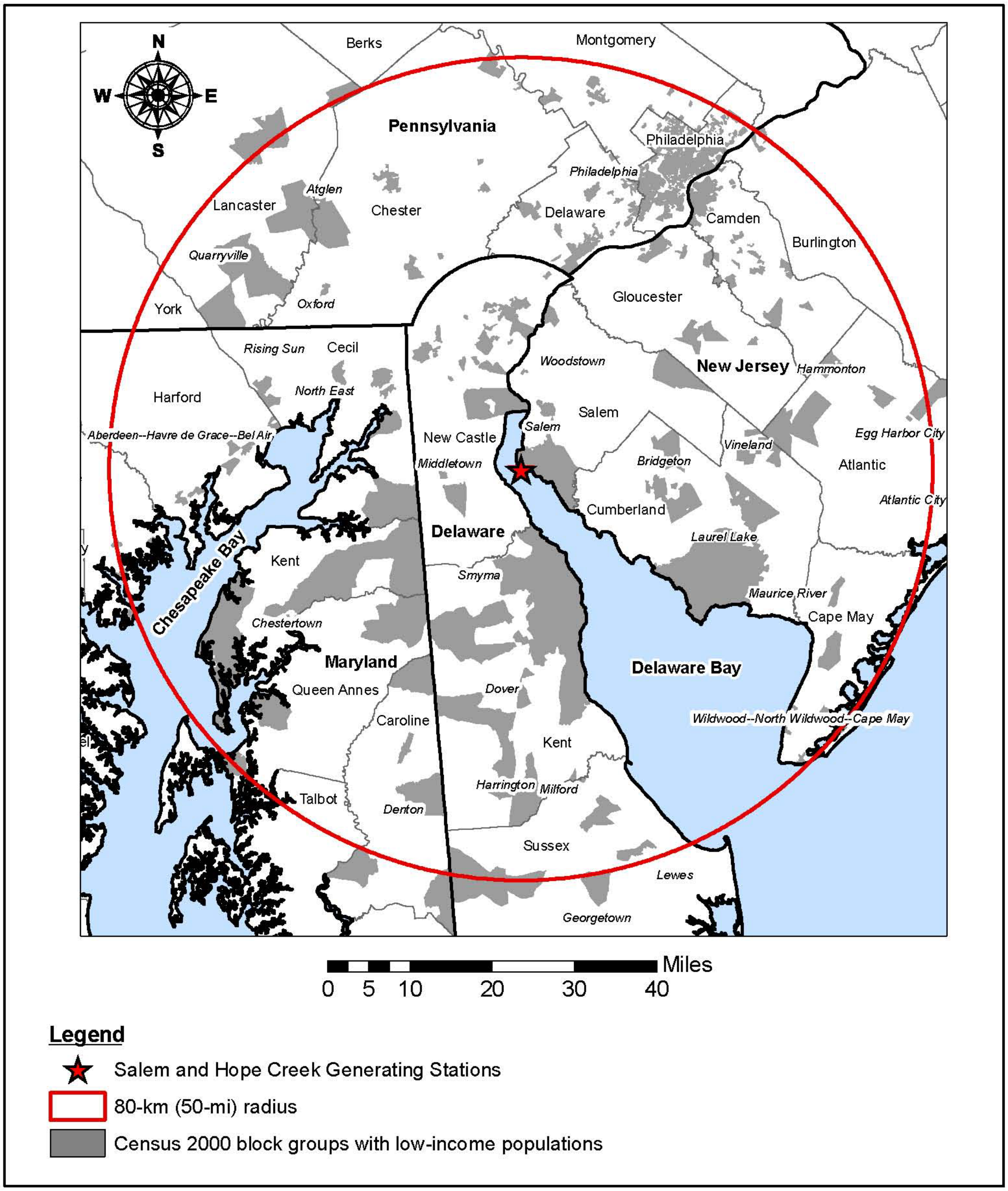
According to 2000 Census data, 119,283 families (2.2 percent) and 620,903 individuals (11.6 percent) residing within a 50-mi (80 km) radius of Salem and HCGS were identified as living below the Federal poverty threshold in 1999 (USCB, 2003). (The 1999 Federal poverty threshold was $17,029 for a family of four). The USCB reported 6.3 percent of families and 8.5 percent of individuals in New Jersey, 6.5 percent of families and 9.2 percent of individuals in Delaware, 7.8 percent of families and 11.0 percent of individuals in Pennsylvania, and 6.1 percent of families and 8.5 percent of individuals in Maryland living below the Federal poverty threshold in 1999 (USCB, 2000a; 2000b).

Census block groups were considered low-income block groups if the percentage of families and individuals living below the Federal poverty threshold exceeded the 50-mi (80 km) radius percentage. Based on 2000 Census data, there were 1,778 block groups within a 50-mi (80 km) radius of Salem and HCGS that could be considered low-income block groups. The majority of low-income population census block groups were located in Philadelphia County, Pennsylvania. The low-income population nearest to Salem and HCGS is located in Lower Alloways Creek Township in Salem County, New Jersey. Figure 4-8 shows low-income census block groups within a 50-mi (80 km) radius of Salem and HCGS.



Source: USCB, 2003

Figure 4-7. Census 2000 minority block groups within a 50-mi radius of Salem and HCGS



Source: USCB, 2003

Figure 4-8. Census 2000 low-income block groups within a 50-mi radius of Salem and HCGS

Analysis of Impacts

The NRC addresses environmental justice matters for license renewal through (1) identification of minority and low-income populations that may be affected by the proposed license renewal, and (2) examining any potential human health or environmental effects on these populations to determine if these effects may be disproportionately high and adverse.

The discussion and figures above indentifies the location of minority and low-income populations residing within a 50-mile (80-kilometer) radius of Salem and HCGS. This area of impact is consistent with the impact analysis for public and occupational health and safety, which also considers the radiological effects on populations located within a 50-mile (80-kilometer) radius of the plant. As previously discussed for the other resource areas in Chapter 4, the analyses of impacts for all resource areas indicated that the impact from license renewal would be SMALL.

Chapter 5 discusses the environmental impacts from postulated accidents that might occur during the license renewal term, which include both design basis and severe accidents. In both cases, the Commission has generically determined that impacts associated with such accidents are SMALL because nuclear plants are designed to successfully withstand design basis accidents, and that any risk associated with severe accidents were also SMALL.

Therefore, based on the overall findings discussed in Chapters 4 and 5, the NRC concludes that there would be no disproportionately high and adverse impacts to minority and low-income populations from the continued operation of Salem and HCGS during the license renewal term.

As part of addressing environmental justice associated with license renewal, the Staff also analyzed the risk of radiological exposure through the consumption patterns of special pathway receptors, including subsistence consumption of fish and wildlife, native vegetation, surface waters, sediments, and local produce; absorption of contaminants in sediments through the skin; and inhalation of plant materials. The special pathway receptors analysis, discussed below, is important to the environmental justice analysis because consumption patterns may reflect the traditional or cultural practices of minority and low-income populations in the area.

Subsistence Consumption of Fish and Wildlife

Section 4-4 of EO 12898 (59 FR 7629) directs Federal agencies, whenever practical and appropriate, to collect and analyze information on the consumption patterns of populations that rely principally on fish and/or wildlife for subsistence and to communicate the risks of these consumption patterns to the public. In this draft SEIS, the Staff considered whether there were any means for minority or low-income populations to be disproportionately affected by examining impacts to American Indian, Hispanic, and other traditional lifestyle special pathway receptors. Special pathways that took into account the levels of contaminants in native vegetation, crops, soils and sediments, surface water, fish, and game animals on or near Salem and HCGS were considered.

PSEG has an ongoing comprehensive Radiological Environmental Monitoring Program (REMP) at Salem and HCGS to assess the impact of site operations on the environment (see section 4.8.2 of this draft SEIS for a complete discussion of the REMP). To assess the impact of the plant on the environment, samples of environmental media are collected and analyzed for radioactivity. A plant effect would be indicated if the radioactive material detected in a sample was significantly larger than the background level.

The REMP measures the aquatic, terrestrial, and atmospheric environment for radioactivity, as well as the ambient radiation. In addition, the REMP measures background radiations (i.e., cosmic sources, global fallout, and naturally occurring radioactive material, including radon). Ambient radiation pathways include radiation from radioactive material inside buildings and plant structures and airborne material that may be released from the plants. Thermoluminescent dosimeters (TLDs) are used to measure ambient radiation. The atmospheric environmental monitoring consists of sampling and analyzing the air for radioactive particulates and radioiodine. The aquatic pathways include fish, surface water, fish, crabs, and sediment. The terrestrial environmental monitoring consists of analyzing locally grown vegetables and fodder crops, drinking water, groundwater, meat, and milk. During 2009, analyses performed on samples of environmental media showed no significant or measurable radiological impact above background levels from Salem and HCGS site operations (PSEG, 2010b). The 2009 Salem and Hope Creek REMP report is incorporated by reference in this SEIS.

Previously, PSEG had also tested muskrat populations in the area. Muskrats are trapped and consumed by the local population (PSEG, 2006c). As of 2006, no muskrat samples have been available for testing as the trappers who were supplying PSEG with samples were no longer operating (PSEG, 2007c). The last muskrat data was collected in 2005; only one sample detectable levels of potassium-40; no other radionuclides were detected (PSEG, 2006c).

The results of the 2009 REMP sampling and previous REMP reports (including the consideration of 2005 REMP muskrat data) demonstrate that the routine operation at Salem and HCGS has had no significant or measurable radiological impact on the environment. No elevated radiation levels have been detected in the offsite environment as a result of plant operations and the storage of radioactive waste.

The NJDEP's Bureau of Nuclear Engineering performs an independent Environmental Surveillance and Monitoring Program (ESMP) in the environment around the Salem and Hope Creek Nuclear Generating Stations. The ESMP provides a comprehensive monitoring strategy that ensures that New Jersey citizens are aware of and, if necessary, protected from harmful exposure to radioactive effluent discharges from New Jersey's nuclear power plants during normal or accident operations.

The specific objectives of the ESMP are to monitor pathways for entry of radioactivity into the environment in order to identify potential exposures to the population from routine and accidental releases of radioactive effluent, and to provide a summary and interpretation of this information to members of the public and government agencies.

The NRC reviewed the NJDEP's 2008 report (the most recent report available at the time this draft SEIS was prepared) which contains information on the environmental sampling conducted during the time period of January 1, 2008 through December 31, 2008. The State reported the following: "Overall, the data collected by the NJDEP's ESMP throughout 2008 indicate that residents living in the area around Oyster Creek and Salem/Hope Creek nuclear power plants have not received measurable exposures of radiation above normal background" (NJDEP, 2009a).

Additionally, NJDEP BNE monitors the groundwater on site at Artificial Island in conjunction with the remedial action being undertaken by PSEG to address tritium contamination detected in shallow groundwater near Salem Unit 1. There is no evidence that the tritium has reached any areas outside of the PSEG property. Analyses of fish, shellfish, vegetation, and sediment samples contained only potassium-40, a naturally-occurring radionuclide. Trace amounts of strontium-90 were detected in all milk samples, at levels consistent with what is expected as a result of past atmospheric nuclear weapons testing (NJDEP, 2009b).

Based on these and previous monitoring results, concentrations of radioactive contaminants in native leafy vegetation, sediments, surface water, and fish and game animals in areas surrounding Salem and HCGS have been low. Consequently, no disproportionately high and adverse human health impacts would be expected in special pathway receptor populations in the region as a result of subsistence consumption of fish and wildlife.

4.10 Evaluation of Potential New and Significant Information

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

The new and significant assessment that PSEG conducted during preparation of this license renewal application included: (1) interviews with PSEG subject matter experts on the validity of the conclusions in the GEIS as they relate to Salem and HCGS, (2) an extensive review of documents related to environmental issues at Salem and HCGS and within the Delaware Estuary, (3) correspondence with state and federal agencies to determine if the agencies had concerns relevant to their resource areas that had not been addressed in the GEIS, (4) credit for PSEG environmental monitoring and reporting required by regulations and oversight of station facilities and operations by state and federal regulatory agencies (permanent activities that would bring significant issues to PSEG's attention), and (5) review of previous license renewal applications for issues relevant to the Salem and HCGS license renewal applications.

The NRC also has a process for identifying new and significant information. That process is described in NUREG-1555, Supplement 1, *Standard Review Plans for Environmental Reviews for Nuclear Power Plants, Supplement 1: Operating License Renewal* (NRC, 1999b). The search for new information includes: (1) review of an applicant's ER and the process for discovering and evaluating the significance of new information; (2) review of records of public comments; (3) review of environmental quality standards and regulations; (4) coordination with Federal, State, and local environmental protection and resource agencies, and (5) review of the technical literature. New information discovered by the Staff is evaluated for significance using the criteria set forth in the GEIS. For Category 1 issues where new and significant information is identified, reconsideration of the conclusions for those issues is limited in scope to the assessment of the relevant new and significant information; the scope of the assessment does not include other facets of an issue that are not affected by the new information.

The Staff has not identified any new and significant information on environmental issues listed in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, related to the operation of Salem and HCGS during the period of license renewal. PSEG stated in its Environmental Reports for Salem and HCGS that it is not aware of any new and significant information regarding the environment or plant operations. However, as part of its investigation for new and significant information, PSEG evaluated information about tritium in the groundwater beneath the Salem site. Based on that evaluation, PSEG has concluded that changes in groundwater quality due to the tritium are not significant at Salem and would not preclude current or future uses of the groundwater. The Staff evaluated the applicant's information in section 4.8.2 and agrees that the tritium in the groundwater is not new and significant information. The Staff also determined that information provided during the public comment period did not identify any new issues that require site-specific assessment. The Staff reviewed the discussion of environmental impacts in the GEIS (NRC, 1996) and conducted its own independent review (including two public scoping meetings held in November 2009) to identify new and significant information. The Staff concludes that there are no new and significant information related to the environmental impacts of the Salem and HCGS license renewal.

4.11 Cumulative Impacts

The Staff considered potential cumulative impacts in the environmental analysis of continued operation of Salem and HCGS. For the purposes of this analysis, past actions are those related to the resources at the time of the power plants licensing and construction; present actions are those related to the resources at the time of current operation of the power plants; and future actions are considered to be those that are reasonably foreseeable through the end of plant operations including the period of extended operation. Therefore, the analysis considers potential impacts through the end of the current license terms as well as the 20-year renewal license renewal terms. The geographic area over which past, present, and future actions would occur depend on the type of action considered and is described below for each impact area.

4.11.1 Cumulative Impact on Water Resources

For the purposes of this cumulative impact assessment, the spatial boundary of the groundwater system is the PRM Aquifer, which is a large aquifer of regional importance for municipal and domestic water supply. Although other aquifers (the shallow water-bearing zone, Vincentown Aquifer, and Mt. Laurel-Wenonah Aquifer) underlie the Salem and HCGS facilities, almost all groundwater use by the facilities is from the PRM Aquifer. The spatial boundary for potential cumulative surface water impacts is the Delaware River Basin.

Actions that can impact groundwater and surface water resources in the region include overuse of groundwater resources, unregulated use of water resources, drought impacts, and the need for flow compensation in the Delaware River for consumptive water use.

Within the Salem and HCGS local area, groundwater is not accessed for public or domestic water supply within 1 mi (1.6 km) of the Salem and HCGS facilities (PSEG, 2009a; 2009b). However, groundwater is the primary source of municipal water supply within Salem and the surrounding counties, and groundwater within the PRM Aquifer is an important resource for water supply in a region extending from Mercer and Middlesex counties in New Jersey to the north, and towards Maryland to the southwest. Groundwater withdrawal from the early part of the twentieth century through the 1970s resulted in the development of large-scale cones of depression in the elevation of the piezometric surface, and therefore had a cumulative adverse impact on the availability of groundwater within the aquifer (Walker, 1983). In reaction to this impact, NJDEP implemented water management measures, including limitations on pumping. As of 1998, NJDEP-mandated decreases in water withdrawals had resulted in general recovery of water level elevations in both the Upper and Middle PRM Aquifers in the Salem County area

(USGS, 2009). Therefore, the use of groundwater by the facilities is not contributing to a cumulative effect on local groundwater users or larger regional users. Based on these observations, the Staff concludes that, when added to the groundwater usage from other past, present, and reasonably foreseeable future actions, the cumulative impact on groundwater use is SMALL.

Although the Salem and HCGS facilities use surface water from the Delaware River for cooling purposes, the Delaware River is a tidal estuary at the facility location. Therefore, there is no potential for cumulative surface water use conflicts, and the cumulative impact on surface water use is SMALL.

4.11.2 Cumulative Impacts on Estuarine Aquatic Resources

This section addresses past, present, and future actions that have created or could result in cumulative adverse impacts on the aquatic resources of the Delaware Estuary, the geographic area of interest for this analysis. Cumulative impacts on freshwater aquatic resources other than the Delaware River are discussed with terrestrial resources in Section 4.11.3. A wide variety of historical events have cumulatively affected the Delaware Estuary and its resources (Delaware Estuary Program 1995). Europeans began settling the estuary region early in the 17th century. By 1660 the English had established multiple small settlements, and major changes in the environment began. Philadelphia had 5,000 inhabitants by 1700 and became the predominant city and port in America. Agriculture grew throughout the region, 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 during and after World War II 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 through the 1980s as a result of State, multi-State, and Federal action, including the Clean Water Act and the activities of the Delaware River Basin Commission. (Delaware Estuary Program, 1995)

In addition to past events, a variety of current and likely future activities and processes also have cumulative impacts on the aquatic resources of the Delaware Estuary to which the proposed action may contribute. Stressors associated with the proposed action and other activities or processes that may contribute to cumulative impacts on the aquatic resources of the estuary include the following:

- continued operation of the once-through cooling system for Salem Units 1 and 2
- continued operation of the closed-cycle cooling system for HCGS
- construction and operation of proposed additional unit at Salem/HCGS site
- continued withdrawal and discharge of water to support power generation, industry, and municipal water suppliers
- fishing pressure

- habitat loss and restoration
- changes in water quality
- climate change.

Each of these stressors may influence the structure and function of estuarine food webs and result in observable changes to the aquatic resources in the Delaware Estuary. In most cases, it is not possible to determine quantitatively the impact of individual stressors or groups of stressors on aquatic resources. The stressors affect the estuary simultaneously, and their effects are cumulative. A discussion follows of how the stressors listed above may contribute to cumulative impacts on aquatic resources of the Delaware Estuary.

<u>Continued Operation of the Salem Once-Through Cooling System</u>

Based on the assessment presented in Section 4.5 of this draft SEIS, the Staff concluded that entrainment, impingement, and thermal discharge impacts on aquatic resources from the operation of Salem Units 1 and 2 collectively have not had a noticeable adverse effect on the balanced indigenous community of the Delaware Estuary in the vicinity of Salem. The continued operation of Salem during the renewal term would continue to contribute to cumulative impacts on the estuarine community of fish and shellfish. As discussed in Sections 4.5.2 through 4.5.5, there has been extensive, long-term monitoring of fish and invertebrate populations of the Delaware Estuary. The data collected by these studies reflect the cumulative effects of multiple stressors acting on the estuarine community. For example, data from 1970 through 2004 were analyzed using commonly accepted techniques for assessing species richness (the average number of species in the community) and species density (the average number of species per unit volume or area). This analysis found that in the vicinity of Salem and HCGS since 1978, when Salem began operation, finfish species richness has not changed, and species density has increased (PSEG, 2006c). Operation of Salem during the relicensing period likely would continue to contribute substantially to cumulative impacts on aquatic resources in conjunction with HCGS and other facilities that withdraw water from or discharge to the Delaware Estuary. However, given the long-term improvements in the estuarine community during recent decades while these facilities were operating, NRC expects their cumulative impacts are expected to be limited, with effects on individual species populations potentially ranging from negligible to noticeable.

<u>Continued Operation of the HCGS Closed-Cycle Cooling System</u>

As discussed in Section 4.5.1, the closed-cycle cooling system used by HCGS substantially reduces the volume of water withdrawn by the facility and substantially reduces entrainment, impingement, and thermal discharge effects compared to the Salem once-through cooling system. Accordingly, the impacts of these effects from operation of the HCGS cooling system during the relicensing period would be limited, and the incremental contribution of HCGS to cumulative impacts on the estuarine community would be minimal. HCGS has operated in conjunction with Salem since 1986 and the community has been simultaneously affected by both facilities. Therefore, the analysis of Salem's effects on the aquatic community discussed above incorporates the cumulative effects of both HCGS and Salem. Operation of HCGS during the relicensing period would continue to contribute to cumulative impacts in conjunction with Salem and other facilities that withdraw water from or discharge to the Delaware Estuary. As described above for Salem, NRC expects these cumulative impacts are expected to be limited, with effects on individual species populations potentially ranging from negligible to noticeable.

Construction and Operation of Proposed Additional Unit at Salem/HCGS Site

On May 25, 2010, PSEG submitted to NRC an application for an Early Site Permit for the possible construction and operation of a new nuclear facility with two reactor units on Artificial Island adjacent to Salem and HCGS (PSEG, 2010a). The projected start of construction would be in 2016 (NRC, 2010). If PSEG decides to proceed and construct a new nuclear power facililty at the Salem/HCGS site, it would contribute to cumulative impacts on aquatic resources during construction and operation. The impacts of this action on aquatic resources during the construction period may be substantial in the immediate vicinity of the construction activities, but would be limited in extent and unlikely to significantly contribute to cumulative impacts on the estuarine community in conjunction with the ongoing operation of Salem and HCGS. Given the planned use of a closed-cycle cooling system for the new facility, the impacts on aquatic resources from its operation likely would be similar to those of HCGS and substantially smaller than those of Salem. Nevertheless, the long-term operation of the new facility would add to the cumulative impacts on the estuarine community from Salem and HCGS during the period in which their operations overlap.

NRC concluded in the GEIS that impacts on aquatic ecology are Category 1 issues at individual power plants with closed-cycle cooling systems, such as the system at HCGS and the system planned for the new facility. The Staff concludes in this SEIS (see Section 4.5.5) that impacts on aquatic ecology from the collective effects of entrainment, impingement, and heat shock at Salem during the renewal term would be SMALL. Thus, the incremental contributions of each of the three facilities to impacts on aquatic resources would be minor. However, it is possible that, depending on the characteristics of the new facility, their cumulative impacts could alter an important attribute of the Delaware Estuary, such as certain fish populations, to a noticeable degree.

The specific impacts of this action ultimately would depend on the actual design, operating characteristics, and construction practices proposed by the applicant. Such details are not available at this time. However, if a combined license application is submitted to NRC, the detailed impacts of this additional unit adjacent to the site of the existing Salem and HCGS units then would be analyzed and addressed in a separate NEPA document prepared by NRC.

Continued Water Withdrawals and Discharges

No large industrial facilities lie downstream of Artificial Island on either side of the estuary south to the mouth of Delaware Bay. An oil refinery lies upstream of Artificial Island in Delaware approximately 8 mi (13 km) to the north, and many industrial facilities are upstream from there (PSEG, 2009a). Many of these facilities are permitted to withdraw water from the river and to discharge effluents to the river. In addition, water is withdrawn from the nontidal, freshwater reaches of the river to supply municipal water throughout New Jersey, Pennsylvania, and New York (DRBC, 2010). In the tidal portion of the river, water is used for power plant cooling systems as well as industrial operations. DRBC-approved water users in this reach include 22 industrial facilities and 14 power plants in Delaware, New Jersey, and Pennsylvania (DRBC, 2005). Of these facilities, Salem uses by far the largest volume of water, with a reported water withdrawal volume in 2005 of 1,067,892 million gallons (4,042 million m^3) (DRBC, 2005). This volume exceeds the combined total withdrawal for all other industrial, power, and public water supply purposes in the tidal portion of the river. The volume of water withdrawn by HCGS in 2005 was much lower, at 19,561 million gallons (74 million m^3) (DRBC, 2005).

These activities will likely continue into the future, and water supply withdrawals likely will increase in the future in conjunction with population growth. Because water withdrawals from the Delaware River will continue, and are likely to increase, during the relicensing term, this activity will continue to contribute to cumulative effects in the estuary. Similarly, ongoing discharges of effluents to the river and estuary will continue to have cumulative effects. Withdrawals and discharges are regulated by Federal and State agencies as well as by the DRBC, and such regulation should limit the magnitude of their effects. Permit requirements are expected to limit adverse effects from withdrawals and discharges, and cumulative impacts from these activities on the aquatic resources of the Delaware Estuary are expected to be minimal.

Fishing Pressure

The majority of the RS and EFH species at Salem are commercially or recreationally important and, thus, are subject to effects from the harvesting of fish stocks. Losses from fish populations due to fishing pressure are cumulative in conjunction with losses due to entrainment and impingement at Salem and HCGS as well as other water intakes. In most cases, Federal or State agencies regulate the commercial or recreational catches of RS are regulated by Federal or State agencies, but losses of some RS continue to occur as bycatch caught unintentionally when fishing for other species. The extent and magnitude of fishing pressure and its relationship to cumulative impacts on fish populations and the overall aquatic community of the Delaware Estuary are difficult to determine because of the large geographic scale of the fisheries and the natural variability that occurs in fish populations and the ecosystem. Fishing pressure (and protection of fisheries through catch restrictions) has the potential to influence the food web of the Delaware Estuary by affecting fish and invertebrate populations in areas extending from the Atlantic Ocean and Delaware Bay through the estuary and upriver.

Habitat Loss and Restoration

As described above, alterations to terrestrial, wetland, shoreline, and aquatic habitats have occurred in the Delaware Estuary since colonial times. Development, agriculture, and other upland habitat alterations in the watershed have affected water quality. The creation of dams and the filling or isolation of wetlands to support industrial and agricultural activities has dramatically changed patterns of nutrient and sediment loading to the estuary. Such activities also have reduced productive marsh habitats and limited access of anadromous fish to upstream spawning habitats. In addition, historic dredging and deposition activities have altered estuarine environments and affected flow patterns, and future activities, such as dredging to deepen the shipping channel through the estuary, may continue to influence estuarine habitats. Development along the shores of the estuary in some places also has resulted in the loss of shoreline habitat.

Although habitat loss in the vicinity of the Delaware Estuary continues to occur currently and is likely in the future, habitat restoration activities have had a beneficial effect on the estuary and are expected to continue as a requirement of the Salem NJPDES permit during the license renewal term (see Section 4.5.5). In addition, NRC expects wetland permitting regulations to limit future losses of wetland habitat from development in the watershed. Thus, the net cumulative impacts on aquatic habitats associated with the estuary are likely to be minimal in the future, and restoration activities are expected to provide ongoing habitat improvements.

Water Quality

In general, there is evidence that water quality in the Delaware River Basin, including the estuary, is improving. Upgrades to wastewater treatment facilities and improved agricultural practices during the past 25 years have reduced the amount of untreated sewage, manure, and fertilizer entering the river and contributed to reductions in nutrients and an apparent increase in dissolved oxygen. Chemical contaminants persist in sediments and the tissues of fish and invertebrates, and nonpoint discharges of chemicals still occur (Kauffmann et al, 2008). Water quality in the Delaware Estuary likely will continue to be adversely affected by human activities; however, improvement may continue in many water quality parameters, and the incremental contribution of Salem and HCGS to adverse effects on water quality is expected to be minimal.

Climate Change

The potential cumulative effects of climate change on the Delaware Estuary, whether from natural cycles or related to anthropogenic activities, could result in a variety of environmental alterations that would affect aquatic resources. The environmental changes that could affect estuarine systems include sea level rise, temperature increases, salinity changes, and wind and water circulation changes. Changes in sea level could result in dramatic effects on tidal wetlands and other shoreline communities. Water temperature increases could affect spawning patterns or success, or influence species distributions when cold-water species move northward while warm-water species become established in new habitats. Changes in estuarine salinity patterns could influence the spawning and distribution of RS and the ranges of exotic or nuisance species. Changes in precipitation patterns could have major effects on water circulation and alter the nature of sediment and nutrient inputs to the system. This could result in changes to primary production and influence the estuarine food web on many levels. Thus, the extent and magnitude of climate change impacts may make this process an important contributor to cumulative impacts on the aquatic resources of the Delaware Estuary, and these impacts could be substantial over the long term.

Final Assessment of Cumulative Impacts on Aquatic Resources

Aquatic resources of the Delaware 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 RS and other species have been substantially affected by these stressors historically. The impacts of some of these stressors associated with human activities have been and can be addressed by management actions (e.g., cooling system operation, fishing pressure, water quality, 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 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. Based on this assessment, the Staff concludes that cumulative impacts during the relicensing period from past, present, and future stressors affecting aquatic resources in the Delaware Estuary would range from MODERATE to LARGE. The incremental contributions specifically from the continued operation of Salem and HCGS to impacts on aquatic resources of the estuary would be SMALL for most impacts.

4.11.3 Cumulative Impacts on Terrestrial and Freshwater Resources

This section addresses past, present, and future actions that could result in adverse cumulative impacts on terrestrial resources, including resources associated with uplands, wetlands, and bodies of freshwater other than the Delaware River (discussed in Section 4.11.2). For the purpose of this analysis, the geographic area of interest includes the Salem and HCGS site on Artificial Island and the associated transmission line ROWs identified in Section 2.1.5.

Impacts on terrestrial and freshwater resources in the area began with historical settlement and development by Europeans, which involved clearing of forests and filling and draining of wetlands for agriculture. Colonial settlement of the Delaware River area of southern New Jersey began in 1638. During the 1640s, a fortification, Fort Elfsborg, was built in an area that previously was mostly swampland between Salem and Alloway Creek. As settlement progressed, forested regions in this part of southern New Jersey were further cleared for towns, farming, and lumber (Morris Land Conservancy, 2006). Tidal marshes along the margins of the Delaware Estuary were managed for salt hay farms and other agricultural uses, the hydrology of marshes was altered for mosquito control, and marshes were filled for disposal of dredged material and for development (Philipp, 2005). Industrial development in the area began with the glassmaking industry in the early 1700s and continued through the 1800s (Morris Land Conservancy, 2006). The Industrial Revolution and other historical trends continued the changes in land use and the loss of terrestrial communities of native vegetation and wildlife.

The Salem and HCGS facilities are located within 740 ac (300 ha) of PSEG property on 1,500-ac (600 ha) Artificial Island. Construction of Salem and HCGS converted 373 ac (151 ha) in the southwest corner of Artificial Island to facilities and industrial uses. Artificial Island was originally created by deposition of hydraulic dredge material in the early 20th century, and all terrestrial resources on the island have become established since then. Before development of the land on the Salem and HCGS sites, the vegetative communities of the island consisted mainly of typical coastal tidal marsh species, including salt-tolerant grasses such as cordgrass (*Spartina* spp.) and common reed (*Phragmites australis)*, which could survive in the brackish habitats. There was no known previous development or use of Artificial Island prior to the construction of Salem and HCGS. Currently, the Salem and HCGS sites are developed and maintained for operation of the facilites. The remainder of Artificial Island consists mainly of undeveloped areas of tidal marsh with poor quality soils and very few trees. Non-wetland areas are vegetated mainly with grasses, small shrubs, and planted trees in developed areas (PSEG, 2009a; 2009b).

Construction of the transmission line ROWs maintained by PSEG for Salem and HCGS resulted in subsequent changes to the wildlife and plant species present within the vicinity of Artificial Island and along the length of the transmission line ROWs. The transmission lines ROWs have a total length of approximately 149 mi (240 km) and occupy approximately 4,376 ac (1,771 ha). The three ROWs for the Salem and HCGS power transmission system pass through a variety of habitat types, including marshes and other wetlands, agricultural or forested land, and some urban and residential areas (PSEG, 2009a; 2009b). Fragmentation of the previously contiguous forested, agricultural, and swamp areas that the transmission ROWs traverse likely resulted in edge effects such as changes in light, wind, and temperature; changes in abundance and distribution of interior species; reduced habitat ranges for certain species; and an increased susceptibility to invasive species, such as multiflora rose (*Rosa multiflora*) in uplands, purple loosestrife (*Lythrum salicaria*) in wetlands, and Japanese stiltgrass (*Microstegium vimineum*) in both habitat types (NJDEP, 2004a). ROW maintenance is likely to continue to have future impacts on terrestrial habitat, such as prevention of natural succession stages within the ROWs, increases in edge species, and decreases in interior species.

Land use data provide an indication of the impacts on terrestrial resources that have resulted from historical and ongoing development. Current land uses in the region are discussed by county in Section 2.2.8.3 of this draft SEIS. In Salem County, based on 2008 data, farmland under active cultivation is the predominant type of land cover (42 percent), followed by tidal and freshwater wetlands (30 percent), forests (12 percent), residential/commercial/industrial uses (13 percent), and other undeveloped natural areas (3 percent) (Morris Land Conservancy, 2006). In the two adjacent counties in New Jersey (Cumberland and Gloucester), agriculture accounts for 19 and 26 percent of the land cover, and urban land use in the two counties was 12 percent and 26 percent, respectively (DVRPC, 2009; Gloucester County, 2009). Thus, commercial and industrial facilities, including the Salem and HCGS site and ROWs, have had a smaller impact on the loss of native terrestrial forest and wetland habitats in the region compared to agricultural development.

Although development of PSEG property on Artificial Island has had minimal impact on terrestrial resources as compared to historical and ongoing development in the region, portions of both PSEG land and the island have been protected from development. Approximately 25 percent (100 ac [40 ha]) of PSEG property and approximately 80 percent (1,200 ac [485 ha]) of Artificial Island remain undeveloped. These areas consist predominantly of estuarine marsh and freshwater emergent marsh, wetlands, and ponds. The U.S. government owns the portions of the island adjacent to Salem and HCGS (to the north and east), while the State of New Jersey owns the rest of the island as well as much nearby inland property (LACT,1988a; 1988b; PSEG 2009a; 2009b). In conjunction with the Artificial Island wetlands, public lands in the region also preserve forest and wetland habitat and have a beneficial cumulative impact on terrestrial resources. In compliance with Salem's 1994 and 2001 NJPDES permits, PSEG implemented the EEP, which has preserved and/or restored more than 20,000 ac (8,000 ha) of wetland and adjoining upland buffers around the Delaware Estuary. In particular, the program restored 4,400 ac (1,780 ha) of formerly diked salt hay farms to reestablish conditions suitable for the growth of low marsh vegetation such as saltmarsh cord grass (*Spartina alterniflora*) and provide for tidal exchange with the estuary (PSEG, 2009a).

PSEG has indicated the possibility of constructing one or two new reactor units at the Salem and HCGS site on Artificial Island (PSEG, 2010b) which would be primarily located on previously disturbed land adjacent to the existing Salem and HCGS units. It is not know at this time whether new transmission lines would be constructed. If additional ROW needs to be cleared, terrestrial habitats and the wildlife they support could potentially be affected in the areas it would traverse.

The Staff concluded in Sections 4.6 and 4.7 that the the continued operation of Salem and HCGS, including the operation and maintenance of the transmission line ROWs, would have minimal impacts and would not contribute to the overall decline in the condition of terrestrial resources. However, while the level of impact due to direct and indirect impacts of Salem and HCGS on terrestrial communities is SMALL, the cumulative impacts of historical, ongoing, and future developments in the region combined, as discussed above, would be MODERATE.

4.11.4 Cumulative Human Health Impacts

The radiological dose limits for protection of the public and workers have been developed by the NRC and EPA to address the cumulative impact of acute and long-term exposure to radiation and radioactive material. These dose limits are codified in 10 CFR Part 20 and 40 CFR Part 190. For the purpose of this analysis, the area within a 50-mi (80.4-km) radius of the Salem and HCGS site was included. The radiological environmental monitoring program conducted by PSEG in the vicinity of the Salem and HCGS site measures radiation and radioactive materials from all sources (i.e., hospitals and other licensed users of radioactive material); therefore, the monitoring program measures cumulative radiological impacts. Within the 50-mi (80-km) radius of the Salem and HCGS site, there are no other nuclear power reactors or uranium fuel cycle facilities.

On May 25, 2010 PSEG submitted an application for an Early Site Permit (ESP) for the possible construction of one or two reactor units at the Salem and HCGS site (PSEG 2010a). A specific reactor design has not been selected; therefore, the application uses a plant parameter envelope approach to evaluate the suitability of the site based on the potential environmental impacts from a blend of reactor types. This approach uses surrogate values as upper and lower bounds for issues such as power level, radioactive effluents, public dose estimates, thermal discharges, air quality, and accident consequences, for each of the potential reactor designs being considered. This is a conservative approach allowed by the NRC for the analysis of the environmental impacts from an unspecified reactor design at a specific location. A final decision by the applicant on the reactor design will be deferred until the submission of an application for either a construction permit or a combined construction permit and operating license.

The NRC will evaluate the ESP application in accordance with its regulations to ensure the application meets the NRC requirements for adequate protection and safety of the public and the environment. As discussed above, any new potential source of radioactive emissions from such a facility will be evaluated during its licensing process to address the cumulative impact of acute and long-term exposure to radiation and radioactive material.

The applicant constructed an independent spent fuel storage installation (ISFSI) on the Salem and HCGS site in 2007 for the storage of its spent fuel. Currently, only spent fuel from HCGS is being stored in the ISFSI. The installation and monitoring of this facility is governed by NRC requirements in 10 CFR Part 72, “Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor-Related Greater Than Class C Waste.” Radiation from this facility as well as from the operation of Salem and HCGS are required to be within the radiation dose limits in 10 CFR Part 20, 40 CFR Part 190, and 10 CFR Part 72. The NRC performs periodic inspections of the ISFSI and Salem and HCGS to verify their compliance with licensing and regulatory requirements.

Radioactive effluent and environmental monitoring data for the five-year period from 2005 to 2009 were reviewed as part of the cumulative impacts assessment. These reports show that past and current annual radiological doses to a maximally exposed member of the public at the site boundary are well below regulatory dose limits. In Section 4.8 the Staff concluded that impacts of radiation exposure to the public and workers from operation of Salem and HCGS during the renewal term are SMALL. The possible addition of one or two reactor units to the three-reactor site is not expected to result in any substantial increases in doses that would cause the cumulative dose impact to approach regulatory limits. This is because the reactor would be required to maintain its radiological release within NRC's dose limits for individual reactor units and the cumulative dose from all reactor units and the ISFSI on the site. Also, the NRC and the State of New Jersey would regulate any future actions in the vicinity of the Salem and HCGS site that could contribute to cumulative radiological impacts. Therefore, the staff concludes that the cumulative radiological impact to the public and workers from continued operation of Salem and HCGS, its associated ISFSI, and two potential additional reactor units would be SMALL.

In addition to health impact from radiological sources, the Staff also evaluated and determined that the electric-field-induced currents from the Salem and HCGS transmission lines are below the NESC criteria for preventing electric shock from induced currents. Therefore, the Salem and HCGS transmission lines do not significantly affect the overall potential for electric shock from induced currents within the areac of analysis area and the human health impact from such source is SMALL. The potential effect from future and chronic exposure to these electric fields continues to be studied and is not known at this time. The Staff considers the GEIS finding of "Uncertain" still appropriate and will continue to follow developments on this issue.

4.11.5 Cumulative Air Quality Impacts

The Salem and HCGS facilities are located in Salem County, which is included with the Metropolitan Philadelphia Interstate Air Quality Control Region (AQCR), which encompasses the area geographically located in five counties of New Jersey, including Salem and Gloucester Counties, New Castle County Delaware, and five counties of Pennsylvania (40 CFR 81.15). Salem County is designated as in attainment/unclassified area with respect to the National Ambient Air Quality Standards (NAAQSs) for Particulate Matter less than 2.5 microns in diameter ($PM_{2.5}$), sulfur dioxide (SO_2), nitrogen oxides (NOx), carbon monoxide (CO), and lead. The county, along with all of southern New Jersey, is a nonattainment area with respect to the 1-hour primary ozone standard and the 8-hour ozone standard. For the 1-hour ozone standard, Salem County is located within the multi-state Philadelphia-Wilmington-Trenton non-attainment area, and for the 8-hour ozone standard, it is located in the Philadelphia-Wilmington-Atlantic City (PA-NJ-DE-MD) nonattainment area. Of the adjacent counties, Gloucester County in New Jersey is in non-attainment for the 1-hour and 8-hour ozone standards, as well as the annual and daily $PM_{2.5}$ standard (NJDEP, 2010b). New Castle County, Delaware is considered to be in moderate non-attainment for the ozone standards, and non-attainment for $PM_{2.5}$ (40 CFR 81.315).

The State of New Jersey has implemented several measures to address greenhouse gas (GHG) emissions within the state. In February 2007, the governor signed EO 54 calling for a reduction in GHG emissions to 1990 levels by 2020, and to 80 percent below 2006 levels by 2050. These objectives became mandatory in July 2007, with passage of the Global Warming Response Act. New Jersey also joined with nine other northeastern and mid-Atlantic states in the Regional Greenhouse Gas Initiative (RGGI) through Assembly Bill 4559 in January 2008. The RGGI caps carbon dioxide (CO_2) emissions from power plants, and requires utilities to purchase emissions credits, with the funds used to finance energy efficiency and renewable energy programs.

Potential cumulative effects of climate change on the State of New Jersey, whether or not from natural cycles of anthropogenic (man-induced) activities, could result in a variety of changes to the air quality of the area. As projected in the “Global Climate Change Impacts in the United States” report by the United States Global Change Research Program (USGCRP, 2009), the temperatures in the mid-Atlantic have already risen up to 1°F (0.6°C) since the 1961-1979 baseline, and are projected to increase by 3 to 6°F (1.7 to 3.3°C) more by 2090. Increases in average annual temperatures, higher probability of extreme heat events, higher occurrences of extreme weather events (intense rainfall or drought) and changes in the wind patterns could affect concentrations of the air pollutants and their long-range transport, because their formation partially depends on temperature and humidity and is a result of the interactions between hourly changes in the physical and dynamic properties of the atmosphere, atmospheric circulation features, wind, topography, and energy use (IPCC, 2010).

Consistent with the findings in the GEIS, the Staff concludes that the impacts from continued operation of the Salem and HCGS facilities on air quality are SMALL. As no refurbishment is planned at the facilities during the license renewal period, no additional air emissions would result from refurbishment activities (PSEG, 2009a; 2009b). In comparison with construction and operation of a comparable fossil-fueled power plant, license renewal would result in a new cumulative deferral of GHG emissions, which would otherwise be produced if a new gas or coal-fired plant were instead constructed. When compared with the alternative of a new fossil-fuel power plant, the option of license renewal also results in a substantial new cumulative deferral in toxic air emissions.

For the purpose of this cumulative air impact assessment, the spatial bounds include the Metropolitan Philadelphia Interstate AQCR, which encompasses the area geographically located in five counties of New Jersey, including Salem and Gloucester Counties, New Castle County Delaware, and five counties of Pennsylvania. The Staff concludes that, combined with the emissions from other past, present, and reasonably foreseeable future actions, cumulative hazardous and criteria air pollutant emission impacts on air quality from Salem and HCGS-related actions would be SMALL.

4.11.6 Cumulative Socioeconomic Impacts

As discussed in Section 4.9 of this draft SEIS, continued operation of Salem and HCGS during the license renewal term would have no impact on socioeconomic conditions in the region beyond those already being experienced. Since PSEG has indicated that there would be no major plant refurbishment, overall expenditures and employment levels at Salem and HCGS would remain relatively constant with no additional demand for housing, public utilities, and public services. In addition, since employment levels and the value of Salem and HCGS would not change, there would be no population and tax revenue-related land use impacts. There would also be no disproportionately high and adverse health or environmental impacts on minority and low-income populations in the region. Based on this and other information presented in this draft SEIS, there would be no cumulative socioeconomic impacts from Salem and HCGS operations during the license renewal term.

If PSEG decides to proceed and construct a new nuclear power plant unit at the Salem and HCGS site, the cumulative short-term construction-related socioeconomic impacts of this action could be MODERATE to LARGE in counties located in the immediate vicinity of Salem and HCGS. These impacts would be caused by the short-term increased demand for rental housing and other commercial and public services used by construction workers during the years of power plant construction. During peak construction periods there would be a noticeable increase in the number and volume of construction vehicles on roads in the immediate vicinity of the Salem and HCGS site.

The cumulative long-term operations-related socioeconomic impacts of this action during the operation of the new power plant unit would likely be SMALL to MODERATE. These impacts would be caused by the increased demand for permanent housing and other commercial and public services, such as schools, police and fire, and public water and electric services, from the addition of operations workers at the Salem and HCGS site during the years of new plant operations. During shift changes there would be a noticeable increase in the number of commuter vehicles on roads in the immediate vicinity of the Salem and HCGS site.

Since Salem County has less housing and public services available to handle the influx of construction workers in comparison to New Castle, Gloucester, and Cumberland Counties, the cumulative short-term construction-related socioeconomic impacts on Salem County would likely be MODERATE to LARGE. Over the long-term, cumulative operations impacts on Salem County would likely be SMALL to MODERATE since new operations workers would likely reside in the same counties and in the same pattern as the current Salem and HCGS workforce. Many of the operations workers would be expected to settle in Salem County where nearly 40 percent of the current workforce reside.

Because New Castle, Gloucester, and Cumberland Counties each has a larger available housing supply than Salem County, and the current number of Salem and HCGS workers residing in these three counties combined (43 percent) is the same as those residing in Salem County (40 percent), the cumulative construction- and operations-related socioeconomic impacts are likely to be SMALL in these three counties. If PSEG decides to construct a new nuclear power plant unit at the Salem and HCGS site, the cumulative impacts of this action would likely be SMALL on the four-county socioeconomic region of influence.

The specific impact of this action would ultimately depend on the actual design, characteristics, and construction practices proposed by the applicant. Such details are not available at this time, but if the combined license application is submitted to NRC, the detailed socioeconomic impacts of this action at the Salem and HCGS site would be analyzed and addressed in a separate NEPA document that would be prepared by NRC.

4.11.7 Summary of Cumulative Impacts

The Staff considered the potential impacts resulting from operation of Salem and HCGS during the period of extended operation and other past, present, and reasonably foreseeable future actions in the vicinity of Salem and HCGS. The preliminary determination is that the potential cumulative impacts resulting from Salem and HCGS operation during the period of extended operation would range from SMALL to LARGE. Table 4-24 summarizes the cumulative impact by resource area.

Table 4-24. Summary of Cumulative Impacts on Resource Areas

Resource Area	Impact	Summary
Land Use	SMALL	With respect to the Salem and HCGS facilities, no measureable changes in land use would occur over the proposed license renewal term. When combined with other past, present, and reasonable foreseeable future activities, impacts from continued operation of Salem and HCGS would constitute a SMALL cumulative impact on land use.
Air Quality	SMALL	Impacts of air emissions over the proposed license renewal term would be SMALL. When combined with other past, present, and reasonably foreseeable future activities, impacts to air resources from the Salem and HCGS facilities would constitute a SMALL cumulative impact on air quality. In comparison with the alternative of constructing and operating a comparable gas or coal-fired power plant, license renewal would result in a new cumulative deferral in both GHG and other toxic air emissions, which would otherwise be produced by a fossil-fueled plant.
Ground Water	SMALL	Groundwater consumption constitutes a SMALL cumulative impact on the resource. When this consumption is added to other past, present, and reasonably foreseeable future withdrawals, cumulative impact on groundwater resources is SMALL.
Surface Water	SMALL	Impacts on surface water over the proposed license term would be SMALL. When combined with other past, present, and reasonably foreseeable future activities, impacts to surface water from the Salem and HCGS facilities would constitute a SMALL cumulative impact.
Aquatic Resources	SMALL to MODERATE	Past and present operations have impacted aquatic resources in the vicinity of Salem and HCGS and would likely continue to in the future. Such impacts would continue to be SMALL. When combined with other past, present, and reasonable foreseeable future activities, impacts from continued operation of Salem and HCGS would constitute a SMALL to MODERATE cumulative impact on aquatic resources.
Terrestrial Resources	MODERATE	Past and present operations have impacted terrestrial habitat and species in the vicinity of Salem and HCGS. Continued impacts associated with the proposed license renewal term would be SMALL. When combined with other past, present, and reasonable foreseeable future activities, impacts from continued operation of Salem and HCGS would constitute a MODERATE cumulative impact on terrestrial resources.

Resource Area	Impact	Summary
Threatened or Endangered Species	SMALL	Past and present operations have impacted threatened or endangered species in the vicinity of Salem and HCGS and would likely continue to in the future. Such impacts would continue to be SMALL. When combined with other past, present, and reasonable foreseeable future activities, impacts from continued operation of Salem and HCGS would constitute a SMALL cumulative impact on threatened or endangered species.
Human Health	SMALL	When combined with the other past, present, and reasonably foreseeable future activities, the cumulative human health impacts of continued operation of Salem and HCGS from radiation exposure to the public, and electric-field-induced currents from the Salem and HCGS transmission lines would all be SMALL.
Socioeconomics	SMALL to LARGE	Impacts on socioeconomics over the proposed license term would be SMALL depending on the alternative selected. When combined with other past, present, and reasonably foreseeable future activities, impacts to socioeconomics from the Salem and HCGS facilities would constitute a SMALL to LARGE cumulative impact.

4.12 References

10 CFR 20. *Code of Federal Regulations*, Title 10, *Energ*y, Part 20, “Standards for Protection Against Radiation.”

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

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

10 CFR 72. *Code of Federal Regulations*, Title 10, *Energy,* Part 72, “Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor-Related Greater than Class C Waste.”

18 CFR 410. *Code of Federal Regulations*, Title 18, *Conservation of Power and Water Resources,* Part 410, “Administrative Manual – Part III: Water Quality Regulations, with Amendments through July 16, 2008.”

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5.0 ENVIRONMENTAL IMPACTS OF ACCIDENTS

Environmental Issues associated with the postulated accidents are discussed in NUREG-1437, Volumes 1 and 2, "Generice Environmental Impact Statement for License Renewal of Postulated Nuclear Plants" (hereafter referred to as the GEIS) (NRC 1996, 1999).[1] The GEIS includes determination of whether the analysis of the environmental issues could be applied to all plants and whether additional mitigation measures would be warranted. Issues are tehn assigned a Category 1 or a Category 2 designation. As set forth in the GEIS, Category 1 issues are those that meet all of the following criteria:

(1) The environmental impacts associated with the issue have been determined to apply either to all plants or, for some issues, to plants having specific type of cooling system or other specificied plant or site characteristics.

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

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

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

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

This chapter describes the environmental impacts from postulated accidents that might occur during the license renewal term. Two classes of accidents are evaluated in the GEIs. These are design-basis accidents (DBA) and severe accidents, as discussed below.

5.1 DESIGN-BASIS ACCIDENTS

In order to receive NRC approval for an operating license, an applicant for an initial operating license must submit a final safety analysis report (FSAR) as part of its application. The FSAR presents the design criteria and design information for the proposed reactor and comprehensive data on the proposed site. The FSAR also discusses various hypothetical accident situations and the safety features that are provided to prevent and mitigate accidents. The NRC staff reviews the application to determine whether or not the plant

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[1] The GEIS was originally issued in 1996. Addendum 1 to the GEIS was issued in 1999. Hereafter, all references to the GEIS include the GEIS and its Addenddum 1.

design meets the NRC's regulations and requirements and includes, in part, the nuclear plant design and its anticipated response to an accident.

DBAs are those accidents that both the licensee and the NRC staff evaluate to ensure that the plant can withstand normal and abnormal transients, as well as a broad spectrum of postulated accidents, without undue hazard to the health and safety of the public. A number of these postulated accidents are not expected to occur during the life of the plant, but are evaluated to establish the design basis for the preventive and mitigative safety systems of the facility. The acceptance criteria for DBAs are described in Title 10, Part 50, "Domestic Licensing of Production and Uitilization Facilities," of the *Code of Federal Regulations* (10 CFR Part 50) and 10 CFR Part 100, "Reactor Site Criteria."

The environmental impacts of postulated accidents were evaluated for the license renewal period in Chapter 5 of the GEIS. Section 5.5.1 states:

> All plants have had a previous evaluation of the environmental impacts of design-basis accidents. In addition, the licensee will be required to maintain acceptable design and performance criteria throughout the renewal period. Therefore, the calculated releases from design-basis accidents would not be expected to change. Since the consequences of these events are evaluated for the hypothetical maximally exposed individual at the time of licensing, changes in the plant environment will not affect these evaluations. Therefore, the staff concludes that the environmental impacts of design-basis accidents are of small significance for all plants. Because the environmental impacts of design basis accidents are of small significance and because additional measures to reduce such impacts would be costly, the staff concludes that no mitigation measures beyond those implemented during the current term license would be warranted. This is a Category 1 issue.

This issue, applicable to Salem Nuclear Generating Station Units, 1 and 2 (SGS) and Hope Creek Generating Station (HCGS), is listed in Table 5-1.

Table 5-1. Issues Applicable to Postulated Accidents during the Renewal Term

Issue	GEIS Section	Category
DBAs	5.3.2; 5.5.1	1

No new and significant information related to DBAs was identified during the review of PSEG's environmental report (ER), site audit, scoping process, or evaluation of other available information. Therefore, there are no impacts related to DBA beyond those discussed in the GEIS.

5.2 SEVERE ACCIDENTS

Severe nuclear accidents are those that are more severe than DBAs because they could result in substantial damage to the reactor core, whether or not there are serious offsite consequences. In the GEIS, the staff assessed the impacts of severe accidents during the license renewal period, using the results of existing analyses and information from various sites to predict the environmental impacts of severe accidents for plants during the renewal period.

Severe accidents initiated by external phenomena such as tornadoes, floods, earthquakes, fires, and sabotage have not traditionally been discussed in quantitative terms in the final environmental impact statements and were not specifically considered for the Salem Generating Station, Units 1 and 2 (SGS) and Hope Creek Generating Station (HCGS) sites in the GEIS (NRC, 1996). The GEIS, however, did evaluate existing impact assessments performed by the NRC staff and by the industry at 44 nuclear plants in the United States and segregated all sites into six general categories and then estimated that the risk consequences calculated in existing analyses bound the risks for all other plants within each category. The GEIS further concluded that the risk from beyond design-basis earthquakes at existing nuclear power plants is designated as SMALL. The GEIS for license renewal documents and concluded that the core damage and radiological release from such acts would be no worse than the damage and release to be expected from internally initiated events.

In the GEIS, the NRC staff concludes that the risk from sabotage and beyond design-basis earthquakes at existing nuclear power plants is designated as SMALL, and additionally, that the risks from other external events are adequately addressed by a generic consideration of internally initiated severe accidents (NRC, 1996).

Based on information in the GEIS, the staff found that:

> The generic analysis…applies to all plants and that the probability-weighted consequences of atmospheric releases, fallout onto open bodies of water, releases to ground water, and societal and economic impacts of severe accidents are of small significance for all plants. However, not all plants have performed a site-specific analysis of measures that could mitigate severe accidents. Consequently, severe accidents are a Category 2 issue for plants that have not performed a site-specific consideration of severe accident mitigation and submitted that analysis for Commission review.

This issue, applicable to SGS, and HCGS, is listed in Table 5-2.

Table 5-2. Issues Applicable to Postulated Accidents during the Renewal Term

Issue	GEIS Section	Category
Severe accidents	5.3.3; 5.3.3.2; 5.3.3.3; 5.3.3.4; 5.3.3.5; 5.4; 5.5.2	2

The staff identified no new and significant information related to postulated accidents during the review of PSEG's environmental report, the site audit, the scoping process, or evaluation of other available information. Therefore, there are no impacts related to postulated accidents beyond those discussed in the GEIS. In accordance with 10 CFR

51.53(c)(3)(ii)(L), however, the NRC staff has reviewed severe accident mitigation alternatives (SAMAs) for SGS and HGCS. Review results are discussed in Section 5.3 of this draft SEIS.

5.3 SEVERE ACCIDENT MITIGATION ALTERNATIVES

As required by 10 CFR 51.53(c)(3)(ii)(L), license renewal applicants much consider alternatives to mitigate severe accidents if the staff has not previously evaluated SAMAs for the applicant's plant in an environmental impact statement (EIS), related supplement, or in an environmental assessment. The purpose of this consideration is to ensure that plant changesl (i.e., hardware, procedures, and training) with the potential for improving severe accident safety performance are identified and evaluated. SAMAs have not been previously considered for SGC and HCGS; therefore, the remainder of chapter 5 addresses those alternatives.

5.3.1 Introduction

This section presents a summary of the SAMA evaluation for SGS and HCGS conducted by PSEG and the NRC staff's reviews of those evaluations. The NRC staff performed its review with contract assistance from Pacific Northwest National Laboratory. The NRC staff's reviews are available in greater detail in Appendices F and G; the SAMA evaluations are available in PSEG's ERs and subsequent submittals.

The SAMA evaluations for SGS and HCGS were conducted with a four-step approach. In the first step, PSEG quantified the level of risk associated with potential reactor accidents using the plant specific probabilistic risk assessment (PRA) and other risk models.

In the second step, PSEG examined the major risk contributors and identified possible ways (SAMAs) of reducing that risk. Common ways of reducing risk are changes to components, systems, procedures, and training. PSEG identified 27 potential SAMAs for SGS, and 23 for HCGS. PSEG performed an initial screening to determine if any SAMAs could be eliminated because they are not applicable to SGS or HCGS due to design differences, or have estimated implementation costs that would exceed the dollar-value associated with completely eliminating all severe accident risk at SGS and HCGS. Four SAMAs were eliminated based on this screening, leaving 25 for SGS and 21 for HCGS for further evaluation.

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

Finally, in the fourth step, the costs and benefits of each of the remaining SAMAs were compared to determine whether the SAMA was cost beneficial, meaning the benefits of the

SAMA were greater than the cost (a positive cost benefit). PSEG concluded in its ERs that several of the SAMAs evaluated are potentially cost-beneficial (PSEG 2009a, PSEG 2009b).

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

5.3.2 Estimate of Risk

PSEG submitted an assessment of SAMAs for SGS and HCGS as part of the ERs (PSEG 2009a, PSEG 2009b). For each, two distinct analyses are combined to form the basis for the risk estimates used in the SAMA analysis: (1) the plant-specific Level-1 and Level-2 PSA models, which are updated versions of the IPEs (PSEG 1993, PSEG 1994, PSEG 1995); (2) a supplemental analysis of offsite consequences and economic impacts (essentially a Level-3 PSA model) developed specifically for the SAMA analysis. The most recent plant-specific Level-1 and Level 2 PSA models consisted of the following Internal Events PSAs: (1) for SGS, Salem PRA, Revision 4.1, September 2008, model of record (MOR); (2) for HCGS, the HC108B update. Neither of these analyses accounted for external events.

The SGS CDF is approximately 4.8×10^{-5} per year for internal events as determined from quantification of the Level 1 PRA model at a truncation of 1×10^{-11} per year. When determined from the sum of the containment event tree (CET) sequences, or Level 2 PRA model, the release frequency (from all release categories, which consist of intact containment, late release, and early release) is approximately 5.0×10^{-5} per year, also at a truncation of 1×10^{-11} per year. 5.0×10^{-5} per year was used as the baseline CDF in the SAMA evaluations (PSEG 2009a). The CDF is based on the risk assessment for internally initiated events, which includes internal flooding. PSEG did not explicitly include the contribution from external events within the SGS risk estimates; however, it did account for the potential risk reduction benefits associated with external events by multiplying the estimated benefits for internal events by a factor of 2. The breakdown of CDF by initiating event provided in Table 5-2

Table 5-3. Salem Nuclear Station Core Damage Frequency for Internal Events

Initiating Event	CDF (per year)	% Contribution to CDF
Loss of Control Area Ventilatioln	1.8×10^{-6}	37
Loss of Offsite Power (LOOP)	8.1×10^{-6}	17
Loss of Service water	6.6×10^{-6}	14
Internal Floods	4.5×10^{-6}	9
Transients	4.0×10^{-6}	8
Steam Generator Tupe Rupture (SGTR)	2.7×10^{-6}	6

Initiating Event	CDF (per year)	% Contribution to CDF
Loss of Component Cooling Water (CCW)	1.0×10^{-6}	2
Anticipated Transient Without Scram (ATWS)	7.4 × 10–7	2
Loss of 125 V DC Bus A	6.9×10^{-7}	1
Others (less than 1 percent)[3]	1.8×10^{-6}	4
Total CDF (Internal Events)	**4.8×10^{-5}**	**100**

As shown in Table 5-3, events initiated by losses of control area ventilation, offsite power, or service water are the dominant contributors to the CDF. PSEG identified that Station Blackout (SBO) contributes to 8 x 10^{-6} per year (PSEG 2010a).

PSEG estimated the dose to the population within 50 miles (80 km) of the SGS site to be approximately 0.78 person-sievert (person-Sv) (78 person-rem) per year. The breakdown of the total population dose by containment release mode is summarized in Table 5-2. Containment bypass events (such as SGTR-initiated large early release frequency (LERF) accidents) and late containment failures without feedwater dominate the population dose risk at SGS.

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

Containment Release Mode	Population Dose (Person-Rem[1] Per Year)	% Contribution[2]
Containment over-pressure (late)	42.9	55
Steam Generator Rupturs	31.9	41
Containment Isolation Failure	2.3	3
Inact Containment	0.2	<1
Interface system LOCA	0.6	<1
Catastrophic Islaotion Failue	0.4	<1
Basemat melt-through (late)	negligible	negligilbe
Total	**78.2**	**100**

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

[2]Derived from Table E.3-7 of the ER

[3]Column totals may be different due to round off

The HCGS CDF is approximately 5.1x10^{-6} per year as determined from quantification of the Level 1 PRA at a truncation of 1 x 10^{-12} per year. When determing from the sum of the containment event tree (CET) sequences, or Level 2 PRA modeled, using a higher truncation of 5 x 10^{-11}per a year used and the resulting release frequency (from all release categories, which consist of intact containment, late release, and early release) is approximately 4.4 x 10^{-6} per year. 4.4 x 10^{-6} per year was used as the baseline CDF in the SAMA evaluations (PSEG 2009b). Although this is about 16% less that the internal events CDF of 5.1 x 10^{-6} per year obtained from the Level-1 model, the NRC staff considers that its use will have a negligible impact on the results of the SAMA evaluation because the external event multiplier and uncertainty multiplier used in the SAMA analysis have a much greater impact on the SAMA evaluation results than the small difference arising from the model quantification approach. PSEG did not explicity include the contribution from external events within the HCGS risk estimates; however, it did account for the potential risk reduction benefits associated with external events by multiplying the estimated benefits for internal events by a factor of 6.3. The breakdown of CDF by initiating event is provided in Table 5-4.

Table 5-5. Hope Creek Nuclear Station Core Damage Frequency for Internal Events

Initiating Event	CDF (per year)	% Contribution to CDF
Loss of Offsite Power	9.3 x 10-7	18
Loss of Service Water (SW)	8.1×10^{-7}	15
Manual Shutdown	7.7×10^{-7}	15
Turbine Trip with Bypass	6.2×10^{-7}	12
Small Loss of Coolant Accident (LOCA)-Water (Below Top of Active Fuel)	2.8×10^{-7}	5
Small LOCA-Steam (Above Top of Active Fuel	2.3×10^{-7}	4
Loss of Condenser Vacuum	2.0×10^{-7}	4
Fire Protection System Rupture Outside Control Room	1.9×10^{-7}	4
Isolation LOCA in Emergency Core Cooling System (ECCS) Discharge Paths	1.1×10^{-7}	2
Main Steam Isolation Valve (MSIV) Closure	1.1×10^{-7}	2
Internal Flood Outside Lower Relay Room	9.7×10^{-8}	2
Loss of Feedwater	8.8×10^{-8}	2
Loss of Safety Auxilaries Cooling System	$7.9. \times 10^{-8}$	2
Reactor Auxilaries Cooling System (RACS) Common Header Unisolable Rupture	7.6×10^{-8}	1
Unisolable SW A Pipe Rupture in RACS Room	5.7×10^{-8}	1

Initiating Event	CDF (per year)	% Contribution to CDF
Unisolable SWA B Pipe Rupture in RACS Room	5.7×10^{-8}	1
Others (less than 1% each)	4.1×10^{-6}	8
Total CDF (Internal Events)	$\mathbf{5.1 \times 10^{-6}}$	**100**

As shown in Table 5-5, events initiated by loss of offsite power, loss of service water and other transients (manual shutdown and turbine trip with bypass) are the dominant contributors to the CDF. Anticipated transient without scram (ATWS) sequences account for 3 percent of the CDF, station blackout accounts for 12 percent of the CDF (PSEG 2010b).

PSEG estimated the dose to the population within 50 miles (80 km) of the HCGS site to be approximately 0.23 person-sievert (person-Sv) (22.9 person-rem) per year. The breakdown of the total population dose by containment release mode is summarized in Table 5-4. Releases from the containment within the early time frame (0 to less than 4 hours following event initiaton) and intermediate time frame (4 to less that 24 hours following event initiation) dominate the population dose risk at HCGS.

Table 5-6 Breakdown of Population Dose by Containment Release Mode For HCGS

Containment Release Mode	Population Dose (Person-Rem[1] Per Year)	% Contribution[2]
Early Releases (< 4hrs)	11.9	52
Intermediate Releases(4 to< 24 hrs)	9.9	43
Late Releases (≥ 24hrs)	1.1	5
Inact Containment	<0.1	negligible
Total	**22.9**	**100**

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

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

5.3.3 Potential Plant Improvements

Once the dominant contributors to plant risk were identified, PSEG searched for ways to reduce that risk. In identifying and evaluating potential SAMAs, PSEG considered insights from the plant-specific PRA, and SAMA analyses performed for other operating plants that have submitted license renewal applications. PSEG identified 27 potential risk-reducing improvements (SAMAS) to plant components, systems, procedures, and training for SGS. PSEG identified 23 potential risk-reducing improvements (SAMAs) to plant components, systems, procedures and training for HCGS.

PSEG removed two candidates SAMAS from further consideration for SGS because they are not applicable at SGS due to design differences, have already been implemented at SGS ,or were estimated to have implementation costs that would exceed the dollar value associated with completely eliminating all severe accident risk at SGS. A detail cost-benefit analysis was performed for the SAMAs for SGS, as well as, four additional SAMAs that were analyzed for SGS in response to a NRC staff request for additional information.

PSEG removed two candidates SAMAS from further consideration for HCGS because they are not applicable at HCGS due to design differences, have already been implemented at HCGS, or were estimated to have implementation costs that would exceed the dollar value associated with completely eliminating all severe accident risk at HCGS. A detail cost-benefit analysis was performed for the 21 remaining SAMAs HCGS.

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

5.3.4 Evaluation of Risk Reduction and Costs of Improvements

PSEG evaluated the risk-reduction potential of the remaining 25 SAMAs for SGS,as well as four additional SAMAs that were added in response to an NRC staff reguest for additional information. PSEG evaluated the risk-reduction potential for the remaining 21 SAMAs for HCGS. The majority of the SAMA evaluations were performed in a bounding fashion in that the SAMA was assumed to completely eliminate the risk associated with the proposed enhancement.

PSEG estimated the costs for implementing the candidate SAMAs through the development of site-specific cost estimates. The cost estimates conservatively did not include the cost of replacement power during extended outages required to implement the modifications, nor did they include contingency cost for unforeseen difficulties.

The staff reviewed PSEG's bases for calculating the risk reduction for the various plant improvements and concludes that the rationale and assumptions for estimating risk reduction are reasonable and generally conservative (i.e., the estimated risk reduction is higher than what would actually be realized). Accordingly, the staff based its estimates of averted risk for the various SAMAs on PSEG's risk reduction estimates.

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

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

5.3.5 Cost-Benefit Comparison

The cost-benefit analysis performed by PSEG was based primarily on NUREG/BR-0184 (NRC, 1997) and was executed consistent with this guidance. NUREG/BR-0058 has recently been revised to reflect the agency's revised policy on discount rates. Revision 4 of NUREG/BR-0058 states that two sets of estimates should be developed - one at 3 percent and the other at 7 percent (NRC, 2004). PSEG provided both sets of estimates for SGS and HCGS (PSEG 2009a, 2009b).

For SGS, PSEG identified eleven potentially cost-beneficial SAMAs in the baseline analysis contained in the ER. The potentially cost-beneficial SAMAs are:

- SAMA 1 – Enhance procedures and provide additional equipment to respond to loss of control area ventilation.
- SAMA 2 – Re-configure Salem 3 to provide a more expedient backup to AC power source for Salem 1 and 2.
- SAMA 4 – Install fuel oil transfer pump on "C" emergency diesel generator (EDG) and provide procedural guidance for using "C" EDG to power selected "A" and "B" loads.
- SAMA 6 – Enhance flood detection for 84' auxiliary building and enhance procedural guidance for responding to service water flooding
- SAMA 9 – Connect Hope Creek cooling tower basin to Salem service water system as alternate service water supply.
- SAMA 10 – Provide procedural guidance for faster cooldown on loss of reactor coolant pump (RCP) Seal
- SAMA 11 – Modify plant procedures to make use of other Unit's PDP for RCP seal.
- SAMA 12 – Improve flood barriers outside 220/440VAC switchgear rooms.
- SAMA 14 – Expand anticipated transients without trip mitigation system actuation circuitry (AMSAC) function to include backup breaker trip on RPS failure.

- SAMA 17 – Enhance procedures and provide additional equipment to respond to loss of EDG control room ventilation.
- SAMA 24 – Provide procedural guidance to cross-tie Salem 1 and 2 service water systems.

PSEG performed additional analyses to evaluate the impact of parameter choices and uncertainties on the results of the SAMA assessment (PSEG, 2009a). If the benefits are increased by an additional factor of 2.5 to account for uncertainties, five additional SAMA candidates were determined to be potentially cost-beneficial. The ER also showed that the sentivity case SAMA (SAMA 5A) was potentially cost-benificial:

- SAMA 3 – Install limited emergency diesel generator (EDG) cross-tie capability between Salem 1 and 2.
- SAMA 5 – Install portable diesel generators to charge station battery and circulating water batteries and replace PDP with air-cooled pump.
- SAMA 5A – Install portable diesel generators to charge station battery and circulating water batteries.
- SAMA 7 – Install “B” Train auxiliary feedwater storage tank (AFWST) makeup including alternative water source.
- SAMA 8 – Install high pressure pump powered with portable diesel generator and long-term suction source to supply the AFW Header.
- SAMA 27 – In addition to the equipment installed for SAMA 5, install permanently piped seismically qualified connections to alternative AFW water sources.

PSEG indicated that all 17 potentially cost-beneficial SAMAs will be considered for implementation through the established Salem Plant Health Committee process.

For HCGS, PSEG identified nine potentially cost-beneficial SAMAs in the baseline analysis contained in the ER. The potentially cost-beneficial SAMAs are:

- SAMA 1 – Remove automatic depressurization system (ADS) inhibit from non-ATWS emergency operating procedures.
- SAMA 3 – Install backup air compressor to supply air-operated valves.

- SAMA 4 – Provide procedural guidance to cross-tie residual heat removal (RHR) trains.
- SAMA 10 – Provide procedural guidance to use B.5.b low pressure pump for non-security events.
- SAMA 17 – Replace a supply fan with a different design in service water pump room.
- SAMA 18 – Replace a return fan with a different design in service water pump room.
- SAMA 30 – Provide procedural guidance for partial transfer function of control functions from the control room to the remote shutdown panel.
- SAMA 35 – Relocate, minimize, and/or eliminate electrical heaters in electrical access room.
- SAMA 39 – Provide procedural guidance to bypass reactor core isolation cooling turbine exhaust pressure trip.

PSEG performed additional analyses to evaluate the impact of parameter choices and uncertainties on the results of the SAMA assessment (PSEG, 2009b). If the benefits are increased by an additional factor of 2.84 to account for uncertainties, four additional SAMA candidates were determined to be potentially cost-beneficial:

- SAMA 8 – Convert selected fire protection piping from wet to dry pipe system.
- SAMA 32 – Install additional physical barriers to limit dispersion of fuel oil from DG rooms.
- SAMA 7 – Provide procedural guidance for loss of all 1E 120V AC power.
- SAMA 37 – Reinforce 1E 120V AC distribution panels.

PSEG indicated that all 13 potentially cost-beneificial SAMAs will be considered for implementation through the established HCGS Plant Health Committee process.

Based on the staff’s review, the staff concludes that, with the exception of the potentially cost-beneficial SAMAs discussed above, the costs of the SAMAs evaluated would be higher than the associated benefits.

5.3.6 Conclusions

The staff reviewed PSEG's analysis and concluded that the methods used and the implementation of those methods were sound. The treatment of SAMA benefits and costs support the general conclusion that the SAMA evaluations performed by PSEG are reasonable and sufficient for the license renewal submittal.

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

5.4 REFERENCES

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6.0 ENVIRONMENTAL IMPACTS OF THE URANIUM FUEL CYCLE AND SOLID WASTE MANAGEMENT, AND GREENHOUSE GAS EMISSIONS

6.1 THE URANIUM FUEL CYCLE

This section addresses issues related to the uranium fuel cycle, solid waste management during the period of extended operation. The uranium cycle includes uranium mining and milling, the production of uranium hexafluoride, isotopic enrichment, fuel fabrication, reprocessing of irradiated fuel, transportation of radioactive materials, and management of low-level wastes and high-level wastes related to uranium fuel cycle activities. The generic environmental impact statement (GEIS; NRC, 1996, 1999)[1] details the potential generic impacts of the radiological and non-radiological environmental impacts of the uranium fuel cycle and transportation of nuclear fuel and wastes, as listed in Table 6-1 below. The GEIS is based, in part, on the generic impacts provided in Table S-3, "Table of Uranium Fuel Cycle Environmental Data," in Title 10, Section 51.51(b), of the *Code of Federal Regulations* (10 CFR 51.51(b)), and in Table S-4, "Environmental Impact of Transportation of Fuel and Waste to and from One Light-Water-Cooled Nuclear Power Reactor," in 10 CFR 51.52(c). The GEIS also addresses the impacts from radon-222 and technetium-99.

The staff of the U.S. Nuclear Regulatory Commission (NRC) did not identify any new and significant information related to the uranium fuel cycle during the review of the PSEG Nuclear LLC (PSEG) environmental reports (ERs) for Salem Nuclear Generating Station, Units 1 and 2 (Salem) and Hope Creek Generating Station (HCGS) (PSEG, 2009a; 2009b), the site audit, and the scoping process. Therefore, there are no impacts related to these issues beyond those discussed in the GEIS. For these Category 1 issues, the GEIS concludes that the impacts are SMALL, except for the collective offsite radiological impacts from the fuel cycle and from high-level waste and spent fuel disposal, which the Commission has concluded to be acceptable.

Table 6-1. Issues Related to the Uranium Fuel Cycle and Solid Waste Management. *Nine generic issues are related to the fuel cycle and solid waste management. There are no site-specific issues.*

Issues	GEIS Section	Category
Offsite radiological impacts (individual effects from other than the disposal of spent fuel and high-level waste)	6.1, 6.2.1, 6.2.2.1, 6.2.2.3, 6.2.3, 6.2.4, 6.6	1
Offsite radiological impacts (collective effects)	6.1, 6.2.2.1, 6.2.3, 6.2.4, 6.6	1
Offsite radiological impacts (spent fuel and	6.1, 6.2.2.1, 6.2.3, 6.2.4, 6.6	1

[1] The GEIS was originally issued in 1996. Addendum 1 to the GEIS was issued in 1999. Hereafter, all references to the GEIS include the GEIS and Addendum 1.

Issues	GEIS Section	Category
high-level waste disposal)		
Nonradiological impacts of the uranium fuel cycle	6.1, 6.2.2.6, 6.2.2.7, 6.2.2.8, 6.2.2.9, 6.2.3, 6.2.4, 6.6	1
Low-level waste storage and disposal	6.1, 6.2.2.2, 6.4.2, 6.4.3, 6.4.3.1, 6.4.3.2, 6.4.3.3, 6.4.4, 6.4.4.1, 6.4.4.2, 6.4.4.3, 6.4.4.4, 6.4.4.5, 6.4.4.5.1, 6.4.4.5.2, 6.4.4.5.3, 6.4.4.5.4, 6.4.4.6, 6.6	1
Mixed waste storage and disposal	6.4.5.1, 6.4.5.2, 6.4.5.3, 6.4.5.4, 6.4.5.5, 6.4.5.6, 6.4.5.6.1, 6.4.5.6.2, 6.4.5.6.3, 6.4.5.6.4, 6.6	1
Onsite spent fuel	6.1, 6.4.6, 6.4.6.1, 6.4.6.2, 6.4.6.3, 6.4.6.4, 6.4.6.5, 6.4.6.6, 6.4.6.7, 6.6	1
Nonradiological waste	6.1, 6.5, 6.5.1, 6.5.2, 6.5.3, 6.6	1
Transportation	6.1, 6.3.1, 6.3.2.3, 6.3.3, 6.3.4, 6.6, Addendum 1	1

6.2 GREENHOUSE GAS EMISSIONS

This section provides a discussion of potential impacts from greenhouse gases (GHGs) emitted from the nuclear fuel cycle. The GEIS does not directly address these emissions, and its discussion is limited to an inference that substantial carbon dioxide (CO_2) emissions may occur if coal- or oil-fired alternatives to license renewal are implemented.

6.2.1 Existing Studies

Since the development of the GEIS, the relative volumes of GHGs emitted by nuclear and other electricity generating methods have been widely studied. However, estimates and projections of the carbon footprint of the nuclear fuel cycle vary depending on the type of study conducted. Additionally, considerable debate also exists among researchers regarding the relative impacts of nuclear and other forms of electricity generation on GHG emissions. Existing studies on GHG emissions from nuclear power plants generally take two different forms:

(1) Qualitative discussions of the potential to use nuclear power to reduce GHG emissions and mitigate global warming; and

(2) Technical analyses and quantitative estimates of the actual amount of GHGs generated by the nuclear fuel cycle or entire nuclear power plant life cycle and comparisons to the operational or life cycle emissions from other energy generation alternatives.

Some of these studies are summarized below to give the reader an overview of the current state of these assessments.

6.2.1.1 Qualitative Studies

The qualitative studies consist primarily of broad, large-scale public policy or investment evaluations of whether an expansion of nuclear power is likely to be a technically, economically, and/or politically feasible means of achieving global GHG reductions. Examples of the studies include:

- Evaluations to determine whether investments in nuclear power in developing countries should be accepted as a flexibility mechanism to assist industrialized nations in achieving their GHG reduction goals under the Kyoto Protocols (Schneider, 2000; IAEA, 2000; NEA and OECD, 2002; NIRS/WISE, 2005). Ultimately, the parties to the Kyoto Protocol did not approve nuclear power as a component under the Clean Development Mechanism (CDM) due to safety and waste disposal concerns (NEA and OECD, 2002).

- Analyses developed to assist governments, including the United States, in making long-term investment and public policy decisions in nuclear power (Keepin, 1988; Hagen et al., 2001; MIT, 2003).

Although the qualitative studies sometimes reference and critique the existing quantitative estimates of GHGs produced by the nuclear fuel cycle, their conclusions generally rely heavily on discussions of other aspects of nuclear policy decisions and investment such as safety, cost, waste generation, and political acceptability. Therefore, these studies are typically not directly applicable to an evaluation of GHG emissions associated with the proposed license renewal for a given nuclear power plant.

6.2.1.2 Quantitative Studies

A large number of technical studies, including calculations and estimates of the amount of GHGs emitted by nuclear and other power generation options, are available in the literature and were useful to the NRC staff's efforts in addressing relative GHG emission levels. Examples of these studies include – but are not limited to – Mortimer (1990), Andseta et al. (1998), Spadaro et al. (2000), Storm van Leeuwen and Smith (2008), Fritsche (2006), Parliamentary Office of Science and Technology (POST) (2006), Atomic Energy Authority (AEA) (2006), Weisser (2006), Fthenakis and Kim (2007), and Dones (2007).

Comparing these studies and others like them is difficult because the assumptions and components of the lifecycles the authors evaluate vary widely. Examples of areas in which differing assumptions make comparing the studies difficult include:

- Energy sources that may be used to mine uranium deposits in the future;

- Reprocessing or disposal of spent nuclear fuel;

- Current and potential future processes to enrich uranium and the energy sources that will power them;

- Estimated grades and quantities of recoverable uranium resources;
- Estimated grades and quantities of recoverable fossil fuel resources;
- Estimated GHG emissions other than CO_2, including the conversion to CO_2 equivalents per unit of electric energy produced;
- Performance of future fossil fuel power systems;
- Projected capacity factors for alternatives means of generation; and
- Current and potential future reactor technologies.

In addition, studies may vary with respect to whether all or parts of a power plant's fuel cycle are analyzed, i.e., a full lifecycle analysis will typically address plant construction, operations, resource extraction (for fuel and construction materials), and decommissioning, whereas, a partial lifecycle analysis primarily focuses on operational differences.

In the case of license renewal, a GHG analysis for that portion of the plant's lifecycle (operation for an additional 20 years) would not involve GHG emissions associated with construction because construction activities have already been completed at the time of relicensing. In addition, the proposed action of license renewal would also not involve additional GHG emissions associated with facility decommissioning, because that decommissioning must occur whether the facility is relicensed or not. However, in some of the aforementioned studies, the specific contribution of GHG emissions from construction, decommissioning, or other portions of a plant's lifecycle cannot be clearly separated from one another. In such cases, an analysis of GHG emissions would overestimate the GHG emissions attributed to a specific portion of a plant's lifecycle. Nonetheless, these studies provide some meaningful information with respect to the potential GHG cumulative impacts associated with license renewal as well as the relative magnitude of the emissions among nuclear power plants and other forms of electric generation, as discussed in the following sections.

In Tables 6-2, 6-3, and 6-4, the NRC staff presents the results of the aforementioned quantitative studies to provide an evaluation of the relative GHG emissions that may result from the proposed license renewal as compared to the potential alternative use of coal-fired, natural gas-fired, and renewable generation. Most studies from Mortimer (1990) onward suggest that uranium ore grades and uranium enrichment processes are leading determinants in the ultimate GHG emissions attributable to nuclear power generation. These studies indicate that the relatively lower order of magnitude of GHG emissions from nuclear power when compared to fossil-fueled alternatives (especially natural gas) could potentially disappear if available uranium ore grades drop sufficiently while enrichment processes continued to rely on the same technologies.

Summary of Nuclear Greenhouse Gas Emissions Compared to Coal

Considering that coal fuels the largest share of electricity generation in the United States and that its burning results in the largest GHG emissions for any of the likely alternatives to nuclear power generation, including Salem and HCGS, most of the available quantitative studies focused on comparisons of the relative GHG emissions of nuclear to coal-fired generation. The quantitative estimates of the GHG emissions associated with the nuclear fuel cycle (and, in some cases, the nuclear lifecycle), as compared to an equivalent coal-fired plant, are presented in Table 6-2. The following chart does not include all existing studies, but provides an illustrative range of estimates developed by various sources.

Table 6-2. Nuclear Greenhouse Gas Emissions Compared to Coal

Source	GHG Emission Results
Mortimer (1990)	Nuclear—230,000 tons CO_2 Coal—5,912,000 tons CO_2 Note: Future GHG emissions from nuclear to increase because of declining ore grade.
Andseta et al. (1998)	Nuclear energy produces 1.4 percent of the GHG emissions compared to coal. Note: Future reprocessing and use of nuclear-generated electrical power in the mining and enrichment steps are likely to change the projections of earlier authors, such as Mortimer (1990).
Spadaro et al. (2000)	Nuclear—2.5 to 5.7 g Ceq/kWh Coal—264 to 357 g Ceq/kWh
Storm van Leeuwen and Smith (2008)	Authors did not evaluate nuclear versus coal.
Fritsche (2006) (Values estimated from graph in Figure 4)	Nuclear—33 g Ceq/kWh Coal—950 g Ceq/kWh
POST (2006) (Nuclear calculations from AEA, 2006)	Nuclear—5 g Ceq/kWh Coal—>1000 g Ceq/kWh Note: Decrease of uranium ore grade to 0.03 percent would raise nuclear to 6.8 g Ceq /kWh. Future improved technology and carbon capture and storage could reduce coal-fired GHG emissions by 90 percent.
Weisser (2006) (Compilation of results from other studies)	Nuclear—2.8 to 24 g Ceq/kWh Coal—950 to 1250 g Ceq/kWh
Fthenakis and Kim (2007)	Authors did not evaluate nuclear versus coal.
Dones (2007)	Author did not evaluate nuclear versus coal.

Summary of Nuclear Greenhouse Gas Emissions Compared to Natural Gas

The quantitative estimates of the GHG emissions associated with the nuclear fuel cycle (and, in some cases, the nuclear lifecycle), as compared to an equivalent natural gas-fired plant, are presented in Table 6-3. The following chart does not include all existing studies, but provides an illustrative range of estimates developed by various sources.

Table 6-3. Nuclear Greenhouse Gas Emissions Compared to Natural Gas

Source	GHG Emission Results
Mortimer (1990)	Author did not evaluate nuclear versus natural gas.
Andseta (1998)	Author did not evaluate nuclear versus natural gas.
Spadaro et al. (2000)	Nuclear—2.5 to 5.7 g Ceq/kWh Natural Gas—120 to 188 g Ceq/kWh
Storm van Leeuwen and Smith (2008)	Nuclear fuel cycle produces 20 to 33 percent of the GHG emissions compared to natural gas (at high ore grades). Note: Future nuclear GHG emissions to increase because of declining ore grade.
Fritsche (2006) (Values estimated from graph in Figure 4)	Nuclear—33 g Ceq/kWh Cogeneration Combined Cycle Natural Gas—150 g Ceq/kWh
POST (2006) (Nuclear calculations from AEA, 2006)	Nuclear—5 g Ceq/kWh Natural Gas—500 g Ceq/kWh Note: Decrease of uranium ore grade to 0.03 percent would raise nuclear to 6.8 g Ceq/kWh. Future improved technology and carbon capture and storage could reduce natural gas GHG emissions by 90 percent.
Weisser (2006) (Compilation of results from other studies)	Nuclear—2.8 to 24 g Ceq/kWh Natural Gas—440 to 780 g Ceq/kWh
Fthenakis and Kim (2007)	Authors did not evaluate nuclear versus natural gas.
Dones (2007)	Author critiqued methods and assumptions of Storm van Leeuwen and Smith (2008), and concluded that the nuclear fuel cycle produces 15 to 27 percent of the GHG emissions of natural gas.

Summary of Nuclear Greenhouse Gas Emissions Compared to Renewable Energy Sources

The quantitative estimates of the GHG emissions associated with the nuclear fuel cycle, as compared to equivalent renewable energy sources, are presented in Table 6-4. Calculation of GHG emissions associated with these sources is more difficult than the calculations for nuclear energy and fossil fuels because of the large variation in efficiencies due to their different sources and locations. For example, the efficiency of solar and wind energy is highly dependent on the location in which the power generation facility is installed. Similarly, the range of GHG emissions estimates for hydropower varies greatly depending on the type of dam or reservoir involved (if used at all). Therefore, the GHG emissions estimates for these energy sources have a greater range of variability than the estimates for nuclear and fossil fuel sources. The following chart does not include all existing studies, but provides an illustrative range of estimates developed by various sources.

1 **Table 6-4. Nuclear Greenhouse Gas Emissions Compared to Renewable Energy Sources**

Source	GHG Emission Results
Mortimer (1990)	Nuclear—230,000 tons CO_2 Hydropower—78,000 tons CO_2 Wind power—54,000 tons CO_2 Tidal power—52,500 tons CO_2 Note: Future GHG emissions from nuclear to increase because of declining ore grade.
Andseta (1998)	Author did not evaluate nuclear versus renewable energy sources.
Spadaro et al. (2000)	Nuclear—2.5 to 5.7 g Ceq/kWh Solar PV—27.3 to 76.4 g Ceq/kWh Hydroelectric—1.1 to 64.6 g Ceq/kWh Biomass—8.4 to 16.6 g Ceq/kWh Wind—2.5 to 13.1 g Ceq/kWh
Storm van Leeuwen and Smith (2008)	Author did not evaluate nuclear versus renewable energy sources.
Fritsche (2006) (Values estimated from graph in Figure 4)	Nuclear—33 g Ceq/kWh Solar PV—125 g Ceq/kWh Hydroelectric—50 g Ceq/kWh Wind—20 g Ceq/kWh
POST (2006) (Nuclear calculations from AEA, 2006)	Nuclear—5 g Ceq/kWh Biomass—25 to 93 g Ceq/kWh Solar PV—35 to 58 g Ceq/kWh Wave/Tidal—25 to 50 g Ceq/kWh Hydroelectric—5 to 30 g Ceq/kWh Wind—4.64 to 5.25 g Ceq/kWh Note: Decrease of uranium ore grade to 0.03 percent would raise nuclear to 6.8 g Ceq/kWh.
Weisser (2006) (Compilation of results from other studies)	Nuclear—2.8 to 24 g Ceq/kWh Solar PV—43 to 73 g Ceq/kWh Hydroelectric—1 to 34 g Ceq/kWh Biomass—35 to 99 g Ceq/kWh Wind—8 to 30 g Ceq/kWh
Fthenakis and Kim (2007)	Nuclear—16 to 55 g Ceq/kWh Solar PV—17 to 49 g Ceq/kWh
Dones (2007)	Author did not evaluate nuclear versus renewable energy sources.

6.2.2 Conclusions: Relative GHG Emissions

The sampling of data presented in Tables 6-2, 6-3, and 6-4 above demonstrates the challenges of any attempt to determine the specific amount of GHG emission attributable to nuclear energy production sources, as different assumptions and calculation methodology will yield differing results. The differences and complexities in these assumptions and analyses will further increase when they're used to project future GHG emissions. Nevertheless, several conclusions can be drawn from the information presented.

First, the various studies indicate a general consensus that nuclear power currently produces fewer GHG emissions than fossil-fuel-based electrical generation, e.g., the GHG emissions from a complete nuclear fuel cycle currently range from 2.5 to 55 g C_{eq}/kWh, as compared to the use of coal plants (264 to 1250 g C_{eq}/kWh) and natural gas plants (120 to 780 g C_{eq}/kWh). The studies also provide estimates of GHG emissions from five renewable energy sources based on current technology. These estimates included solar-photovoltaic (17 to 125 g C_{eq}/kWh), hydroelectric (1 to 64.6 g C_{eq}/kWh), biomass (8.4 to 99 g C_{eq}/kWh), wind (2.5 to 30 g C_{eq}/kWh), and tidal (25 to 50 g C_{eq}/kWh). The range of these estimates is wide, but the general conclusion is that current GHG emissions from the nuclear fuel cycle are of the same order of magnitude as from these renewable energy sources.

Second, the studies indicate no consensus on future relative GHG emissions from nuclear power and other sources of electricity. There is substantial disagreement among the various authors regarding the GHG emissions associated with declining uranium ore concentrations, future uranium enrichment methods, and other factors, including changes in technology. Similar disagreement exists regarding future GHG emissions associated with coal and natural gas for electricity generation. Even the most conservative studies conclude that the nuclear fuel cycle currently produces fewer GHG emissions than fossil-fuel-based sources, and is expected to continue to do so in the near future. The primary difference between the authors is the projected cross-over date (the time at which GHG emissions from the nuclear fuel cycle exceed those of fossil-fuel-based sources) or whether cross-over will actually occur.

Considering the current estimates and future uncertainties, it appears that GHG emissions associated with the proposed Salem and HCGS relicensing action are likely to be lower than those associated with fossil-fuel-based energy sources. The NRC staff bases this conclusion on the following rationale:

1. As shown in Tables 6-2 and 6-3, the current estimates of GHG emissions from the nuclear fuel cycle are far below those for fossil-fuel-based energy sources;

2. Salem and HCGS license renewal will involve continued GHG emissions due to uranium mining, processing, and enrichment, but will not result in increased GHG emissions associated with plant construction or decommissioning (as the plant will have to be decommissioned at some point whether or not the license is renewed); and

3. Few studies predict that nuclear fuel cycle emissions will exceed those of fossil fuels within a timeframe that includes the Salem and HCGS period of extended operation. Several studies suggest that future extraction and enrichment methods, the potential for

higher grade resource discovery, and technology improvements could extend this timeframe.

With respect to a comparison of GHG emissions among the proposed Salem and HCGS license renewal action and renewable energy sources, it appears likely that there will be future technology improvements and changes in the type of energy used for mining, processing, and constructing facilities of all types. Currently, the GHG emissions associated with the nuclear fuel cycle and renewable energy sources are comparable i.e., within the same order of magnitude. Because nuclear fuel production is the most significant contributor to possible future increases in GHG emissions from nuclear power, and because most renewable energy sources lack a fuel component, it is likely that GHG emissions from renewable energy sources would be lower than those associated with Salem and HCGS at some point during the period of extended operation.

The NRC staff also provides an additional discussion about the contribution of GHG to cumulative air quality impacts in Section 4.11.2 of this SEIS.

6.3 REFERENCES

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10 CFR Part 63. *Code of Federal Regulations*, Title 10, *Energy*, Part 63, "Disposal of High-Level Radioactive Wastes in a Geologic Repository at Yucca Mountain, Nevada."

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7.0 ENVIRONMENTAL IMPACTS OF DECOMMISSIONING

Decommissioning is defined as the safe removal of a nuclear facility from service and the reduction of residual radioactivity to a level that permits release of the property for unrestricted use and termination of the license. The U.S. Nuclear Regulatory Commission (NRC) issued a generic environmental impact statement (GEIS) for decommissioning (NRC, 2002) that evaluated the environmental impacts from the activities associated with the decommissioning of any reactor before or at the end of an initial or renewed license.

The NRC staff has not identified any new and significant information during the review of the PSEG Nuclear, LLC (PSEG) environmental reports (ERs) for Salem Nuclear Generating Station, Units 1 and 2 (Salem) and Hope Creek Generating Station (HCGS) (PSEG, 2009a; PSEG, 2009b), the site audit, or the scoping process. Therefore, there are no impacts related to these issues beyond those discussed in the GEIS (NRC, 1996; NRC, 1999). For the issues listed in Table 7-1 below, the GEIS concluded that the impacts are SMALL.

Table 7-1. Issues Related to Decommissioning. *Decommissioning would occur regardless of whether the Salem and HCGS units were shut down at the end of their currect operating licenses or at the end of the extended operation periods. There are no site-specific issues related to decommissioning.*

Issues	GEIS Section	Category
Radiation doses	7.3.1; 7.4	1
Waste management	7.3.2; 7.4	1
Air quality	7.3.3; 7.4	1
Water quality	7.3.4; 7.4	1
Ecological resources	7.3.5; 7.4	1
Socioeconomic impacts	7.3.7; 7.4	1

7.1 References

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8.0 ENVIRONMENTAL IMPACTS OF ALTERNATIVES

The National Environmental Policy Act (NEPA) mandates that each environmental impact statement (EIS) consider alternatives to any proposed major Federal action significantly affecting the quality of the human environment. U.S. Nuclear Regulatory Commission (NRC) regulations implementing NEPA for license renewal require that a supplemental environmental impact statement (SEIS) consider and weigh “the environmental effects of the proposed action (license renewal); the environmental impacts of alternatives to the proposed action; and alternatives available for reducing or avoiding adverse environmental impacts” (Title 10 of the *Code of Federal Regulations* (CFR) 51.71(d)).

This SEIS considers the proposed Federal action of issuing a renewed license for the Salem Nuclear Generating Stations, Units 1 and 2 (Salem) and Hope Creek Generating Station (HCGS), which would allow the plants to operate for 20 years beyond the current license expiration dates. In this chapter, the NRC staff (Staff) examines the potential environmental impacts of alternatives to issuing a renewed operating license for Salem and HCGS, as well as alternatives that may reduce or avoid adverse environmental impacts from license renewal, when and where these alternatives are applicable.

While the *Generic Environmental Impact Statement (GEIS) for License Renewal of Nuclear Plants*, NUREG-1437 (NRC, 1996; NRC, 1999), reached generic conclusions regarding many environmental issues associated with license renewal, it did not determine which alternatives are reasonable or reach conclusions about site-specific environmental impact levels. As such, the Staff must evaluate environmental impacts of alternatives on a site-specific basis.

Alternatives to the proposed action of issuing renewed Salem and HCGS operating licenses must meet the purpose and need for issuing a renewed license. They must:

> provide an option that allows for power generation capability beyond the term of a current nuclear power plant operating license to meet future system generating needs, as such needs may be determined by State, utility, and, where authorized, Federal (other than NRC) decision makers. (NRC, 1996)

The Staff ultimately makes no decision as to which alternative (or the proposed action) to implement, since that decision falls to energy-planning decision-makers. If NRC decides not to renew the licenses (or takes no action at all), then energy-planning decision-makers may no longer elect to continue operating Salem and HCGS and will have to resort to another alternative—which may or may not be one of the alternatives considered in this section—to meet their energy needs.

In evaluating alternatives to license renewal, the Staff first selects energy technologies or options currently in commercial operation, as well as some technologies not currently in commercial operation but likely to be commercially available by the time the current Salem and HCGS operating licenses expire. The current Salem operating licenses will expire on August 13, 2016, for Unit 1 and April 18, 2020, for Unit 2. The current HCGS operating license will expire on April 11, 2026. An alternative must be available (constructed, permitted, and connected to the grid) by the time the current Salem and HCGS licenses expire.

Second, the Staff screens the alternatives to remove those that cannot meet future system needs, and then screens the remaining options to remove those with costs or benefits that do not justify their inclusion in the range of reasonable alternatives. Any alternatives remaining, then, constitute alternatives to the proposed action that the Staff evaluates in detail throughout this section. In Section 8.2, the SEIS briefly addresses each alternative that the Staff removed during screening and explains why each alternative was removed.

The Staff initially considered 17 discrete alternatives to the proposed action, and then narrowed the list to two discrete alternatives and a combination of alternatives considered in Section 8.1.

Once the Staff identifies alternatives for in-depth review, the Staff refers to generic environmental impact evaluations in the GEIS. The GEIS provides overviews of some energy technologies available at the time of its publishing in 1996, though it does not reach any conclusions regarding which alternatives are most appropriate, nor does it categorize impacts for each site. In addition, since 1996, many energy technologies have evolved significantly in capability and cost, while regulatory structures have changed to either promote or impede development of particular alternatives.

As a result, the Staff's analysis starts with the GEIS and then includes updated information from sources like the Energy Information Administration (EIA), other organizations within the Department of Energy (DOE), the Environmental Protection Agency (EPA), industry sources and publications, and information submitted in the PSEG Nuclear, LLC (PSEG, the applicant) environmental report (ER).

For each in-depth analysis, the Staff analyzes environmental impacts across seven impact categories: (1) air quality, (2) groundwater use and quality, (3) surface water use and quality, (4) aquatic and terrestrial ecology, (5) human health, (6) socioeconomics, and (7) waste management. As in earlier chapters of this draft SEIS, the Staff uses the NRC's three-level standard of significance—SMALL, MODERATE, or LARGE—to indicate the degree of the environmental effect on each of the seven aforementioned categories that have been evaluated.

In-Depth Alternatives:

- **Supercritical coal-fired**
- **Natural gas-fired combined-cycle**
- **Combination**

Other Alternatives Considered:

- **Offsite Coal-Fired and Natural Gas-Fired**
- **New nuclear**
- **Conservation/ Efficiency**
- **Purchased power**
- **Solar power**
- **Wood-fired**
- **Wind (onshore/offshore)**
- **Hydroelectric power**
- **Wave and ocean energy**
- **Geothermal power**
- **Municipal solid waste**
- **Biofuels**
- **Oil-fired power**
- **Fuel cells**
- **Delayed retirement**

The in-depth alternatives that the Staff considered include (1) a supercritical coal-fired plant in Section 8.1.1, (2) a natural gas-fired combined-cycle power plant in Section 8.1.2, and (3) a combination of alternatives in Section 8.1.3 that includes natural gas-fired combined-cycle generation, energy conservation, and a wind power component. In Section 8.2, the Staff explains why it dismissed many other alternatives from in-depth consideration. In Section 8.3, the Staff considers the environmental effects that may occur if NRC takes no action and does not issue renewed licenses for Salem and HCGS. Finally, in Section 8.4, the impacts of all alternatives are summarized.

> **Energy Outlook:** Each year the Energy Information Administration (EIA), part of the U.S. Department of Energy (DOE), issues its updated *Annual Energy Outlook (AEO)*. *AEO 2009* indicates that natural gas, coal, and renewable are likely to fuel most new electrical capacity through 2030, with some growth in nuclear capacity (EIA, 2009a), though all projections are subject to future developments in fuel price or electricity demand:
>
> "Natural-gas-fired plants account for 53 percent of capacity additions in the reference case, as compared with 22 percent for renewable, 18 percent for coal-fired plants, and 5 percent for nuclear. Capacity expansion decisions consider capital, operating, and transmission costs. Typically, coal-fired, nuclear, and renewable plants are capital-intensive, whereas operating (fuel) expenditures account for most of the costs associated with natural-gas-fired capacity."

In addition, for each of the alternatives mentioned above, the Staff took the general approach of evaluating each as a potential alternative to completely replace the power production capacity of all three units currently at Salem and HCGS. However, during the preparation of this SEIS, the Staff also considered the possible scenarios of license renewal for Salem but not HCGS and vice versa, as the application for each plant was submitted separately. The Staff has determined that such scenarios would present various combinations of alternatives that would essentially equate to different variations of alternatives (1), (2), and (3) above (e.g., a supercritical coal-fired plant that replaces Salem alongside a renewed HCGS, or a natural gas-fired combined-cycle plant that replaces HCGS alongside a renewed Salem). Given the large number of combinations that this would create, the Staff evaluated the alternatives using a bounding approach, as provided in Section 8.1 below, which can be scaled down for a qualitative representation of what the impacts would be for combinations such as a supercritical coal-fired plant replacing Salem alongside a renewed HCGS. For example, the Staff estimates that the resource impacts for that combination would fall between those of the continued operation at Salem and HCGS and those of the impacts from a supercritical coal-fired plant as described in Section 8.1.1, where impacts for air quality, human health, socioeconomics, and waste management would range from SMALL to MODERATE.

8.1 Alternative Energy Sources

8.1.1 Supercritical Coal-Fired Generation

The GEIS indicates that a 3,656 megawatt-electric (MW[e]) supercritical coal-fired power plant (a plant equivalent in capacity to each individual Salem Unit 1, Salem Unit 2, and HCGS plants) could require 6,200 ac (2,600 ha) of available land area, and thus would not fit on the existing 1,480 ac (599 ha) owned by PSEG at the Salem and HCGS sites; however, the Staff notes that many coal-fired power plants with larger capacities have been located on smaller sites. In the ERs, PSEG assumed that a coal-fired alternative would be developed on the existing Salem and HCGS sites. The Staff believes this to be reasonable and, as such, will consider a coal-fired alternative located on the current Salem and HCGS sites.

Coal-fired generation accounts for 48.2 percent of U.S. electrical power generation, a greater share than any other fuel (EIA, 2010a). Furthermore, the EIA projects that coal-fired power plants will account for the greatest share of added capacity through 2030—more than natural gas, nuclear or renewable generation options (EIA, 2009a). While coal-fired power plants are widely used and likely to remain widely used, the Staff notes that future coal capacity additions may be affected by perceived or actual efforts to limit greenhouse gas (GHG) emissions. For now, the Staff considers a coal-fired alternative to be a feasible, commercially available option that could provide electrical generating capacity after the Salem and HCGS current licenses expire.

Supercritical technologies are increasingly common in new coal-fired plants. Supercritical plants operate at higher temperatures and pressures than most existing coal-fired plants (beyond water's "critical point", where boiling no longer occurs and no clear phase change occurs between steam and liquid water). Operating at higher temperatures and pressures allows this coal-fired alternative to function at a higher thermal efficiency than many existing coal-fired power plants do. While supercritical facilities are more expensive to construct, they consume less fuel for a given output, reducing environmental impacts. Based on technology forecasts from EIA, the Staff expects that a new, supercritical coal-fired plant beginning operation in 2014 would operate at a heat rate of 9069 British thermal units/kilowatt hour (Btu/kWh), or approximately 38 percent thermal efficiency (EIA, 2009a).

In a supercritical coal-fired power plant, burning coal heats pressurized water. As the supercritical steam/water mixture moves through plant pipes to a turbine generator, the pressure drops and the mixture flashes to steam. The heated steam expands across the turbine stages, which then spin and turn the generator to produce electricity. After passing through the turbine, any remaining steam is condensed back to water in the plant's condenser.

In most modern U.S. facilities, condenser cooling water circulates through cooling towers or a cooling pond system (either of which are closed-cycle cooling systems). Older plants often withdraw cooling water directly from existing rivers or lakes and discharge heated water directly to the same body of water (called open-cycle cooling). Salem operates open-cycle cooling water using once-through cooling at both of their units, while HCGS operates a closed-cycle cooling system with a natural draft cooling tower. Although nuclear plants require more cooling capacity than an equivalently sized coal-fired plant, the existing cooling tower at HCGS, by itself, is not expected to be adequate to support a coal-fired alternative that would have the capacity to replace both Salem and HCGS. Therefore, implementation of a coal-fired alternative would require the construction of additional cooling towers to provide the necessary cooling capacity to support the replacement of both Salem and HCGS. Under the coal-fired alternative, the facility would withdraw makeup water from and discharge blowdown (water containing concentrated dissolved solids and biocides) from cooling towers back to the Delaware River, similar to the manner in which the current HCGS cooling tower operates. However, additional cooling towers would be required, so the volume of water managed in cooling towers would increase. At the same time, the once-through cooling system associated with the Salem Units 1 and 2 would cease operation.

In order to replace the 3,656 net MW(e) that Salem and HCGS currently supply, the coal-fired alternative would need to produce roughly 3889 gross MW(e), using about 6 percent of power output for onsite power usage (PSEG, 2009a; PSEG, 2009b). Onsite electricity demands include scrubbers, cooling towers, coal-handling equipment, lights, communication, and other onsite needs. A supercritical coal-fired plant equivalent in capacity to Salem and HCGS would require less cooling water than Salem and HCGS because the alternative operates at a higher thermal efficiency. The 3,889 gross MW(e) would be achieved using standard-sized units, which are assumed to be approximately equivalent to six units of 630 MW(e) each.

The 3,656 net MW(e) power plants would consume approximately 12.2 million tons (11.1 million metric tons [MT]) of coal annually (EPA, 2006). EIA reports that most coal consumed in New Jersey originates in West Virginia or Pennsylvania (EIA, 2010b). Given current coal mining operations in this area, the coal used in this alternative would likely be mined by a combination of strip (mountaintop-removal) mining and underground mining. The coal would be mechanically processed and washed, and transported by barge to the Salem and HCGS facility. Limestone for scrubbers would also likely be delivered by barge. This coal-fired alternative would produce roughly 753,960 tons (684,440 MT) of ash annually (EIA, 2010b), and roughly 245,300 tons (222,700 MT) of scrubber sludge annually (PSEG, 2009a; PSEG, 2009b). Much of the coal ash and scrubbed sludge could be reused depending on local recycling and reuse markets.

The coal-fired alternative would also include construction impacts such as clearing the plant site of vegetation, excavation, and preparing the site surface before other crews begin actual construction of the plant and any associated infrastructure. Because this alternative would be constructed at the Salem and HCGS site, it is unlikely that new transmission lines would be necessary. Because coal would be supplied by barge, no construction of a new rail line would be necessary.

8.1.1.1 Air Quality

Air quality impacts from coal-fired generation can increase substantially as compared to license renewal because these power plants emit significant quantities of sulfur oxides (SO_x), nitrogen oxides (NO_x), particulates, carbon monoxide (CO), and hazardous air pollutants such as mercury. However, many of these pollutants can be reduced using various pollution control technologies.

As previously discussed in Section 4.1.1.5, Salem and HCGS are located in Salem County, New Jersey. Salem County is designated as an attainment/unclassified area with respect to the National Ambient Air Quality Standards (NAAQSs) for particulate matter 2.5 microns or less in diameter ($PM_{2.5}$), sulfur dioxide (SO_2), NO_x, CO, and lead. The county, along with all of southern New Jersey, is a nonattainment area with respect to the 1-hour primary ozone standard and the 8-hour ozone standard. For the 1-hour ozone standard, Salem County is located within the multi-state Philadelphia-Wilmington-Trenton non-attainment area, and for the 8-hour ozone standard, it is located in the Philadelphia-Wilmington-Atlantic City (PA-NJ-DE-MD) non attainment area.

A new coal-fired generating plant would qualify as a new major-emitting industrial facility and would be subject to Prevention of Significant Deterioration of Air Quality Review under requirements of Clean Air Act (CAA), adopted by the New Jersey Department of Environmental Protection (NJDEP) Bureau of Air Quality Permitting. A new coal-fired generating plant would need to comply with the new source performance standards for coal-fired plants set forth in 40 CFR 60 Subpart Da. The standards establish limits for particulate matter and opacity (40 CFR 60.42(a)), SO_2 (40 CFR 60.43(a)), and NO_x (40 CFR 60.44(a)). Regulations issued by NJDEP adopt the EPA's CAA rules (with modifications) to limit power plant emissions of SO_x, NO_x, particulate matter, and hazardous air pollutants. The new coal-fired generating plant would qualify as a major facility as defined in Section 7:27-22.1 of the New Jersey Administrative Code, and would be required to obtain a major source permit from NJDEP.

Section 169A of the CAA (42 *United States Code* (U.S.C.) 7401) establishes a national goal of preventing future and remedying existing impairment of visibility in mandatory Class I Federal areas when impairment results from man-made air pollution. The EPA issued a new regional haze rule in 1999 (64 *Federal Register* (FR) 35714). The rule specifies that for each mandatory Class I Federal area located within a state, the State must establish goals that provide for reasonable progress towards achieving natural visibility conditions through developing and implementing air quality protection plans to reduce the pollution that causes visibility impairment. The reasonable progress goals must provide an improvement in visibility for the most-impaired days over the period of implementation plan and ensure no degradation in visibility for the least-impaired days over the same period (40 CFR 51.308(d)(1)). Five regional planning organizations (RPO) collaborate on the visibility impairment issue, developing the technical basis for these plans. The State of New Jersey is among eleven member states (Maryland, Delaware, New Jersey, Pennsylvania, New York, Connecticut, Rhode Island, Massachusetts, Vermont, New Hampshire, and Maine) of the Mid-Atlantic/Northeast Visibility Union (MANE-VU), along with tribes, Federal agencies, and other interested parties that identifies regional haze and visibility issues and develops strategies to address them (NJDEP, 2009a). The visibility protection regulatory requirements, contained in 40 CFR Part 51, Subpart P, include the review of the new sources that would be constructed in the attainment or unclassified areas and may affect visibility in any Federal Class I area (40 CFR Part 51, Subpart P, §51.307). If a coal-fired plant were located close to a mandatory Class I area, additional air pollution control requirements would be imposed. There is one mandatory Class I Federal area in the State of New Jersey, which is the Brigantine National Wildlife Refuge (40 CFR 81.420), located approximately 58 miles (mi; 93 kilometers [km]) southeast of the Salem and HCGS facilities. There are no Class I Federal areas in Delaware, and no other areas located within 100 mi (161 km) of the facilities (40 CFR 81.400). New Jersey is also subject to the Clean Air Interstate Rule (CAIR), which has outlined emissions reduction goals for both SO_2 and NO_x for the year 2015. CAIR will aid New Jersey sources in reducing SO_2 emissions by 25,000 tons (23,000 MT, or 49 percent), and NO_x emissions by 11,000 tons (10,000 MT, or 48 percent; EPA, 2010).

The Staff projects that the coal-fired alternative at the Salem and HCGS site would have the following emissions for criteria and other significant emissions based on published EIA data, EPA emission factors and on performance characteristics for this alternative and likely emission controls:

- Sulfur oxides (SO_x) – 12,566 tons (11,407 MT) per year
- Nitrogen oxides (NO_x) – 3,050 tons (769 MT) per year
- Particulate matter (PM) PM_{10} – 85.4 tons (77.5 MT) per year
- Particulate matter (PM) $PM_{2.5}$ – 22.6 tons (20.5 MT) per year
- Carbon monoxide (CO) – 3,050 tons (2,769 MT) per year

Sulfur Oxides

The coal-fired alternative at the Salem and HCGS site would likely use wet, limestone-based scrubbers to remove SO_x. The EPA indicates that this technology can remove more than 95 percent of SO_x from flue gases. The Staff projects total SO_x emissions after scrubbing would be 12,566 tons (11,407 MT) per year. SO_x emissions from a new coal-fired power plant would be subject to the requirements of Title IV of the CAA. Title IV was enacted to reduce emissions of SO_2 and NO_x, the two principal precursors of acid rain, by restricting emissions of these pollutants from power plants. Title IV caps aggregate annual power plant SO_2 emissions and imposes controls on SO_2 emissions through a system of marketable allowances. The EPA issues one allowance for each ton of SO_2 that a unit is allowed to emit. New units do not receive allowances, but are required to have allowances to cover their SO_2 emissions. Owners of new units must therefore purchase allowances from owners of other power plants or reduce SO_2 emissions at other power plants they own. Allowances can be banked for use in future years. Thus, provided a new coal-fired power plant is able to purchase sufficient allowances to operate, it would not add to net regional SO_2 emissions, although it might do so locally.

Nitrogen Oxides

A coal-fired alternative at the Salem and HCGS site would most likely employ various available NO_x-control technologies, which can be grouped into two main categories: combustion modifications and post-combustion processes. Combustion modifications include low-NO_x burners, over fire air, and operational modifications. Post-combustion processes include selective catalytic reduction and selective non-catalytic reduction. An effective combination of the combustion modifications and post-combustion processes allow the reduction of NO_x emissions by up to 95 percent (EPA, 1998). PSEG indicated in its ER that the technology would use low NO_x burners, overfire air, and selective catalytic reduction to reduce NO_x emissions by approximately 95 percent from uncontrolled emissions. As a result, the NO_x emissions associated with a coal-fired alternative at the Salem and HCGS site would be approximately 3,050 tons (2,769 MT) per year.

Section 407 of the CAA establishes technology-based emission limitations for NO_x emissions. A new coal-fired power plant would be subject to the new source performance standards for such plants as indicated in 40 CFR 60.44a(d)(1). This regulation, issued on September 16, 1998 (63 FR 49442), limits the discharge of any gases that contain nitrogen oxides (NO_2) to 1.6 pounds per megawatt hour (lb/MWh) of NO_x per joule (J) of gross energy output (equivalent to

200 nanograms [ng]), based on a 30-day rolling average. Based on the projected emissions, the proposed alternative would easily meet this regulation.

Particulates

The new coal-fired power plant would use baghouse-based fabric filters to remove particulates from flue gases. PSEG indicated that this technology would remove 99.9 percent of particulate matter. The EPA notes that filters are capable of removing in excess of 99 percent of particulate matter, and that SO_2 scrubbers further reduce particulate matter emissions (EPA, 2008a). Based on EPA emission factors, the new supercritical coal-fired plant would emit 85.4 tons (77.5 MT) per year of particulate matter having an aerodynamic diameter less than or equal to 10 microns (PM_{10}) annually (EPA, 1998; EIA, 2010b). In addition, coal burning would also result in approximately 22.6 tons (20.5 MT) per year of $PM_{2.5}$. Coal-handling equipment would introduce fugitive dust emissions when fuel is being transferred to onsite storage and then reclaimed from storage for use in the plant. During the construction of a coal-fired plant, onsite activities would also generate fugitive dust. Vehicles and motorized equipment would create exhaust emissions during the construction process. These impacts would be intermittent and short-lived, however, and to minimize dust generation construction crews would use applicable dust-control measures.

Carbon Monoxide

Based on EPA emission factors and assumed plant characteristics, the Staff computed that the total CO emissions would be approximately 3,050 tons (2,769 MT) per year (EPA, 1998).

Hazardous Air Pollutants

Consistent with the D.C. Circuit Court's February 8, 2008 ruling that vacated its Clean Air Mercury Rule (CAMR), the EPA is in the process of developing mercury emissions standards for power plants under the CAA (Section 112) (EPA, 2009a). Before CAMR, the EPA determined that coal-and oil-fired electric utility steam-generating units are significant emitters of hazardous air pollutants (HAPs; 65 FR 79825). The EPA determined that coal plants emit arsenic, beryllium, cadmium, chromium, dioxins, hydrogen chloride, hydrogen fluoride, lead, manganese, and mercury (65 FR 79825). The EPA concluded that mercury is the HAP of greatest concern; it further concluded 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).

On February 6, 2009, the Supreme Court dismissed the EPA's request to review the 2008 Circuit Court's decision, and also denied a similar request by the Utility Air Regulatory Group later that month (EPA, 2009a).

Carbon Dioxide

A coal-fired plant would also have unregulated carbon dioxide (CO_2) emissions during operations as well as during mining, processing, and transportation, which the GEIS indicates could contribute to global warming. The coal-fired plant would emit approximately 33,611,000 tons (30,512,000 MT) per year of CO_2.

Construction Impacts

Activities associated with the construction of a new coal-fired plant at the Salem and HCGS site would cause some additional air effects as a result of equipment emissions and fugitive dust from operation of the earth-moving and material handling equipment. Workers' vehicles and motorized construction equipment would generate temporary exhaust emissions. The construction crews would employ dust-control practices in order to control and reduce fugitive dust, which would be temporary in nature. The staff concludes that the impact of vehicle exhaust emissions and fugitive dust from operation of earth-moving and material handling equipment would be SMALL.

Summary of Air Quality

While the GEIS analysis mentions global warming from unregulated CO_2 emissions and acid rain from SO_x and NO_x emissions as potential impacts, it does not quantify emissions from coal-fired power plants. However, the GEIS analysis does imply that air impacts would be substantial (NRC, 1996). The above analysis shows that emissions of air pollutants, including SO_x, NO_x, CO, and particulates, exceed those produced by the existing nuclear power plant, as well as those of the other alternatives considered in this section. Operational emissions of CO_2 are also much greater under the coal-fired alternative, as reviewed by the Staff in Section 6.2 and in the previous sections. Adverse human health effects such as cancer and emphysema have also been associated with air emissions from coal combustion, and are discussed further in Section 8.1.1.5.

The NRC analysis for a coal-fired alternative at the Salem and HCGS site indicates that impacts from the coal-fired alternative would have clearly noticeable effects, but given existing regulatory regimes, permit requirements, and emissions controls, the coal-fired alternative would not destabilize air quality. Therefore, the appropriate characterization of air quality impacts from operation of a coal-fired plant located at the Salem and HCGS site would be MODERATE. Existing air quality would result in varying needs for pollution control equipment to meet applicable local requirements, or varying degrees of participation in emissions trading schemes.

8.1.1.2 Groundwater Use and Quality

If the onsite coal-fired alternative continued to use groundwater for drinking water and service water, the need for groundwater at the plant would be minor. Total usage would likely be less than Salem and HCGS because many fewer workers would be onsite, and because the coal-fired unit would have fewer auxiliary systems requiring service water. No effect on groundwater quality would be apparent.

Construction of a coal-fired plant could have a localized effect on groundwater due to temporary dewatering and run-off control measures. Because of the temporary nature of construction and the likelihood of reduced groundwater usage during operation, the impact of the coal-fired alternative would be SMALL.

8.1.1.3 Surface Water Use and Quality

The alternative would require a consumptive use of water from the Delaware River for cooling purposes. Because this consumptive loss would be from an estuary, the NRC concludes the impact of surface water use would be SMALL. A new coal-fired plant would be required to obtain a National Pollutant Discharge and Elimination System (NPDES) permit from the NJDEP for regulation of industrial wastewater, storm water, and other discharges. Assuming the plant operates within the limits of this permit, the impact from any cooling tower blowdown, site runoff, and other effluent discharges on surface water quality would be SMALL.

8.1.1.4 Aquatic and Terrestrial Ecology

Aquatic Ecology

Impacts to aquatic ecology resources from a coal-fired alternative at the Salem and HCGS site could result from effects on water bodies both adjacent to and distant from the site. Temporary effects on some aquatic organisms likely would result from construction that could occur in the water near the shoreline at the facility. Longer-term, more extensive effects on aquatic organisms likely would occur during the period of operation of the facility due to the intake of cooling water and discharge of effluents to the estuary. The numbers of fish and other aquatic organisms affected by impingement, entrainment, and thermal impacts would be substantially smaller than those associated with license renewal. Water consumption from and discharge of blowdown to the Delaware Estuary would be lower due to the higher thermal efficiency of the coal-fired facility and its use of only closed-cycle cooling. In addition, the intake and discharge would be monitored and regulated by the NJDEP under the facility's NPDES permit, including requirements under Clean Water Act (CWA) Section 316(a) and 316(b) for thermal discharges and cooling water intakes, respectively. Assuming the use of closed-cycle cooling and adherence to regulatory requirements, the impact on ecological resources of the Delaware Estuary from operation of the intake and discharge facilities would be minimal for this alternative.

Thus, impacts to aquatic ecology as a result of the effects of facility operations may occur on the adjacent Delaware Estuary. The coal-fired alternative potentially would have noticeable effects on aquatic resources in multiple areas. Given existing regulatory regimes, permit requirements, and emissions controls, these effects would be limited and unlikely to destabilize aquatic communities. Therefore, the impacts to aquatic resources from a coal-fired plant located at the Salem and HCGS site would be SMALL for the Delaware Estuary.

Terrestrial Ecology

Constructing the coal-fired alternative onsite would require approximately 505 ac (204 ha) of land for construction of the power block with an additional 193–386 ac (56–78 ha) for waste disposal, which PSEG indicated could be accommodated on the existing site (see Section 8.1.1.6) (PSEG, 2009a; PSEG, 2009b). Onsite impacts to terrestrial ecology may occur if additional land requirements result in the encroachment into or filling of the adjacent tidal marsh. In addition, if additional roads would need to be constructed through less disturbed areas, impacts could occur as these construction activities may fragment or destroy local ecological communities. Land disturbances could affect habitats of native wildlife; however, these impacts are not expected to be extensive. Cooling tower operation would produce drift that could result in some deposition of dissolved solids on surrounding vegetation and soils onsite and offsite.

Onsite or offsite waste disposal by landfilling also would affect terrestrial ecology at least until the time when the disposal area is reclaimed. Deposition of acid rain resulting from NO_x and SO_x emissions, as well as the deposition of other pollutants, also could affect terrestrial ecology. Air deposition impacts may be noticeable but, given the emission controls discussed in Section 8.1.1.1, are unlikely to be destabilizing. Thus, the impacts to terrestrial resources from a coal-fired plant located at the Salem and HCGS site would be SMALL to MODERATE.

8.1.1.5 Human Health

Coal-fired power plants introduce worker risks from new plant construction, coal and limestone mining, from coal and limestone transportation, and from disposal of coal combustion and scrubber wastes. In addition, there are public risks from inhalation of stack emissions (as addressed in Section 8.1.1.1) and the secondary effects of eating foods grown in areas subject to deposition from plant stacks.

Human health risks of coal-fired power plants are described, in general, in Table 8-2 of the GEIS (NRC, 1996). Cancer and emphysema as a result of the inhalation of toxins and particulates are identified as potential health risks to occupational workers and members of the public (NRC, 1996). The human health risks of coal-fired power plants, both to occupational workers and to members of the public, are greater than those of the current Salem and HCGS facilities due to exposures to chemicals such as mercury; SO_x; NO_x; radioactive elements such as uranium and thorium contained in coal and coal ash; and polycyclic aromatic hydrocarbon (PAH) compounds, including benzo(a)pyrene.

During construction activities there would be also risk to workers from typical industrial incidents and accidents. Accidental injuries are not uncommon in the construction industry and accidents resulting in fatalities do occur. However, the occurrence of such events is mitigated by the use of proper industrial hygiene practices, worker safety requirements, and training. Occupational and public health impacts during construction are expected to be controlled by continued application of accepted industrial hygiene and occupational health and safety practices.

Regulations restricting emissions—enforced by EPA or State agencies—have acted to significantly reduce potential health effects but have not entirely eliminated them. These agencies also impose site-specific emission limits as needed to protect human health. Even if the coal-fired alternative were located in a nonattainment area, emission controls and trading or offset mechanisms could prevent further regional degradation; however, local effects could be visible. Many of the byproducts of coal combustion responsible for health effects are largely controlled, captured, or converted in modern power plants (as described in Section 8.1.1.1), although some level of health effects may remain.

Aside from emission impacts, the coal-fired alternative introduces the risk of coal pile fires and, for those plants that use coal combustion liquid and sludge waste impoundments, the release of the waste due to a failure of the impoundment. Although there have been several instances of this occurring in recent years, these types of events are still relatively rare.

Based on the cumulative potential impacts of construction activities, emissions, and materials management on human health, the NRC staff considers the overall impact of constructing and operating a new coal-fired facility to be MODERATE.

8.1.1.6 Socioeconomics

Land Use

The GEIS generically evaluates the impacts of nuclear power plant operations on land use both on and off each power plant site. The analysis of land use impacts focuses on the amount of land area that would be affected by the construction and operation of a new supercritical coal-fired power plant on the Salem and HCGS site.

The GEIS indicates that an estimated 1,700 ac (700 ha) would be required for constructing a 1,000-MW(e) coal plant. Scaling from the GEIS estimate, approximately 6,200 ac (2,500 ha) would be required to replace the 3,656 MW(e) provided by Salem and HCGS. PSEG indicated that approximately 505 ac (204 ha) of land would be needed to support a coal-fired alternative capable of replacing the Salem and HCGS facilities (PSEG, 2009a; PSEG, 2009b). This amount of land use includes power plant structures and associated coal delivery and waste disposal infrastructure. However, many coal-fired power plants with larger capacities have been located on smaller sites, and the PSEG estimate is considered reasonable. PSEG indicated that an additional 193 ac (78 ha) of land area may be needed for waste disposal over the 20-year license renewal term, or 386 ac (156 ha) over the 40-year operational life of a coal-fired alternative, which PSEG indicated could be accommodated onsite (PSEG, 2009a; PSEG, 2009b).

Offsite land use impacts would occur from coal mining, in addition to land use impacts from the construction and operation of the new power plant. According to the GEIS, supplying coal to a 1,000-MW(e) plant would disturb approximately 22,000 ac (8,900 ha) of land for the mining of coal and disposing of wastes during the 40-year operational life. Scaling from GEIS estimates, approximately 80,500 ac (32,580 ha) of land would be required for a coal-fired alternative to replace Salem and HCGS. However, most of the land in existing coal-mining areas has already experienced some level of disturbance. The elimination of the need for uranium mining to supply fuel for the Salem and HCGS facilities would partially offset this offsite land use impact. Scaling from GEIS estimates, approximately 3,660 ac (1,480 ha) of land used for uranium mining and processing would no longer be needed.

Based on this information and the need for additional land at Salem and HCGS, land use impacts would range from SMALL to MODERATE.

Socioeconomics

Socioeconomic impacts are defined in terms of changes to the demographic and economic characteristics and social conditions of a region. For example, the number of jobs created by the construction and operation of a new coal-fired power plant could affect regional employment, income, and expenditures. Two types of job creation result from this alternative: (1) construction-related jobs, and (2) operation-related jobs in support of power plant operations, which have the greater potential for permanent, long-term socioeconomic impacts. The Staff estimated workforce requirements during power plant construction and operation for the coal-fired alternative in order to measure their possible effect on current socioeconomic conditions.

According to the GEIS, a peak construction workforce of 1,200 to 2,500 would be required for a 1,000 MW(e) plant. Scaling from GEIS estimates, this would require a lower-end workforce of approximately 4,400 for a 3,660-MW(e) plant). PSEG projected a peak workforce of about 5,660 would be required to construct the coal-fired alternative at the Salem and HCGS site (PSEG, 2009a; PSEG, 2009b). During the construction period, the communities surrounding the plant site would experience increased demand for rental housing and public services. The relative economic contributions of these workers to local business and tax revenues would vary.

After construction, local communities could be temporarily affected by the loss of construction jobs and associated loss in demand for business services. In addition, the rental housing market could experience increased vacancies and decreased prices. As noted in the GEIS, the socioeconomic impacts at a rural construction site could be larger than at an urban site, because the workforce would need to relocate closer to the construction site. Although the ER indicates that Salem and HCGS is a rural site (PSEG, 2009a; PSEG, 2009b), it is located near the Philadelphia and Wilmington metropolitan areas. Therefore, these effects may be somewhat lessened because workers are likely to commute to the site from these areas instead of relocating closer to the construction site. Based on the site's proximity to these metropolitan areas, construction impacts would be SMALL.

PSEG estimated an operational workforce of approximately 500 workers for the 3,660 MW(e) supercritical coal-fired power plant alternative (PSEG, 2009a; PSEG 2009b). This would result in a loss of approximately 1,100 relatively high-paying jobs (based on a current Salem and HCGS workforce of 1,614), with a corresponding reduction in purchasing activity and tax contributions to the regional economy. The impact of the job loss, however, may not be noticeable given the amount of time that would be required for the construction of a new power plant and the decommissioning of the existing facilities and the relatively large region from which Salem and HCGS personnel are currently drawn. The size of property tax payments under the coal-fired alternative may increase if additional land is required at Salem and HCGS to support this alternative. Operational impacts would therefore range from SMALL to MODERATE.

Transportation

During periods of peak construction activity, up to 5,660 workers could be commuting daily to the site, as well as the current 1,614 workers already at Salem and HCGS. In addition to commuting workers, trucks would be transporting construction materials and equipment to the worksite, thereby increasing the amount of traffic on local roads. The increase in vehicular traffic on roads would peak during shift changes resulting in temporary level of service impacts and delays at intersections. Barges would likely be used to deliver large components to the Salem and HCGS site. Transportation impacts would likely be MODERATE during construction.

Transportation traffic-related impacts would be greatly reduced after construction, but would not disappear during plant operations. The maximum number of plant operating personnel commuting to the Salem and HCGS site would be approximately 500 workers. This is much smaller than the number of operations workers commuting to Salem and HCGS today. Deliveries of coal and limestone would be by barge. The coal-fired alternative transportation impacts would likely be SMALL during plant operations.

Aesthetics

The aesthetics impact analysis focuses on the degree of contrast between the coal-fired alternative and the surrounding landscape and the visibility of the coal plant.

The coal-fired power plant would be up to 200 feet (61 meters [m]) tall with exhaust stacks up to 500 feet (152 m). The facility would be visible offsite during daylight hours. The supercritical coal-fired power plant would be similar in height to the current Salem and HCGS reactor containment buildings (190 to 200 feet, or 58 to 61 m, tall) and the HCGS cooling tower, which stands at 514 feet (157 m). The coal-fired alternative would require more than one cooling tower, thus increasing the size of the plume. Lighting on plant structures would be visible offsite at night. Overall, aesthetic impacts associated with the supercritical coal-fired alternative would range from SMALL to MODERATE.

Coal-fired generation would introduce new sources of noise that would be audible offsite. Sources contributing to noise produced by coal-fired power plant operations would be classified as continuous or intermittent. Continuous noise sources include the mechanical equipment associated with normal plant operations. Intermittent noise sources include the equipment related to coal handling, solid-waste disposal, use of outside loudspeakers, and the commuting of plant employees. The impact of plant noise emissions are expected to be SMALL due to the distance from the Salem and HCGS site to the nearest receptors.

Historic and Archaeological Resources

Cultural resources are the indications of human occupation and use of the landscape as defined and protected by a series of Federal laws, regulations, and guidelines. Prehistoric resources are physical remains of human activities that predate written records; they generally consist of artifacts that may alone or collectively yield information about the past. Historic resources consist of physical remains that postdate the emergence of written records; in the United States, they are architectural structures or districts, archaeological objects, and archaeological features dating from 1492 and later. Ordinarily, sites less than 50 years old are not considered historic, but exceptions can be made for such properties if they are of particular importance, such as structures associated with the development of nuclear power (e.g., Shippingport Atomic Power Station) or Cold War themes. American Indian resources are sites, areas, and materials important to American Indians for religious or heritage reasons. Such resources may include geographic features, plants, animals, cemeteries, battlefields, trails, and environmental features. The cultural resource analysis encompassed the power plant site and adjacent areas that could potentially be disturbed by the construction and operation of alternative power plants.

The potential for historic and archaeological resources can vary greatly depending on the location of the proposed site. To consider a project's effects on historic and archaeological resources, any affected areas would need to be surveyed to identify and record historic and archaeological resources, identify cultural resources (e.g., traditional cultural properties), and develop possible mitigation measures to address any adverse effects from ground disturbing activities.

Before construction at the Salem and HCGS site studies would likely be needed to identify, evaluate, and address mitigation of potential impacts of new plant construction on cultural resources. Studies would be needed for all areas of potential disturbance at the proposed plant site and along associated corridors where construction would occur (e.g., roads, transmission corridors, rail lines, or other Right-of-Ways [ROWs]). Areas with the greatest sensitivity should be avoided.

As noted in Section 4.9.6, there is little potential for historic and archaeological resources to be present on most of the Salem and HCGS site; therefore, the impact for a coal-fired alternative at the Salem and HCGS site would likely be SMALL.

Environmental Justice

The environmental justice impact analysis evaluates the potential for disproportionately high and adverse human health and environmental effects on minority and low-income populations that could result from the construction and operation of a new supercritical coal-fired power plant. Adverse health effects are measured in terms of the risk and rate of fatal or nonfatal adverse impacts on human health. Disproportionately high and adverse human health effects occur when the risk or rate of exposure to an environmental hazard for a minority or low-income population is significant and exceeds the risk or exposure rate for the general population or for another appropriate comparison group. Disproportionately high environmental effects refer to impacts or risk of impact on the natural or physical environment in a minority or low-income community that are significant and appreciably exceed the environmental impact on the larger community. Such effects may include biological, cultural, economic, or social impacts. Some of these potential effects have been identified in resource areas discussed in this SEIS. For example, increased demand for rental housing during power plant construction could disproportionately affect low-income populations. Minority and low-income populations are subsets of the general public residing around Salem and HCGS, and all are exposed to the same hazards generated from constructing and operating a new coal-fired power plant. For socioeconomic data regarding the analysis of environmental justice issues, the reader is referred to Section 4.9.7, Environmental Justice.

Potential impacts to minority and low-income populations from the construction and operation of a new supercritical coal-fired power plant at Salem and HCGS would mostly consist of environmental and socioeconomic effects (e.g., noise, dust, traffic, employment, and housing impacts). Noise and dust impacts from construction would be short-term and primarily limited to onsite activities. Minority and low-income populations residing along site access roads would also be affected by increased commuter vehicle traffic during shift changes and truck traffic. However, these effects would be temporary during certain hours of the day and not likely to be high and adverse. Increased demand for rental housing in the vicinity of Salem and HCGS during construction could affect low-income populations. Given the close proximity to the Philadelphia and Wilmington metropolitan areas, most construction workers would likely commute to the site, thereby reducing the potential demand for rental housing.

Based on this information and the analysis of human health and environmental impacts presented in this SEIS, the construction and operation of a new supercritical coal-fired power plant would not have disproportionately high and adverse human health and environmental effects on minority and low-income populations residing in the vicinity of Salem and HCGS.

8.1.1.7 Waste Management

Coal combustion generates several waste streams including ash (a dry solid) and sludge (a semi-solid byproduct of emission control system operation). The Staff estimates that an approximately 3,656 MW(e) power plant comprised of six units of approximately 630 MW(e) each would generate annually a total of approximately 684,440 MT (753,960 tons) of ash (EIA, 2010b), and 245,300 tons (222,700 MT) of scrubber sludge (PSEG, 2009a; PSEG, 2009b) About 340,000 tons (309,000 MT) or 45 percent of the ash waste and 193,800 tons (176,000 MT) or 79 percent of scrubber sludge would be recycled, based on industry-average recycling rates (ACAA, 2007). Therefore, approximately 414,000 tons (375,000 MT) of ash and 51,500 tons (46,700 MT) of scrubber sludge would remain annually for disposal. Disposal of the remaining waste could noticeably affect land use and groundwater quality, but would require proper citing in accordance with the describe local ordinance and the implementation of the required monitoring and management practices in order to minimize these impacts (state reference). After closure of the waste site and revegetation, the land could be available for other uses.

In May 2000, the EPA issued a “Notice of Regulatory Determination on Wastes from the Combustion of Fossil Fuels” (65 FR 32214) stating that it would issue regulations for disposal of coal combustion waste under Subtitle D of the Resource Conservation and Recovery Act. The EPA has not yet issued these regulations.

The impacts from waste generated during operation of this coal-fired alternative would be clearly visible, but would not destabilize any important resource.

The amount of the construction waste would be small compared to the amount of waste generated during operational stage and much of it could be recycled. Overall, the impacts from waste generated during construction stage would be minor.

Therefore, the Staff concludes that the overall impacts from construction and operation of this alternative would be MODERATE.

Table 8-1. Summary of the Direct and Indirect Environmental Impacts of the Supercritical Coal-Fired Alternative Compared to Continued Operation of Salem and HCGS

	Supercritical Coal-Fired Generation	Continued Salem and HCGS Operation
Air Quality	MODERATE	SMALL
Groundwater	SMALL	SMALL
Surface Water	SMALL	SMALL
Aquatic and Terrestrial Resources	SMALL to MODERATE	SMALL
Human Health	MODERATE	SMALL
Socioeconomics	SMALL to MODERATE	SMALL to LARGE
Waste Management	MODERATE	SMALL

8.1.2 Natural Gas-fired Combined-Cycle Generation

In this section, the Staff evaluates the environmental impacts of a natural gas-fired combined-cycle generation plant at the Salem and HCGS site.

Natural gas fueled 21.4 percent of electric generation in the US in 2008 (the most recent year for which data are available); this accounted for the second greatest share of electrical power after coal (EIA, 2010a). Like coal-fired power plants, natural gas-fired plants may be affected by perceived or actual actions to limit GHG emissions; they produce markedly lower GHG emissions per unit of electrical output than coal-fired plants. Natural gas-fired power plants are feasible and provide commercially available options for providing electrical generating capacity beyond Salem and HCGS's current license expiration dates.

Combined-cycle power plants differ significantly from coal-fired and existing nuclear power plants. They derive the majority of their electrical output from a gas-turbine cycle, and then generate additional power—without burning any additional fuel—through a second, steam-turbine cycle. The first, gas turbine stage (similar to a large jet engine) burns natural gas that turns a driveshaft that powers an electric generator. The exhaust gas from the gas turbine is still hot enough, however, to boil water into steam. Ducts carry the hot exhaust to a heat recovery steam generator, which produces steam to drive a steam turbine and produce additional electrical power. The combined-cycle approach is significantly more efficient than any one cycle on its own; thermal efficiency can exceed 60 percent. Since the natural gas-fired alternative derives much of its power from a gas turbine cycle, and because it wastes less heat than either the coal-fired alternative or the existing Salem and HCGS, it requires significantly less cooling.

In order to replace the 3,656 MW(e) that Salem and HCGS currently supply, the Staff selected a gas-fired alternative that uses nine GE STAG 107H combined-cycle generating units. While any number of commercially available combined-cycle units could be installed in a variety of combinations to replace the power currently produced by Salem and HCGS, the STAG 107H is a highly efficient model that would help minimize environmental impacts (GE, 2001). Other manufacturers, like Siemens, offer similarly high efficiency models. This gas-fired alternative produces a net 400 MW(e) per unit. Nine units would produce a total of 3,600 MW(e), or nearly the same output as the existing Salem and HCGS plants.

The combined-cycle alternative operates at a heat rate of 5,687 btu/kWh, or about 60 percent thermal efficiency (GE, 2001). Allowing for onsite power usage, including cooling towers and site lighting, the gross output of these units would be roughly 3,744 MW(e). As noted above, this gas-fired alternative would require much less cooling water than Salem and HCGS because it operates at a higher thermal efficiency and because it requires much less water for steam cycle condenser cooling. This alternative would likely make use of the site's existing natural draft cooling tower, but may require the construction of an additional tower.

In addition to the already existing natural draft cooling tower, other visible structures onsite would include the turbine buildings, two exhaust stacks, an electrical switchyard, and, possibly, equipment associated with a natural gas pipeline, like a compressor station. The GEIS estimates indicate that this 3,600 MW(e) plant would require 400 ac (165 ha), which would be feasible on the 1,480 ac (599 ha) PSEG site.

This 3600 MW(e) power plant would consume 161.65 billion cubic feet (ft^3; 4,578 million cubic meters [m^3]) of natural gas annually assuming an average heat content of 1,029 btu/ft^3 (EIA, 2009b). Natural gas would be extracted from the ground through wells, then treated to remove impurities (like hydrogen sulfide), and blended to meet pipeline gas standards, before being piped through the interstate pipeline system to the power plant site. This gas-fired alternative would produce relatively little waste, primarily in the form of spent catalysts used for emissions controls.

Environmental impacts from the gas-fired alternative would be greatest during construction. The closest natural gas pipeline that could serve as a source of natural gas for the plant is located in Logan Township, approximately 25 mi (40 km) from the Salem and HCGS facilities (PSEG, 2010). Site crews would clear vegetation from the site, prepare the site surface, and begin excavation before other crews begin actual construction on the plant and any associated infrastructure, including the 25-mi (40 km) pipeline spur to serve the plant and electricity transmission infrastructure connecting the plant to existing transmission lines. Constructing the gas-fired alternative on the Salem and HCGS site would allow the gas-fired alternative to make use of the existing electric transmission system.

8.1.2.1 Air Quality

Salem and HCGS are located in Salem County, New Jersey. The general air quality regulatory status of the Salem County region is as described in Section 8.1.1.1 for the coal-fired generation alternative. A new gas-fired generating plant would qualify as a new major-emitting industrial facility and would be subject to Prevention of Significant Deterioration of Air Quality Review under requirements of CAA, adopted by the NJDEP Bureau of Air Quality Permitting. The natural gas-fired plant would need to comply with the standards of performance for stationary gas turbines set forth in 40 CFR Part 60 Subpart GG. Regulations issued by NJDEP adopt the EPA's CAA rules (with modifications) to limit power plant emissions of SO_x, NO_x, particulate matter, and hazardous air pollutants. The new gas-fired generating plant would qualify as a major facility as defined in Section 7:27-22.1 of the New Jersey Administrative Code, and would be required to obtain a major source permit from NJDEP.

As previously discussed in Section 8.1.1.1, Section 169A of the CAA (42 U.S.C. 7401) establishes a national goal of preventing future and remedying existing impairment of visibility in mandatory Class I Federal areas when impairment results from man-made air pollution. If a gas-fired plant were located close to a mandatory Class I area, additional air pollution control requirements would be imposed. There is one mandatory Class I Federal area in the State of New Jersey, which is the Brigantine National Wildlife Refuge (40 CFR 81.420), located approximately 58 mi (93 km) southeast of the Salem and HCGS facilities. There are no Class I Federal areas in Delaware, and no other area located within 100 mi (161 km) of the facilities (40 CFR 81.400). New Jersey is also subject to the CAIR, which has outlined emissions reduction goals for both SO_2 and NO_x for the year 2015 (See Section 8.1.1.1). The Staff projects the following emissions for a gas-fired alternative based on data published by the EIA, the EPA, and on performance characteristics for this alternative and its emissions controls:

- Sulfur oxides (SO_x) – 53 tons (48 MT) per year
- Nitrogen oxides (NO_x) – 932 tons (846 MT) per year
- Carbon monoxide (CO) – 193 tons (175 MT) per year
- Total suspended particles (TSP) – 162 tons (147 MT) per year
- Particulate matter (PM) PM_{10} – 162 tons (147 MT) per year
- Carbon dioxide (CO_2) – 9,400,000 tons (8,500,000 MT) per year

Sulfur and Nitrogen Oxides

As stated above, the new natural gas-fired alternative would produce 53 tons (48 MT) per year of SO_x (assumed to be all SO_2) (EPA, 2000; INGAA, 2000) and 932 tons (846 MT) per year of NO_x based on the use of the dry low NO_x combustion technology and use of the selective catalytic reduction (SCR) in order to significantly reduce NO_x emissions (INGAA, 2000). The new plant would be subjected to the continuous monitoring requirements for SO_2, NO_x and CO_2 as specified in 40 CFR Part 75. A new natural gas-fired plant would have to comply with Title IV of the CAA reduction requirements for SO_2 and NO_x, which are the main precursors of acid rain and the major cause of reduced visibility. Title IV establishes maximum SO_2 and NO_x emission rate from the existing plants and a system of the SO_2 emission allowances that can be used, sold or saved for future use by new plants.

Particulates

Based on EPA emission factors (EPA, 2000), the new natural gas-fired alternative would produce 162 tons (147 MT) per year of TSP, all of which would be emitted as PM_{10}.

Carbon Monoxide

Based on EPA emission factors (EPA, 2000), the Staff estimates that the total CO emissions would be approximately 193 tons (175 MT) per year.

Hazardous Air Pollutants

The EPA issued in December 2000 regulatory findings (65 FR 79825) on emissions of hazardous air pollutants from electric utility steam-generating units, which identified that natural gas-fired plants emit hazardous air pollutants such as arsenic, formaldehyde and nickel and stated that

> . . . the impacts due to HAP emissions from natural gas-fired electric utility steam generating units were negligible based on the results of the study. The Administrator finds that regulation of HAP emissions from natural gas-fired electric utility steam generating units is not appropriate or necessary.

Carbon Dioxide

The new plant would be subjected to the continuous monitoring requirements for SO_2, NO_x and CO_2 specified in 40 CFR Part 75. The Staff computed that the natural gas-fired plant would emit approximately 9.4 million tons (8.5 million MT) per year of unregulated CO_2 emissions. In response to the Consolidated Appropriations Act of 2008, the EPA has proposed a rule that requires mandatory reporting of GHG emissions from large sources that would allow collection of accurate and comprehensive emissions data to inform future policy decisions (EPA, 2009b). The EPA proposes that suppliers of fossil fuels or industrial GHGs, manufacturers of vehicles and engines, and facilities that emit 25,000 MT or more per year of GHG emissions submit annual reports to the EPA. The gases covered by the proposed rule are CO_2, methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFC), perfluorocarbons (PFC), sulfur hexafluoride (SF_6), and other fluorinated gases including nitrogen trifluoride (NF_3) and hydrofluorinated ethers (HFE).

Construction Impacts

Activities associated with the construction of the new natural gas-fired plant at the Salem and HCGS site would cause some additional air effects as a result of equipment emissions and fugitive dust from operation of the earth-moving and material handling equipment. Workers' vehicles and motorized construction equipment would generate temporary exhaust emissions. The construction crews would employ dust-control practices in order to control and reduce fugitive dust, which would be temporary in nature. The Staff concludes that the impact of vehicle exhaust emissions and fugitive dust from operation of earth-moving and material handling equipment would be SMALL.

The overall air quality impacts from a new natural gas-fired plant located at the Salem and HCGS site would be SMALL to MODERATE, primarily due to air pollutant emissions from plant operation.

8.1.2.2 Groundwater Use and Quality

The use of groundwater for a natural gas-fired combined-cycle plant would likely be limited to supply wells for drinking water and possibly filtered service water for system cleaning purposes. Total usage would likely be much less than Salem and HCGS because many fewer workers would be onsite, and because the gas-fired alternative would have fewer auxiliary systems requiring service water.

No effects on groundwater quality would be apparent except during the construction phase due to temporary dewatering and run-off control measures. Because of the temporary nature of construction and the likelihood of reduced groundwater usage during operation, the impact of the natural gas-fired alternative would be SMALL.

8.1.2.3 Surface Water Use and Quality

The alternative would require a consumptive use of water from the Delaware River for cooling purposes. Because this consumptive loss would be from an estuary, the NRC concludes the impact of surface water use would be SMALL. A new natural gas-fired plant would be required to obtain an NPDES permit from the NJDEP for regulation of industrial wastewater, storm water, and other discharges. Assuming the plant operates within the limits of this permit, the impact from any cooling tower blowdown, site runoff, and other effluent discharges on surface water quality would be SMALL.

8.1.2.4 Aquatic and Terrestrial Ecology

Aquatic Ecology

Compared to the existing Salem and HCGS facilities, impacts on aquatic ecology from the onsite, gas-fired alternative would be substantially smaller because the combined-cycle plant would inject significantly less heat to the environment and require less water. Also, any new plants (including coal) would fall under EPA's Phase I rules for new plants and would have closed cycle cooling. Adverse effects (impingement and entrainment and thermal effects) would be substantially less than those of the existing Salem and HCGS facilities. The numbers of fish and other aquatic organisms affected by impingement, entrainment, and thermal impacts would be smaller than those associated with license renewal because water consumption and blowdown discharged to the Delaware Estuary would be substantially lower. Some temporary impacts on aquatic organisms may occur due to construction. Longer-term effects could result from effluents discharged to the river. However, NRC assumes that the appropriate agencies would monitor and regulate such activities. The number of organisms affected by impingement, entrainment, and thermal effects of this alternative would be substantially less than for license renewal, so NRC expects that the levels of impact for the natural gas alternative would be SMALL.

Terrestrial Ecology

Constructing the natural gas alternative would require approximately 128 ac (52 ha) of land according to PSEG estimates (PSEG, 2009a; PSEG, 2009b). Scaling from the GEIS estimate, approximately 400 ac (165 ha) would be required to replace the 3,600 MW(e) provided by Salem and HCGS. These land disturbances are the principal means by which this alternative would affect terrestrial ecology.

Onsite impacts to terrestrial ecology may occur if additional land requirements result in the encroachment into or filling of the adjacent tidal marsh. However, based on the anticipated land requirements, the encroachment should be minimal. In addition, if additional roads would need to be constructed through less disturbed areas, impacts could occur as these construction activities may fragment or destroy local ecological communities. Land disturbances could affect habitats of native wildlife; however, these impacts are not expected to be extensive. Gas extraction and collection would also affect terrestrial ecology in offsite gas fields, although much of this land is likely already disturbed by gas extraction, and the incremental effects of this alternative on gas field terrestrial ecology are difficult to gauge.

Construction of the nine natural-gas-fired units could entail some loss of native wildlife habitats; however, these impacts are not expected to be extensive. If new roads and a new cooling tower were required to be constructed through less disturbed areas, these activities could fragment or destroy local ecological communities, thereby increasing impacts. Operation of the cooling tower would cause some deposition of particulates on surrounding vegetation (including wetlands) and soils from cooling tower drift. Overall, impacts to terrestrial resources at the site would be minimal and limited mostly to the construction period. Construction of a 150-ft (46-m), wide 25-mi (40-km) long gas pipeline (to the nearest assumed tie-in) could lead to further disturbance to undeveloped areas. However, PSEG indicated that the pipeline would be routed along existing, previously disturbed rights-of-way and would expect to only temporarily impact terrestrial species. Because of the relatively small potential for undisturbed land to be affected, impacts from construction of the pipeline are expected to be minimal.

Based on this information, impacts to terrestrial resources from the onsite, gas-fired alternative would be SMALL.

8.1.2.5 Human Health

Like the coal-fired alternative discussed above, a gas-fired plant would emit criteria air pollutants, but in smaller quantities (except NO_x, which requires additional controls to reduce emissions). Human health effects of gas-fired generation are generally low, although in Table 8-2 of the GEIS (NRC, 1996), the Staff identified cancer and emphysema as potential health risks from gas-fired plants. NO_x emissions contribute to ozone formation, which in turn contributes to human health risks. Emission controls on this gas-fired alternative maintain NO_x emissions well below air quality standards established for the purposes of protecting human health, and emissions trading or offset requirements mean that overall NO_x in the region would not increase. Health risks to workers may also result from handling spent catalysts from NO_x emission control equipment that may contain heavy metals.

During construction activities there would be a risk to workers from typical industrial incidents and accidents. Accidental injuries are not uncommon in the construction industry, and accidents resulting in fatalities do occur. However, the occurrence of such events is mitigated by the use of proper industrial hygiene practices, worker safety requirements, and training. Occupational and public health impacts during construction are expected to be controlled by continued application of accepted industrial hygiene and occupational health and safety practices. Fewer workers would be on site for a shorter period of time to construct a gas-fired plant that other new power generation alternatives, and so exposure to occupational risks tends to be lower than other alternatives.

Overall, human health risks to occupational workers and to members of the public from gas-fired power plant emissions sited at the Salem and HCGS site would be less than the risks described for coal-fired alternative and therefore, would likely be SMALL.

8.1.2.6 Socioeconomics

Land Use

The analysis of land use impacts focuses on the amount of land area that would be affected by the construction and operation of a nine-unit natural gas-fired combined-cycle power plant at the Salem and HCGS site.

PSEG indicated that approximately 128 ac (52 ha) of land would be needed to support a natural gas-fired alternative to replace Salem and HCGS (PSEG 2009a; PSEG, 2009b). Scaling from the GEIS estimate, approximately 400 ac (165 ha) would be required to replace the 3,600 MW(e) provided by Salem and HCGS. This amount of onsite land use would include other plant structures and associated infrastructure. Onsite land use impacts from construction would be SMALL.

In addition to onsite land requirements, land would be required offsite for natural gas wells and collection stations. Scaling from GEIS estimates, approximately 12,960 ac (5,200 ha) would be required for wells, collection stations, and a 25-mi (40 km) pipeline spur to bring the gas to the plant. Most of this land requirement would occur on land where gas extraction already occurs. In addition, some natural gas could come from outside of the United States and be delivered as liquefied gas.

The elimination of uranium fuel for the Salem and HCGS facilities could partially offset offsite land requirements. Scaling from GEIS estimates, approximately 3,660 ac (1,480 ha) would not be needed for mining and processing uranium during the 40-year operating life of the plant. Based on this information and the need for additional land at Salem and HCGS, overall land use impacts from a gas-fired power plant would be SMALL to MODERATE.

Socioeconomics

Socioeconomic impacts are defined in terms of changes to the demographic and economic characteristics and social conditions of a region. For example, the number of jobs created by the construction and operation of a new natural gas-fired power plant could affect regional employment, income, and expenditures. Two types of job creation would result: (1) construction-related jobs, which are transient, short in duration, and less likely to have a long-term socioeconomic impact; and (2) operation-related jobs in support of power plant operations, which have the greater potential for permanent, long-term socioeconomic impacts. Workforce requirements for the construction and operation of the natural gas-fired power plant alternative were evaluated in order to measure their possible effect on current socioeconomic conditions.

While the GEIS estimates a peak construction workforce of 4,320, PSEG projected a maximum construction workforce of 2,920 (PSEG 2009a; PSEG, 2009b). During construction, the communities surrounding the power plant site would experience increased demand for rental housing and public services. The relative economic effect of construction workers on local economy and tax revenue would vary.

After construction, local communities could be temporarily affected by the loss of construction jobs and associated loss in demand for business services, and the rental housing market could experience increased vacancies and decreased prices. As noted in the GEIS, the socioeconomic impacts at a rural construction site could be larger than at an urban site, because the workforce would have to move to be closer to the construction site. Although the ER identifies the Salem and HCGS site as a primarily rural site (PSEG, 2009a; PSEG, 2009b), it is located near the Philadelphia and Wilmington metropolitan areas. Therefore, these effects would likely be lessened because workers are likely to commute to the site from these areas instead of relocating closer to the construction site. Because of the site's proximity to these larger population centers, the impact of construction on socioeconomic conditions would be SMALL.

PSEG estimated a power plant operations workforce of approximately 132 (PSEG, 2009a), (PSEG, 2009b). Scaling from GEIS estimates of an operational workforce of 150 employees for a 1,000-MW(e) gas-fired plant, 540 workers would be required to replace the 3600 MW(e) provided by Salem and HCGS. The PSEG estimate appears reasonable and is consistent with trends toward lowering labor costs by reducing the size of power plant operations workforces. This would result in a loss of approximately 1,070 to 1,480 relatively high-paying jobs (based on a current Salem and HCGS workforce of 1,614), with a corresponding reduction in purchasing activity and tax contributions to the regional economy. The impact of the job loss, however, may not be noticeable given the amount of time required for the construction of a new power plant and the decommissioning of the existing facilities and the relatively large region from which Salem and HCGS personnel are currently drawn. The size of property tax payments under the gas-fired alternative may increase if additional land is required at Salem and HCGS to support this alternative. Operational impacts would therefore range from SMALL to MODERATE.

Transportation

Transportation impacts associated with construction and operation of a nine-unit gas-fired power plant would consist of commuting workers and truck deliveries of construction materials to the Salem and HCGS site. During periods of peak construction activity, between 2,900 and 4,300 workers could be commuting daily to the site, as well as the current 1,614 workers already at Salem and HCGS. In addition to commuting workers, trucks would be transporting construction materials and equipment to the worksite thereby increasing the amount of traffic on local roads. The increase in vehicular traffic would peak during shift changes resulting in temporary level of service impacts and delays at intersections. Some large plant components would likely be delivered by barge. Pipeline construction and modification to existing natural gas pipeline systems could also have an impact on local traffic. Traffic-related transportation impacts during construction would likely be MODERATE.

During plant operations, traffic-related transportation impacts would be greatly reduced. According to PSEG, approximately 132 workers would be needed to operate the gas-fired power plant. Fuel for the plant would be transported by pipeline. The transportation infrastructure would experience little to no increased traffic from plant operations. Overall, the gas-fired alternative transportation impacts would be SMALL during plant operations.

Aesthetics

The aesthetics impact analysis focuses on the degree of contrast between the natural gas-fired alternative and the surrounding landscape and the visibility of the gas-fired plant.

The nine gas-fired units would be approximately 100 foot (30 m) tall, with an exhaust stack up to 200 feet (61 m). The facility would be visible offsite during daylight hours. However, the gas-fired power plant would be shorter than the existing HCGS cooling tower, which stands at 514 feet (157 m). This alternative would likely make use of the site's existing natural draft cooling tower. The condensate plume that would be generated would be no more noticeable than the existing plume from HCGS. Noise from plant operations, as well as lighting on plant structures, would be detectable offsite. Pipelines delivering natural gas fuel could be audible offsite near gas compressors.

In general, aesthetic changes would be limited to the immediate vicinity of Salem and HCGS and would be SMALL.

Historic and Archaeological Resources

Cultural resources are the indications of human occupation and use of the landscape as defined and protected by a series of Federal laws, regulations, and guidelines. Prehistoric resources are physical remains of human activities that predate written records; they generally consist of artifacts that may alone or collectively yield information about the past. Historic resources consist of physical remains that postdate the emergence of written records; in the United States, they are architectural structures or districts, archaeological objects, and archaeological features dating from 1492 and later. Ordinarily, sites less than 50 years old are not considered historic, but exceptions can be made for such properties if they are of particular importance, such as structures associated with the development of nuclear power (e.g., Shippingport Atomic Power Station) or Cold War themes. American Indian resources are sites, areas, and materials important to American Indians for religious or heritage reasons. Such resources may include geographic features, plants, animals, cemeteries, battlefields, trails, and environmental features. The cultural resource analysis encompassed the power plant site and adjacent areas that could potentially be disturbed by the construction and operation of alternative power plants.

The potential for historic and archaeological resources can vary greatly depending on the location of the proposed site. To consider a project's effects on historic and archaeological resources, any affected areas would need to be surveyed to identify and record historic and archaeological resources, identify cultural resources (e.g., traditional cultural properties), and develop possible mitigation measures to address any adverse effects from ground disturbing activities.

Before construction at the Salem and HCGS site, studies would likely be needed to identify, evaluate, and address mitigation of potential impacts of new plant construction on cultural resources. Studies would be needed for all areas of potential disturbance at the proposed plant site and along associated corridors where construction would occur (e.g., roads, transmission corridors, rail lines, or other ROWs). Areas with the greatest sensitivity should be avoided.

As noted in Section 4.9.6, there is little potential for historic and archaeological resources to be present on most of the Salem and HCGS site; therefore, the impact for a natural gas-fired alternative at the Salem and HCGS site would likely be SMALL.

Environmental Justice

The environmental justice impact analysis evaluates the potential for disproportionately high and adverse human health and environmental effects on minority and low-income populations that could result from the construction and operation of a new natural gas-fired combined-cycle power plant. Adverse health effects are measured in terms of the risk and rate of fatal or nonfatal adverse impacts on human health. Disproportionately high and adverse human health effects occur when the risk or rate of exposure to an environmental hazard for a minority or low-income population is significant and exceed the risk or exposure rate for the general population or for another appropriate comparison group. Disproportionately high environmental effects refer to impacts or risk of impact on the natural or physical environment in a minority or low-income community that are significant and appreciably exceeds the environmental impact on the larger community. Such effects may include biological, cultural, economic, or social impacts. Some of these potential effects have been identified in resource areas discussed in this SEIS. For example, increased demand for rental housing during power plant construction could disproportionately affect low-income populations. Minority and low-income populations are subsets of the general public residing around Salem and HCGS, and all are exposed to the same hazards generated from constructing and operating a new natural gas-fired combined-cycle power plant. For socioeconomic data regarding the analysis of environmental justice issues, the reader is referred to Section 4.9.7, Environmental Justice.

Potential impacts to minority and low-income populations from the construction and operation of a new natural gas-fired combined-cycle power plant at Salem and HCGS would mostly consist of environmental and socioeconomic effects (e.g., noise, dust, traffic, employment, and housing impacts). Noise and dust impacts from construction would be short-term and primarily limited to onsite activities. Minority and low-income populations residing along site access roads would also be affected by increased commuter vehicle traffic during shift changes and truck traffic. However, these effects would be temporary during certain hours of the day and not likely to be high and adverse. Increased demand for rental housing in the vicinity of Salem and HCGS during construction could affect low-income populations. Given the close proximity to the Philadelphia and Wilmington metropolitan areas, most construction workers would likely commute to the site, thereby reducing the potential demand for rental housing.

Based on this information and the analysis of human health and environmental impacts presented in this SEIS, the construction and operation of a new natural gas-fired combined-cycle power plant would not have disproportionately high and adverse human health and environmental effects on minority and low-income populations residing in the vicinity of Salem and HCGS.

8.1.2.7 Waste Management

During the construction phase of this alternative, land clearing and other construction activities would generate waste that can be recycled, disposed onsite or shipped to an offsite waste disposal facility. Because the alternative would be constructed on the previously disturbed Salem and HCGS site, the amounts of wastes produced during land clearing would be reduced.

During the operational stage, spent SCR catalysts used to control NOx emissions from the natural gas-fired plants would make up the majority of the waste generated by this alternative. This waste would be disposed of according to applicable Federal and state regulations.

The Staff concluded in the GEIS (NRC, 1996), that a natural gas-fired plant would generate minimal waste and the waste impacts would be SMALL for a natural gas-fired alternative located at the Salem and HCGS site.

Table 8-2. Summary of the Direct and Indirect Environmental Impacts of the Natural Gas Combined-Cycle Generation Alternative Compared to Continued Operation of Salem and HCGS

	Natural Gas Combined-Cycle Generation	Continued Salem and HCGS Operation
Air Quality	SMALL to MODERATE	SMALL
Groundwater	SMALL	SMALL
Surface Water	SMALL	SMALL
Aquatic and Terrestrial Resources	SMALL	SMALL
Human Health	SMALL	SMALL
Socioeconomics	SMALL to MODERATE	SMALL to LARGE
Waste Management	SMALL	SMALL

8.1.3 Combination Alternative

Even though individual alternatives to license renewal might not be sufficient on their own to replace the 3,656 MW(e) total capacity of Salem and HCGS because of the lack of resource availability, technical maturity, or regulatory barriers, it is conceivable that a combination of alternatives might be sufficient.

There are many possible combinations of alternatives that could be considered to replace the power generated by Salem and HCGS. In the GEIS, NRC staff indicated that consideration of alternatives would be limited to single, discrete generating options, given the virtually unlimited number of combinations available. In this section, the NRC staff examines a possible combination of alternatives. Under this alternative, both Salem and HCGS would be retired and a combination of other alternatives would be considered, as follows:

- Denying the re-license application for Salem and HCGS
- Constructing five 400 MW(e) natural gas-fired combined-cycle plants at Salem
- Obtaining 878 MW(e) from renewable energy sources (primarily offshore wind)
- Implementing 731 MW(e) of efficiency and conservation programs, from among the 3,300 MW of energy efficiency and conservation goals identified by the New Jersey Energy Master Plan (State of New Jersey, 2008) and the Northeast Energy Efficiency Partnerships, Inc. (NEEP, 2009).

The potential contributions of efficiency and conservation programs and renewable energy are based on achievement of the goals of the New Jersey Energy Master Plan (State of New Jersey, 2008). Goal #1 of this Plan is to reduce energy consumption by 20 percent through efficiency and conservation programs. Based on the current generating capacity of 3656 MW(e) of Salem and HCGS, achievement of the 20 percent objective would contribute 731 MW(e) equivalent to this combination alternative. Goal #3 of the New Jersey Energy Master Plan is to increase the current Renewable Portfolio Standard (RPS) to 30 percent. Based on the original generating capacity of 3656 MW(e), with demand reduced by 20 percent to 2925 MW(e) through achievement of Goal #1, a 30 percent renewable energy contribution to this portfolio would comprise 878 MW(e). The remainder of the capacity, or approximately 2000 MW(e), would be generated by the implementation of natural gas generating units.

The following sections analyze the impacts of the alternative outlined above. In some cases, detailed impact analyses for similar actions are described in previous sections of this Chapter. When this occurs, the impacts of the combined alternatives are discussed in a general manner with reference to other sections of this draft SEIS.

Each component of the combination alternative produces different environmental impacts, though several of the options would have impacts similar to—but smaller than—alternatives already addressed in this SEIS. Constructing a total of 2,000 MW(e) of gas-fired capacity on the Salem and HCGS sites would create roughly the same impacts as the on-site combined-cycle natural gas alternative described in Section 8.1.2. This alternative would make use of the existing transmission lines at the sites, but would require construction of a 25-mi (40 km) long natural gas pipeline, the same as would be required under the combined-cycle natural gas alternative evaluated in Section 8.1.2. The amount of air emissions, land use, and water consumption would be reduced due to the smaller number of natural-gas fired units.

The Staff has not yet addressed the impacts of wind power or conservation in this SEIS. A wind installation capable of yielding 878 MW(e) of capacity would likely entail placing wind turbines off of the New Jersey coast. A wind installation capable of delivering 878 MW(e) on average would require approximately 245 turbines with a capacity of 3.6 MW each (MMS, 2010). Because wind power installations do not provide full power all the time, the total installed capacity exceeds the capacity stated here.

Impacts from conservation measures are likely to be negligible, as indicated in the GEIS (NRC, 1996). The primary concerns identified in the GEIS related to indoor air quality and waste disposal. In the GEIS, air quality appeared to become an issue when weatherization initiatives exacerbated existing problems, and were expected not to present significant effects. Waste disposal concerns related to energy-saving measures like fluorescent lighting could be addressed by recycling programs. The overall impact from conservation is considered to be SMALL in all resource areas, though measures that provide weatherization assistance to low-income populations may have positive effects on environmental justice conditions.

8.1.3.1 Air Quality

The combination alternative will have some impact on air quality as a result of emissions from the onsite gas turbines. Because of the size of the units, an individual unit’s impacts would be SMALL. Section 8.1.2.1 of this draft SEIS describes the impacts on air quality from the construction and operation of natural gas units as SMALL to MODERATE. The construction and operation of the wind farm would have only minor impacts on air quality.

Overall, the Staff considers that the air quality impacts from the combination alternative would be SMALL.

8.1.3.2 Groundwater Use and Quality

The use of groundwater for a natural gas-fired combined-cycle plant would likely be limited to supply wells for drinking water and possibly filtered service water for system cleaning purposes. Total usage would likely be much less than Salem and HCGS because many fewer workers would be onsite, and because the gas-fired alternative would have fewer auxiliary systems requiring service water.

No effects on groundwater quality would be apparent except during the construction phase due to temporary dewatering and run-off control measures. Because of the temporary nature of construction and the likelihood of reduced groundwater usage during operation, the impact of the natural gas-fired alternative would be SMALL.

8.1.3.3 Surface Water Use and Quality

The primary water use and quality issues from this alternative would be from the gas-fired units at Salem and HCGS. While construction of a wind farm, particularly if located offshore, would result in some impacts to surface water, these impacts are likely to be short lived. An offshore wind farm is unlikely to be located immediately adjacent to any water users. Construction activities may increase turbidity; however, construction of an onshore wind farm could create additional erosion, as would construction of a gas-fired unit on the Salem and HCGS sites. In general, site management practices keep these effects to a small level.

During operations, only the gas-fired plants would require water for cooling. The natural gas would likely use closed-cycle cooling, which would limit the effects on water resources. As the Staff indicated for the coal-fired and gas-fired alternatives, the gas-fired portion of this alternative is likely to rely on surface water for cooling (or, as is the case in some locations, treated sewage effluent).

The Staff considers impacts on water use and quality to be SMALL for the combination alternative. The onsite impacts at the Salem and HCGS facility would be expected to be similar to the impacts described in Sections 8.1.2.2 and 8.1.2.3 of this draft SEIS.

8.1.3.4 Aquatic and Terrestrial Ecology

Impacts on aquatic and terrestrial ecology from the gas-fired power plant component of the combination alternative, which includes seven gas-fired units, would be similar to those described for the gas-fired alternative in Section 8.1.2.4. Therefore, ecological impacts would similarly be SMALL.

Aquatic Ecology

The wind farm component of this alternative, if located offshore, could have temporary impacts on aquatic organisms due to construction activities, which would likely increase turbidity in the area of construction. The Staff assumes that the appropriate agencies would monitor and regulate such activities. Overall, the impacts to aquatic resources would be SMALL to MODERATE.

Based on data in the GEIS, an onshore wind farm component of the combination alternative producing 878 MW(e) of electricity would require approximately 132,000 ac (53,400 ha) spread over several offsite locations, with less than 10 percent of that land area in actual use for turbines and associated infrastructure. The remainder of the land, if located onshore, could remain in use for activities such as agriculture. Additional land would likely be needed for construction of support infrastructure to connect to existing transmission lines. During construction, there would be an increased potential for erosion and adverse effects on adjacent water bodies, though stormwater management practices are expected to minimize such impacts.

Terrestrial Ecology

Impacts to terrestrial ecology from construction of the wind farm portion of the combination alternative and any needed transmission lines could include loss of terrestrial habitat, an increase in habitat fragmentation and corresponding increase in edge habitat. The GEIS notes that habitat fragmentation may lead to declines of migrant bird populations. Once operational, birds would be likely to collide with the turbines, and migration routes would need to be considered during site selection. Based on this information, impacts to terrestrial resources would be MODERATE.

8.1.3.5 Human Health

The primary health concerns under this option would be occupational health and safety risks during the construction of the new gas turbine and the wind farm. As described previously, if the risks are appropriately managed, the human health impacts from construction and operation of a gas-fired power plant are SMALL. Human health impacts from a wind farm would also be associated primarily with the construction of the facility and would also be minimal. Continued operation of HCGS with the existing closed-cycle cooling system would not change the human health impacts designation of SMALL as discussed in Chapter 4.

Therefore, the Staff concludes that the overall human health impact from the combination alternative would be SMALL.

8.1.3.6 Socioeconomics

Land Use

Impacts from this alternative would include the types of impacts discussed for land use in Section 8.1.2.6 of this draft SEIS. Section 8.1.2.6 states that the land use impacts from the construction of nine gas-fired units at the Salem site would be SMALL to MODERATE. The combined alternative includes seven gas-fired units, which would fit on the existing site without purchasing additional land. In addition to onsite land requirements, land would be required offsite for natural gas wells and collection stations. The land use impacts of the gas-fired component of the combination alternative would be similar to the impacts described in Sections 8.1.2.6, SMALL to MODERATE.

Impacts from the wind power component of this alternative would depend largely on whether the wind facility is located onshore or offshore. Onshore wind facilities would require more land than offshore facilities, simply because all towers and supporting infrastructure would be located on land. According to the GEIS, onshore installations could require approximately 60,000 ac (24,400 ha), though turbines and infrastructure would actually occupy only a small percentage (less than 10 percent) of that land area. The wind farm would most likely be located on agricultural cropland, which would be largely unaffected by the wind turbines.

Although the wind farm would require a large amount of land, only a small component of that land would be in actual use. Also, the elimination of uranium fuel for Salem and HCGS could partially offset offsite land requirements.

Land use impacts of an energy efficiency and conservation program would be SMALL. Rapid replacement and disposal of old energy inefficient appliances and other equipment would generate waste material and could potentially increase the size of landfills. However, given time for program development and implementation, the cost of replacements, and the average life of appliances and other equipment, the replacement process would probably be gradual. Older energy inefficient appliances and equipment would likely be replaced by more efficient appliances and equipment as they fail (especially frequently replaced items, like light bulbs). In addition, many items (like home appliances or industrial equipment) have substantial recycling value and would likely not be disposed of in landfills. Based on this information and the need for additional land, overall, land use impacts from the combination alternative could range from SMALL to MODERATE.

Socioeconomics

As previously discussed, socioeconomic impacts are defined in terms of changes to the demographic and economic characteristics and social conditions of a region. For example, the number of jobs created by the construction and operation of a natural gas-fired power plant at Salem and HCGS and wind farm could affect regional employment, income, and expenditures. Two types of jobs would be created: (1) construction-related jobs, which are transient, short in duration, and less likely to have a long-term socioeconomic impact; and (2) operation-related jobs in support of power generating operations, which have the greater potential for permanent, long-term socioeconomic impacts. The Staff conducted evaluations of construction and operations workforce requirements in order to measure their possible effect on current socioeconomic conditions.

Impacts from this alternative would include the types of impacts discussed for socioeconomics in Section 8.1.2.6 of this draft SEIS. Section 8.1.2.6 states that the socioeconomics impacts from the construction and operation of nine gas-fired units at the Salem site would be SMALL to MODERATE. The combined alternative includes seven gas-fired units. The size of the construction workforce and number of operational workers would be similar. Accordingly, the socioeconomic impacts from the gas-fired component of the combination alternative would be SMALL to MODERATE.

An estimated additional 300 construction workers would be required for the wind farm. These workers could cause a short-term increase in demand for services and temporary (rental) housing in the region around the construction site(s).

After construction, some local communities may be temporarily affected by the loss of the construction jobs and associated loss in demand for business services. The rental housing market could also experience increased vacancies and decreased prices. However, these effects would likely be spread over a larger area, as the wind farms may be constructed in more than one location. The combined effects of these two construction activities would range from SMALL to MODERATE.

Additional estimated operations workforce requirements for this combination alternative would include 50 operations workers for the wind farm. Given the small number of operations workers at these facilities, socioeconomic impacts associated with operation of the natural gas-fired power plant at Salem and HCGS and the wind farm would be SMALL. Socioeconomic effects of an energy efficiency and conservation program would also be SMALL. As noted in the GEIS, the program would likely employ some additional workers.

Transportation

Construction and operation of a natural gas-fired power plant and a wind farm would increase the number of vehicles on roads in the vicinity of these facilities. During construction, cars and trucks would deliver workers, materials, and equipment to the work sites. The increase in vehicular traffic would peak during shift changes resulting in temporary level of service impacts and delays at intersections. Transporting components of wind turbines could have a noticeable impact, but is likely to be spread over a large area. Pipeline construction and modification to existing natural gas pipeline systems could also have an impact on local traffic. Traffic-related transportation impacts during construction could range from SMALL to MODERATE depending on the location of the wind farm site, current road capacities and average daily traffic volumes.

During plant operations, transportation impacts would lessen. Given the small numbers of operations workers at these facilities, levels of service traffic impacts on local roads from operation of the gas-fired power plant at the Salem and HCGS site as well as the wind farm would be SMALL. Transportation impacts at the wind farm site or sites would also depend on current road capacities and average daily traffic volumes, but are likely to be SMALL given the low number of workers employed by that component of the alternative.

Aesthetics

Aesthetic impact analysis focuses on the degree of contrast between the power plant and the surrounding landscape and the visibility of the power plant. In general, aesthetic changes would be limited to the immediate vicinity of Salem and HCGS and the wind farm facilities.

Aesthetic impacts from the gas-fired power plant component of the combination alternative would be essentially the same as those described for the gas-fired alternative in Section 8.1.2.6. Noise during power plant operations would be limited to industrial processes and communications. In addition to the power plant structures, construction of natural gas pipelines would have a short-term impact. Noise from the pipelines could be audible offsite near compressors. In general, aesthetic changes would be limited to the immediate vicinity of Salem and HCGS and would be SMALL.

The wind farm would have the greatest visual impact. Several hundred wind turbines over 300 feet (100 m) in height and spread over 60,000 acres (24,400 ha) would dominate the view and would likely become the major focus of attention. Depending on its location, the aesthetic impacts from the construction and operation of the wind farm would be MODERATE to LARGE.

Historic and Archaeological Resources

Cultural resources are the indications of human occupation and use of the landscape as defined and protected by a series of Federal laws, regulations, and guidelines. Prehistoric resources are physical remains of human activities that predate written records; they generally consist of artifacts that may alone or collectively yield information about the past. Historic resources consist of physical remains that postdate the emergence of written records; in the United States, they are architectural structures or districts, archaeological objects, and archaeological features dating from 1492 and later. Ordinarily, sites less than 50 years old are not considered historic, but exceptions can be made for such properties if they are of particular importance, such as structures associated with the development of nuclear power (e.g., Shippingport Atomic Power Station) or Cold War themes. American Indian resources are sites, areas, and materials important to American Indians for religious or heritage reasons. Such resources may include geographic features, plants, animals, cemeteries, battlefields, trails, and environmental features. The cultural resource analysis encompassed the power plant site and adjacent areas that could potentially be disturbed by the construction and operation of alternative power plants.

The potential for historic and archaeological resources can vary greatly depending on the location of the proposed site. To consider a project's effects on historic and archaeological resources, any affected areas would need to be surveyed to identify and record historic and archaeological resources, identify cultural resources (e.g., traditional cultural properties), and develop possible mitigation measures to address any adverse effects from ground disturbing activities.

Onsite impacts to historical and cultural resources from the construction of a gas turbine plant are expected to be SMALL. Depending on the resource richness of the alternative site ultimately chosen for the wind power alternative, the impacts could range between SMALL to MODERATE. Therefore, the overall impacts on historic and archaeological resources from the combination alternative could range from SMALL to MODERATE.

Impacts to historic and archaeological resources from implementing the energy efficiency and conservation program would be SMALL and would not likely affect land use or historical or cultural resources elsewhere in the State.

Environmental Justice

The environmental justice impact analysis evaluates the potential for disproportionately high and adverse human health and environmental effects on minority and low-income populations that could result from the construction and operation of a new natural gas-fired power plant at Salem and HCGS, wind farm, and energy efficiency and conservation programs. Adverse health effects are measured in terms of the risk and rate of fatal or nonfatal adverse impacts on human health. Disproportionately high and adverse human health effects occur when the risk or rate of exposure to an environmental hazard for a minority or low-income population is significant and exceeds the risk or exposure rate for the general population or for another appropriate comparison group. Disproportionately high environmental effects refer to impacts or risk of impact on the natural or physical environment in a minority or low-income community that are significant and appreciably exceed the environmental impact on the larger community. Such effects may include biological, cultural, economic, or social impacts. Some of these potential effects have been identified in resource areas discussed in this SEIS. For example, increased demand for rental housing during power plant construction could disproportionately affect low-income populations. Minority and low-income populations are subsets of the general public residing around a power plant, and all are exposed to the same hazards generated from constructing and operating a natural gas-fired combined-cycle power plant and wind farm.

Low-income families could benefit from weatherization and insulation programs. This effect would be greater than the effect for the general population because (according to the Office of Management and Budget [OMB]) low-income households experience home energy burdens more than four times larger than the average household (OMB, 2007). Weatherization programs could target low-income residents as a cost-effective energy efficiency option since low-income populations tend to spend a larger proportion of their incomes paying utility bills (OMB, 2007). Overall impacts to minority and low-income populations from energy efficiency programs would be nominal, depending on program design and enrollment.

Potential impacts to minority and low-income populations from the construction and operation of a new natural gas-fired combined-cycle power plant at Salem and HCGS and wind farm would mostly consist of environmental and socioeconomic effects (e.g., noise, dust, traffic, employment, and housing impacts). Noise and dust impacts from construction would be short-term and primarily limited to onsite activities. Minority and low-income populations residing along site access roads would also be affected by increased commuter vehicle traffic during shift changes and truck traffic. However, these effects would be temporary during certain hours of the day and not likely to be high and adverse. Increased demand for rental housing during construction in the vicinity of Salem and HCGS and the wind farm could affect low-income populations. Given the close proximity to the Philadelphia and Wilmington metropolitan areas, most construction workers would likely commute to the site, thereby reducing the potential demand for rental housing.

Based on this information and the analysis of human health and environmental impacts presented in this SEIS, the construction and operation of a natural gas-fired power plant and the wind farm (depending on its location) would not have disproportionately high and adverse human health and environmental effects on minority and low-income populations.

8.1.3.7 Waste Management

The primary source of waste would be associated with the construction of the new gas-fired combined-cycle plant and the wind farm. During the construction phase of this alternative, land clearing and other construction activities would generate waste that can be recycled, disposed onsite, or shipped to an offsite waste disposal facility. Because the gas-fired combined-cycle plant would be constructed on the previously disturbed Salem site, the amounts of waste produced during land clearing would be reduced. Waste impacts could be substantial but likely not noticeably alter or destabilize the resource during construction of the wind farms, depending on how the various sites handle wastes.

The waste contribution from the remaining HCGS unit would be roughly one-third of the waste generated by the current facility (Salem and HCGS) described in Sections 2.1.2 and 2.1.3. If the remaining HCGS unit were to continue operation with the existing closed-cycle cooling system, waste impacts would be minor.

Therefore, the Staff concludes that the overall impact from waste from the combination alternative would be SMALL.

Table 8-3. Summary of the Direct and Indirect Environmental Impacts of the Combination Alternative Compared to Continued Operation of Salem and HCGS

	Combination	Continued Salem and HCGS Operation
Air Quality	SMALL	SMALL
Groundwater	SMALL	SMALL
Surface Water	SMALL	SMALL
Aquatic and Terrestrial Resources	SMALL to MODERATE	SMALL
Human Health	SMALL	SMALL
Socioeconomics	SMALL to LARGE	SMALL to LARGE
Waste Management	SMALL	SMALL

8.2 Alternatives Considered But Dismissed

In the sections below, the Staff presents other alternatives it initially considered for analysis as alternatives to license renewal of Salem and HCGS, but later dismissed due to technical, resource availability, or commercial limitations that currently exist and that the Staff believes are likely to continue to exist when the existing Salem and HCGS licenses expire. Under each of the following technology headings, the Staff indicates why it dismissed each alternative from further consideration.

8.2.1 Offsite Coal- and Natural Gas-Fired

While it is possible that coal- and natural gas-fired alternatives like those considered in 8.1.1 and 8.1.2, respectively, could be constructed at sites other than Salem and HCGS, the Staff determined that they would likely result in greater impacts than alternatives constructed at the Salem and HCGS site. Greater impacts would occur from construction of support infrastructure, like transmission lines, and roads that are already present on the Salem and HCGS site. Further, the community around Salem and HCGS is already familiar with the appearance of a power facility and it is an established part of the region's aesthetic character. Workers skilled in power plant operations would also be available in this area. The availability of these factors are only likely to be available on other recently-industrial sites. In cases where recently-industrial sites exist, other remediation may also be necessary in order to ready the site for redevelopment. In short, an existing power plant site would present the best location for a new power facility.

8.2.2 New Nuclear

In its ER, PSEG indicated that it is unlikely that a nuclear alternative could be sited, constructed and operational by the time the HCGS operating license expires in 2026 (PSEG, 2009b), nor could this be accomplished in a timeframe necessary to replace the generating output of Salem Unit 1, which has a license expiration date of 2016 (PSEG, 2009a). On May 25, 2010, PSEG submitted an application for an early site permit for two reactor units. Given the relatively short time remaining on the current Salem and HCGS licenses, the Staff has not evaluated new nuclear generation as an alternative to license renewal.

8.2.3 Energy Conservation/Energy Efficiency

Though often used interchangeably, energy conservation and energy efficiency are different concepts. Energy efficiency typically means deriving a similar level of services by using less energy, while energy conservation simply indicates a reduction in energy consumption. Both fall into a larger category known as demand-side management (DSM). DSM measures—unlike the energy supply alternatives discussed in previous sections—address energy end uses. DSM can include measures that shift energy consumption to different times of the day to reduce peak loads, measures that can interrupt certain large customers during periods of high demand, measures that interrupt certain appliances during high demand periods, and measures like replacing older, less efficient appliances, lighting, or control systems. DSM also includes measures that utilities use to boost sales, such as encouraging customers to switch from gas to electricity for water heating.

Unlike other alternatives to license renewal, the GEIS notes that conservation is not a discrete power generating source; it represents an option that states and utilities may use to reduce their need for power generation capability (NRC, 1996).

In October 2008, the State of New Jersey published their Energy Master Plan (New Jersey, 2008), which established goals and evaluated potential options for meeting the projected increase in electricity demand in the state through 2020. As part of this Master Plan, actions were identified to maximize energy conservation and energy efficiency, including: transitioning the state's current energy efficiency programs to be implemented by the electric and gas utilities, modifying the statewide building code for new buildings to make new buildings as least 30 percent more energy efficient, increasing energy efficiency standards for new appliances and other equipment, and developing education and outreach programs for the public. An additional goal is to reduce peak electricity demand, primarily by expanding incentives developing technologies to increase participation in regional demand response programs. A separate goal established in the report (not related to energy conservation) included successful accomplishment of the state's Renewable Energy Portfolio Standard by 2020.

The report concluded that the combination of all of these efforts (energy conservation, efficiency, and renewable energy sources) would still not result in meeting the increased demand for electricity in the state, and that additional development of traditional electricity sources would still be required. Therefore, these measures would not be able to replace the output of the Salem and HCGS facilities. Because of this, the Staff has not evaluated energy conservation/efficiency as a discrete alternative to license renewal. It has, however, been considered as a component of the combination alternative.

8.2.4 Purchased Power

In the Salem and HCGS ERs, PSEG indicated that purchased electrical power is a potentially viable option for replacing the generating capacity of the Salem and HCGS facilities. PSEG anticipated that this power could be purchased from other generation sources within the PJM region, but that the source would likely be from new capacity generated using technologies that are evaluated in the GEIS. The technologies that would most likely be used to generate the purchased power would be coal and natural gas, and therefore the impacts associated with the power purchase would be similar to those evaluated in Sections 8.1.1 and 8.1.2. In addition, purchased power would likely require the addition of transmission capacity, which would result in additional land use impacts. Because purchased electrical power would likely be provided by new generation sources evaluated elsewhere in this section, and would also require new transmission capacity, the Staff has not evaluated purchased power as a separate alternative to license renewal.

8.2.5 Solar Power

Solar technologies use the sun's energy to produce electricity. Currently, the Salem and HCGS area receives approximately 4.5 to 5.5 kWh per square meter per day, for solar collectors oriented at an angle equal to the installation's latitude (NREL, 2010). Since flat-plate photovoltaics tend to be roughly 25 percent efficient, a solar-powered alternative would require more than 140,000 ac (57,000 ha) of collectors to provide an amount of electricity equivalent to that generated by Salem and HCGS. Space between parcels and associated infrastructure increase this land requirement. This amount of land, while large, is consistent with the land required for coal and natural gas fuel cycles. In the GEIS, the Staff noted that, by its nature, solar power is intermittent (i.e., it does not work at night and cannot serve baseload when the sun is not shining), and the efficiency of collectors varies greatly with weather conditions. A solar-powered alternative would require energy storage or backup power supply to provide electric power at night. Given the challenges in meeting baseload requirements, the Staff did not evaluate solar power as an alternative to license renewal of Salem and HCGS.

8.2.6 Wood-Fired

The National Renewable Energy Laboratory estimates the amount of biomass fuel resources, including forest, mill, agricultural, and urban residues, available within New Jersey, Delaware, and Pennsylvania to be approximately 5.6 million dry tons per year (5.1 MT; Milbrandt, 2005). Based on an estimate of 9.961 million Btu per dry ton and a thermal conversion efficiency of 25%, conversion of this entire resource would generate the equivalent of less than 500 MW(e). Of the available biomass in the three states, the vast majority (80 percent) is in Pennsylvania, and assumed to be located primarily in the western portion of the state. Therefore, the volume that would be available for fueling a plant in the local area would be much less, and is not likely to be sufficient to substitute for the capacity provided by Salem and HCGS. As a result, the Staff has not considered a wood-fired alternative to Salem and HCGS license renewal.

8.2.7 Wind (Onshore/Offshore)

The American Wind Energy Association indicates that New Jersey currently ranks 33rd among the states in installed wind power capacity (7.5 MW), and 29th among the state in potential capacity. No projects are currently under construction (AWEA, 2010). No wind capacity is installed in Delaware. Although Pennsylvania ranks 15th among the states in installed capacity, with a total of 748 MW, most of this installed capacity is located in the western portion of the state (AWEA, 2010). The Report of the New Jersey Governor's Blue Ribbon Panel on Development of Wind Turbine Facilities in Coastal Waters

(State of New Jersey, 2006) concluded that onshore wind speeds in New Jersey are not viable for commercial wind power development, and that the vast majority of the state's wind generation capacity was offshore. The report also concluded that development of the offshore resources is not commercially viable without significant state and/or federal subsidies. Also, preliminary information evaluated in the report indicated that the timing of peak offshore wind speeds did not coincide with the times of peak energy demand, and that offshore wind alone could not significantly reduce reliance on fossil fuel and domestic nuclear capacity (State of New Jersey, 2006). Finally, the results of a study of potential impacts of large-scale wind turbine siting by NJDEP identified large areas along the New Jersey Coast that would likely be considered to be off limits to large scale wind development due to documented bird concentrations, nesting for resident threatened and endangered bird species, and stopover locations for migratory birds (NJDEP, 2009b).

Given wind power's intermittency, the lack of easily implementable onshore resources in New Jersey, and restrictions on placement of turbines in areas that would otherwise have high resource potential, the Staff will not consider wind power as a stand-alone alternative to license renewal. However, given the potential for development of offshore resources, the Staff will consider wind power as a portion of a combination alternative.

8.2.8 Hydroelectric Power

According to researchers at Idaho National Energy and Environmental Laboratory [INEEL], New Jersey has an estimated 11 MW of technically available, undeveloped hydroelectric resources at 12 sites throughout the State (INEEL, 1996). Given that the available hydroelectric potential in the State of New Jersey constitutes only a small fraction of generating capacity of Salem and HCGS, the Staff did not evaluate hydropower as an alternative to license renewal.

8.2.9 Wave and Ocean Energy

Wave and ocean energy has generated considerable interest in recent years. Ocean waves, currents, and tides are often predictable and reliable. Ocean currents flow consistently, while tides can be predicted months and years in advance with well-known behavior in most coastal areas. Most of these technologies are in relatively early stages of development, and while some results have been promising, they are not likely to be able to replace the capacity of Salem and HCGS by the time their licenses expire. Therefore, the NRC did not consider wave and ocean energy as an alternative to Salem and HCGS license renewal.

8.2.10 Geothermal Power

Geothermal energy has an average capacity factor of 90 percent and can be used for baseload power where available. However, geothermal electric generation is limited by the geographical availability of geothermal resources (NRC, 1996). Although New Jersey has some geothermal potential in a heating capacity, it does not have geothermal electricity potential for electricity generation (GHC, 2008). The Staff concluded that geothermal energy is not a reasonable alternative to license renewal at Salem and HCGS.

8.2.11 Municipal Solid Waste

Municipal solid waste combustors use three types of technologies—mass burn, modular, and refuse-derived fuel. Mass burning is currently the method used most frequently in the United States and involves no (or little) sorting, shredding, or separation. Consequently, toxic or hazardous components present in the waste stream are combusted, and toxic constituents are exhausted to the air or become part of the resulting solid wastes. Currently, approximately 87 waste-to-energy plants operate in the United States. These plants generate approximately 2,531 MW(e), or an average of 29 MW(e) per plant (Energy Recovery Council, 2010). This includes five plants in New Jersey generating a total of 173 MW(e). More than 124 average-sized plants would be necessary to provide the same level of output as the other alternatives to Salem and HCGS license renewal.

Estimates in the GEIS suggest that the overall level of construction impact from a waste-fired plant would be approximately the same as that for a coal-fired power plant. Additionally, waste-fired plants have the same or greater operational impacts than coal-fired technologies (including impacts on the aquatic environment, air, and waste disposal). The initial capital costs for municipal solid-waste plants are greater than for comparable steam-turbine technology at coal-fired facilities or at wood-waste facilities because of the need for specialized waste separation and handling equipment (NRC, 1996).

The decision to burn municipal waste to generate energy is usually driven by the need for an alternative to landfills rather than energy considerations. The use of landfills as a waste disposal option is likely to increase in the near term as energy prices increase; however, it is possible that municipal waste combustion facilities may become attractive again.

Given the small average installed size of municipal solid waste plants and the unfavorable regulatory environment, the Staff does not consider municipal solid waste combustion to be a feasible alternative to Salem and HCGS license renewal.

8.2.12 Biofuels

In addition to wood and municipal solid waste fuels, there are other concepts for biomass-fired electric generators, including direct burning of energy crops, conversion to liquid biofuels, and biomass gasification. In the GEIS, the Staff indicated that none of these technologies had progressed to the point of being competitive on a large scale or of being reliable enough to replace a baseload plant such as Salem and HCGS. After reevaluating current technologies, the Staff finds other biomass-fired alternatives are still unable to reliably replace the Salem and HCGS capacity. For this reason, the Staff does not consider other biomass-derived fuels to be feasible alternatives to Salem and HCGS license renewal.

8.2.13 Oil-Fired Power

EIA projects that oil-fired plants would account for very little of the new generation capacity constructed in the United States during the 2008 to 2030 time period. Further, EIA does not project that oil-fired power would account for any significant additions to capacity (EIA, 2009a).

The variable costs of oil-fired generation tend to be greater than those of the nuclear or coal-fired operations, and oil-fired generation tends to have greater environmental impacts than natural gas-fired generation. In addition, future increases in oil prices are expected to make oil-fired generation increasingly more expensive (EIA, 2009a). The high cost of oil has prompted a steady decline in its use for electricity generation. Thus, the Staff did not consider oil-fired generation as an alternative to Salem and HCGS license renewal.

8.2.14 Fuel Cells

Fuel cells oxidize fuels without combustion and its environmental side effects. Power is produced electrochemically by passing a hydrogen-rich fuel over an anode and air (or oxygen) over a cathode and separating the two by an electrolyte. The only byproducts (depending on fuel characteristics) are heat, water, and CO_2. Hydrogen fuel can come from a variety of hydrocarbon resources by subjecting them to steam under pressure. Natural gas is typically used as the source of hydrogen.

At the present time, fuel cells are not economically or technologically competitive with other alternatives for electricity generation. In addition, fuel cell units are likely to be small in size. While it may be possible to use a distributed array of fuel cells to provide an alternative to Salem and HCGS, it would be extremely costly to do so and would require many units. Accordingly, the Staff does not consider fuel cells to be an alternative to Salem and HCGS license renewal.

8.2.15 Delayed Retirement

The power generating merchants within the PJM region have retired a large number of generation sources since 2003, totaling 5,945 MW retired and 2,629 MW pending retirement. Most of these retirements involve older fossil fuel-powered plants which are retired due to challenges in meeting increasingly stringent air quality standards (PJM, 2009). Although these retirements have caused reliability criteria violations, PJM does not have any authority to compel owners to delay retirement (PJM, 2009), and therefore retirements are likely to continue. Therefore, delayed retirement of non-nuclear plants is not considered as a feasible alternative to Salem and HCGS license renewal.

8.3 No-Action Alternative

This section examines environmental effects that would occur if NRC takes no action. No Action in this case means that NRC does not issue a renewed operating license for Salem and HCGS and the licenses expire at the end of their current license terms. If NRC takes no action, the plants would shutdown at or before the end of the current license. After shutdown, plant operators would initiate decommissioning according to 10 CFR 50.82. Table 8-4 provides a summary of environmental impacts of No Action compared to continued operation of the Salem and HCGS.

The Staff notes that the option of No Action is the only alternative considered in-depth that does not satisfy the purpose and need for this SEIS, as it does not provide power generation capacity nor would it meet the needs currently met by Salem and HCGS or that the alternatives evaluated in Section 8.1 would satisfy. Assuming that a need currently exists for the power generated by Salem and HCGS, the no-action alternative would require that the appropriate energy planning decision-makers rely on an alternative to replace the capacity of Salem and HCGS or reduce the need for power.

This section addresses only those impacts that arise directly as a result of plant shutdown. The environmental impacts from decommissioning and related activities have already been addressed in several other documents, including the *Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities*, NUREG-0586, Supplement 1 (NRC, 2002); the license renewal GEIS (chapter 7; NRC, 1996); and Chapter 7 of this SEIS. These analyses either directly address or bound the environmental impacts of decommissioning whenever PSEG ceases operating Salem and HCGS.

The Staff notes that, even with renewed operating licenses, Salem and HCGS would eventually shut down, and the environmental effects addressed in this section would occur at that time. Since these effects have not otherwise been addressed in this SEIS, the impacts will be addressed in this section. As with decommissioning effects, shutdown effects are expected to be similar whether they occur at the end of the current license or at the end of a renewed license.

8.3.1 Air Quality

When the plant stops operating, there would be a reduction in emissions from activities related to plant operation such as use of diesel generators and employees vehicles. In Chapter 4, the Staff determined that these emissions would have a SMALL impact on air quality during the renewal term. Therefore, if the emissions decrease, the impact to air quality would also decrease and would be SMALL.

8.3.2 Groundwater Use and Quality

The use of groundwater would diminish as plant personnel are removed from the site and operations cease. Some consumption of groundwater may continue as a small staff remains onsite to maintain facilities prior to decommissioning. Overall impacts would be smaller than during operations, but would remain SMALL.

8.3.3 Surface Water Use and Quality

The rate of consumptive use of surface water would decrease as the plant is shut down and the reactor cooling system continues to remove the heat of decay. Wastewater discharges would also be reduced considerably. Shutdown would reduce the already SMALL impact on surface water resources and quality.

8.3.4 Aquatic and Terrestrial Resources

Aquatic Ecology

If the plant were to cease operating, operational impacts to aquatic ecology would decrease, as the plant would withdraw and discharge less water than it does during operations. Shutdown would reduce the already SMALL impacts to aquatic ecology.

Terrestrial Ecology

Shutdown would result in no additional land disturbances onsite or offsite, and terrestrial ecology impacts would be SMALL.

8.3.5 Human Health

Human health risks would be smaller following plant shutdown. The plant, which is currently operating within regulatory limits, would emit less gaseous and liquid radioactive material to the environment. In addition, following shutdown, the variety of potential accidents at the plant (radiological or industrial) would be reduced to a limited set associated with shutdown events and fuel handling and storage. In Chapter 4 of this draft SEIS, the Staff concluded that the impacts of continued plant operation on human health would be SMALL. In Chapter 5, the Staff concluded that the impacts of accidents during operation were SMALL. Therefore, as radioactive emissions to the environment decrease, and as the likelihood and variety of accidents decrease following shutdown, the Staff concludes that the risks to human health following plant shutdown would be SMALL.

8.3.6 Socioeconomics

Land Use

Plant shutdown would not affect onsite land use. Plant structures and other facilities would likely remain in place until decommissioning. Most transmission lines connected to Salem and HCGS would remain in service after the facilities stop operating. Maintenance of most existing transmission lines would continue as before. The transmission lines could be used to deliver the output of any new capacity additions made on the Salem and HCGS site. Impacts on land use from plant shutdown would be SMALL.

Socioeconomics

Plant shutdown would have an impact on socioeconomic conditions in the region around Salem and HCGS. Should the plants shut down, there would be immediate socioeconomic impacts from loss of jobs (some, though not all, of the approximately 1,614 employees would begin to leave) and property tax payments may be reduced. These impacts, however, would not be considered significant on a regional basis given the close proximity to the Philadelphia and Wilmington metropolitan areas and because plant workers' residences are not concentrated in a single community or county.

Revenue losses from Salem and HCGS operations would affect Salem County and the communities closest to and most reliant on the plant's tax revenue (like Lower Alloways Creek Township, which receives approximately 57 percent of its property tax revenue from Salem and HCGS).. The socioeconomic impacts of plant shutdown would (depending on the jurisdiction) range from SMALL to LARGE. See Appendix J to NUREG-0586, Supplement 1 (NRC, 2002), for additional discussion of the potential socioeconomic impacts of plant decommissioning.

Transportation

Traffic volumes on the roads in the vicinity of Salem and HCGS would be greatly reduced after plant shutdown due to the loss of jobs. Deliveries of materials and equipment to Salem and

HCGS would also be reduced until decommissioning. Transportation impacts from the termination of plant operations would be SMALL.

Aesthetics

Plant structures and other facilities would likely remain in place until decommissioning. The plume from the cooling tower would cease or greatly decrease after shutdown. Noise caused by power plant operations would cease. Aesthetic impacts of plant closure would be SMALL.

Historic and Archaeological Resources

Impacts from the no-action alternative would be SMALL, since Salem and HCGS would be decommissioned. A separate environmental review would be conducted for decommissioning. That assessment would address the protection of historic and archaeological resources.

Environmental Justice

Impacts to minority and low-income populations when Salem and HCGS cease operation would depend on the number of jobs and the amount of tax revenues lost by the communities surrounding the facilities. Closure of Salem and HCGS would reduce the overall number of jobs (there are currently 1,614 permanent positions at the facilities) and the tax revenue attributed to plant operations (approximately 57 percent of Lower Alloways Creek Township's tax revenues and 2.9 percent of Salem County's tax revenues are from Salem and HCGS). Since the Salem and HCGS tax payments represent such a significant percentage of Lower Alloways Creek Township's total annual property tax revenue, it is likely that economic impacts within the township would range from MODERATE to LARGE should Salem and HCGS be shut down and closed. Therefore, minority and low-income populations in the vicinity of Salem and HCGS could experience disproportionately high and adverse environment effects from plant shutdown.

8.3.7 Waste Management

If the no-action alternative were implemented the generation of high-level waste would stop and generation of low-level and mixed waste would decrease. Impacts from implementation of no-action alternative are expected to be SMALL.

Wastes associated with plant decommissioning are unavoidable and will be significant whether the plant is decommissioned at the end of the initial license period or at the end of the relicensing period. Therefore, the selection of the no-action alternative has no impact on issues relating to decommissioning waste.

Table 8-4. Summary of the Direct and Indirect Environmental Impacts of No Action Compared to Continued Operation of Salem and HCGS

	No Action	Continued Salem and HCGS Operation
Air Quality	SMALL	SMALL
Groundwater	SMALL	SMALL
Surface Water	SMALL	SMALL
Aquatic and Terrestrial Resources	SMALL	SMALL
Human Health	SMALL	SMALL
Socioeconomics	SMALL to LARGE	SMALL to LARGE
Waste Management	SMALL	SMALL

8.4 Alternatives Summary

In this chapter, the Staff considered the following alternatives to Salem and HCGS license renewal: supercritical coal-fired generation; natural gas combined-cycle generation; and a combination of alternatives. No Action by the NRC and the effects it would have were also considered. The impacts for all alternatives are summarized in Table 8-5.

Socioeconomic and groundwater impacts would range from SMALL to MODERATE. The Staff did not determine a single significance level for these impacts, but the Commission determined them to be Category 1 issues nonetheless. The environmental impacts of the proposed action (issuing renewed Salem and HCGS operating licenses) would be SMALL for all other impact categories, except for the Category 1 issue of collective offsite radiological impacts from the fuel cycle, high level waste (HLW), and spent fuel disposal.

The environmental impacts of the proposed action (issuing renewed Salem and HCGS operating licenses) would be SMALL for all impact categories except for the Category 1 issue of collective offsite radiological impacts from the fuel cycle, high level waste (HLW), and spent fuel disposal.

In the Staff's professional opinion, the coal-fired alternative would have the greatest overall adverse environmental impact. This alternative would result in MODERATE air quality, human health, and waste management impacts. Its impacts upon socioeconomic and biological resources would range from SMALL to MODERATE. This alternative is not an environmentally preferable alternative due to air quality impacts from NO_x, SO_x, PM, PAHs, CO, CO_2, and mercury (and the corresponding human health impacts), as well as construction impacts to transportation, aquatic, and terrestrial resources.

With the exception of socioeconomic and air quality impacts, the gas-fired alternative would result in SMALL impacts. Socioeconomic and air quality impacts would range from SMALL to MODERATE. This alternative would result in substantially lower air emissions and waste management than the coal-fired alternative.

The combination alternative would have lower air emissions and waste management impacts than both the gas-fired and coal-fired alternatives; however, it would have relatively higher construction impacts in terms of aquatic and terrestrial resources and potential disruption to historic and archaeological resources, mainly as a result of the wind turbine component.

Under the no-action alternative, plant shutdown would begin to eliminate most of the approximately 1,614 jobs at Salem and HCGS and would reduce general tax revenue in the region. Depending on the jurisdiction, the economic loss would have a SMALL to LARGE impact. The no-action alternative, however, would not meet the purpose and need stated in this draft SEIS.

Therefore, in the Staff's best professional opinion, the environmentally preferred alternative in this case is the license renewal of Salem and HCGS. All other alternatives capable of meeting the needs currently served by Salem and HCGS entail potentially greater impacts than the proposed action of license renewal of Salem and HCGS.

Table 8-5. Summary of the Direct and Indirect Environmental Impacts of Proposed Action and Alternatives

Alternative	Impact Area						
	Air Quality	**Groundwater**	**Surface Water**	**Aquatic and Terrestrial Resources**	**Human Health**	**Socioeconomics**	**Waste Management**
License Renewal	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL to LARGE	SMALL[a]
Supercritical Coal-fired Alternative	MODERATE	SMALL	SMALL	SMALL to MODERATE	MODERATE	SMALL to MODERATE	MODERATE
Gas-fired Alternative	SMALL to MODERATE	SMALL	SMALL	SMALL	SMALL	SMALL to MODERATE	SMALL
Combination Alternative	SMALL	SMALL	SMALL	SMALL to MODERATE	SMALL	SMALL to LARGE	SMALL
No Action Alternative	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL to LARGE	SMALL

(a) For the Salem and HCGS license renewal alternative, waste management was evaluated in Chapter 6. Consistent with the findings in the GEIS, these impacts were determined to be SMALL with the exception of collective offsite radiological impacts from the fuel cycle and from high-level waste and spent fuel disposal.

8.5 References

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

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

40 CFR Part 60. *Code of Federal Regulations*, Title 40, *Protection of Environment*, Part 60, "Standards of Performance for New Stationary Sources."

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9.0 CONCLUSION

This draft supplemental environmental impact statement (SEIS) contains the preliminary environmental review of PSEG Nuclear, LLC (PSEG) application for a renewed operating licenses for Salem Nuclear Generating Station, Units 1 and 2 (Salem) and Hope Creek Generating Station (HCGS) as required by Part 51 of Title 10, of the *Code of Federal Regulations* (10 CFR Part 51), the U.S Regulatory Commission (NRC's) regulations that implement the National Environmental Policy Act of 1969 (NEPA). Chapter 9 presents the conclusions and recommendations from the site-specific environmental review of Salem and HCGS and summarizes site-specific environmental issues of license renewal that were identified during the review. The environmental impacts of license renewal are summarized in Section 9.1; a comparison of the environmental impacts of license renewal and energy alternatives is presented in Section 9.2; resource commitments are discussed in Section 9.3; and conclusions and NRC staff (the Staff) recommendations are presented in Section 9.4.

9.1 Environmental Impacts of License Renewal

The Staff's review of site-specific environmental issues in this draft SEIS leads it to conclude that issuing a renewed license would have SMALL impacts for the 21 Category 2 issues applicable to license renewal at Salem and HCGS, as well as environmental justice and chronic effects of electromagnetic fields.

Mitigation measures were considered for each Category 2 issue, as applicable. For air quality and ground water and surface water use issues, current measures to mitigate the environmental impacts of plant operation were found to be adequate. Additionally, the Staff concludes that impacts to fish and shellfish from entrainment, impingement, and heat shock at Salem and HCGS would not warrant additional mitigation beyond the Estuary Enhancement Program.

The Staff identified a variety of mitigation measures that could reduce human health impacts by minimizing public exposures to electric shock hazards. However, no cost benefit studies applicable to these mitigation measures were identified. The potential for chronic effects from these fields continues to be studied and is not known at this time. The Staff considers the GEIS finding of "Uncertain" still appropriate and will continue to follow developments on this issue.

There are no known historic and archaeological resources on the Salem and HCGS site. The potential for National Register eligible historic or archaeological resources to be impacted by renewal of this operating license is SMALL. Based on this conclusion there would be no need to review mitigation measures.

The Staff also considered cumulative impacts of past, present, and reasonably foreseeable future actions, regardless of what agency (Federal or non-Federal) or person undertakes them. The Staff concluded that cumulative impacts of Salem and HCGS site license renewal is SMALL for potentially affected resources with one exception. Cumulative impacts affecting aquatic resources in the Delaware Estuary would range from MODERATE to LARGE. However, the incremental contribution from the continued operation of Salem and HCGS on aquatic resources would be SMALL for most impacts. The potential direct and indirect impacts to socioeconomics from continued operation of the Salem and HCGS would be SMALL. However, if PSEG decides to proceed with the construction of a new nuclear plant at the Salem and HCGS site, the cumulative impacts to socioeconomics could be SMALL to LARGE.

9.2 Comparison of Environmental Impacts of License Renewal and Alternatives

In the conclusion to Chapter 8, the Staff determined that impacts from license renewal are generally less than the impacts of alternatives to license renewal. In comparing likely environmental impacts from supercritical coal-fired generation, natural gas combined-cycle generation, and a combination alternative (natural gas, renewable energy, and conservation/efficiency) to environmental impacts from license renewal, the Staff found that license renewal of Salem and HCGS results in the lowest environmental impact. Therefore, in the Staff's best professional opinion, the environmentally preferred alternative in this case is the license renewal of Salem and HCGS. All other alternatives capable of meeting the needs currently served by Salem and HCGS entail potentially greater impacts than the proposed action of license renewal of Salem and HCGS.

9.3 Resource Commitments

9.3.1 Unavoidable Adverse Environmental Impacts

Unavoidable adverse environmental impacts are impacts that would occur after implementation of all feasible mitigation measures. Implementing any of the energy alternatives considered in this SEIS, including the proposed action, would result in some unavoidable adverse environmental impacts.

Minor unavoidable adverse impacts on air quality would occur due to emission and release of various chemical and radiological constituents from power plant operations. Nonradiological emissions resulting from power plant operations are expected to comply with U.S. Environmental Protection Agency (EPA) emissions standards, although the alternative of operating a fossil-fueled power plant in some areas may worsen existing attainment issues. Chemical and radiological emissions would not exceed the National Emission Standards for Hazardous Air Pollutants.

During nuclear power plant operations, workers and members of the public would face unavoidable exposure to radiation and hazardous and toxic chemicals. Workers would be exposed to radiation and chemicals associated with routine plant operations and the handling of nuclear fuel and waste material. Workers would have higher levels of exposure than members of the public, but doses would be administratively controlled and would not exceed any standards or administrative control limits. In comparison, the alternatives entailing the construction and operation of a non-nuclear power generating facility would also result in unavoidable exposure to hazardous and toxic chemicals to workers and the general public.

The generation of spent nuclear fuel and waste material, including low-level radioactive waste, hazardous waste, and nonhazardous waste would also be unavoidable. In comparison, hazardous and nonhazardous wastes would also be generated at non-nuclear power generating facilities. Wastes generated during plant operations would be collected, stored, and shipped for suitable treatment, recycling, or disposal in accordance with applicable Federal and State regulations. Due to the costs of handling these materials, power plant operators would be expected to conduct all activities and optimize all operations in a way that generates the smallest amount of waste practical.

9.3.2 Relationship Between Local Short-Term Uses of the Environment and the Maintenance and Enhancement of Long-Term Productivity

The operation of power generating facilities would result in short-term uses of the environment as described in Chapters 4, 5, 6, 7, and 8. "Short term" is the period of time during which continued power generating activities would take place.

Power plant operations would necessitate short-term use of the environment and commitments of resources, and would also commit certain resources (e.g., land and energy) indefinitely or permanently. Certain short-term resource commitments would be substantially greater under most energy alternatives, including license renewal, than under the No Action Alternative due to the continued generation of electrical power as well as continued use of generating sites and associated infrastructure. During operations, all energy alternatives would entail similar relationships between local short-term uses of the environment and the maintenance and enhancement of long term productivity.

Air emissions from power plant operations would introduce small amounts of radiological and nonradiological constituents to the region around the plant site. Over time, these emissions would result in increased concentrations and exposure, but are not expected to impact air quality or radiation exposure to the extent that public health and long-term productivity of the environment would be impaired.

Continued employment, expenditures, and tax revenues generated during power plant operations would directly benefit local, regional, and State economies over the short term. Local governments investing project-generated tax revenues into infrastructure and other required services could enhance economic productivity over the long term.

The management and disposal of spent nuclear fuel, low-level radioactive waste, hazardous waste, and nonhazardous waste would require an increase in energy and would consume space at treatment, storage, or disposal facilities. Regardless of the location, the use of land to meet waste disposal needs would reduce the long-term productivity of the land.

Power plant facilities would be committed to electricity production over the short term. After decommissioning these facilities and restoring the area, the land could be available for other future productive uses.

9.3.3 Irreversible and Irretrievable Commitments of Resources

This section describes the irreversible and irretrievable commitments of resources that have been identified in this SEIS. Irreversible resources refer to when primary or secondary impacts limit the future options for a resource. An irretrievable commitment refers to the use or consumption of resources that are neither renewable nor recoverable for future use. Irreversible and irretrievable commitment of resources for electrical power generation would include the commitment of land, water, energy, raw materials, and other natural and man-made resources required for power plant operations. In general, the commitment of capital, energy, labor, and material resources would also be irreversible.

The implementation of any of the energy alternatives considered in this SEIS would entail the irreversible and irretrievable commitment of energy, water, chemicals, and, in some cases, fossil fuels. These resources would be committed during the license renewal term and over the entire life cycle of the power plant and would essentially be unrecoverable.

Energy expended would be in the form of fuel for equipment, vehicles, and power plant operations and electricity for equipment and facility operations. Electricity and fuels would be purchased from offsite commercial sources. Water would be obtained from existing water supply systems. These resources are readily available, and the amounts required are not expected to deplete available supplies or exceed available system capacities.

The irreversible and irretrievable commitment of material resources includes materials that cannot be recovered or recycled, materials that are rendered radioactive and cannot be decontaminated, and materials consumed or reduced to unrecoverable forms of waste. However, none of the resources used by these power generating facilities are in short supply, and, for the most part, are readily available.

Various materials and chemicals, including acids and caustics, would be required to support operations activities. These materials would be derived from commercial vendors, and their consumption is not expected to affect local, regional, or national supplies.

The treatment, storage, and disposal of spent nuclear fuel, low-level radioactive waste, hazardous waste, and nonhazardous waste would require the irretrievable commitment of energy and fuel and would result in the irreversible commitment of space in disposal facilities.

9.4 Recommendations

Based on (1) the analysis and findings in the GEIS, (2) information provided in the environmental report (ER) submitted by PSEG, (3) consultation with Federal, State, and local agencies, (4) a review of pertinent documents and reports, and (5) consideration of public comments received during scoping, the preliminary recommendation of the Staff is that the Commission determine that the adverse environmental impacts of license renewal for Salem and HCGS are not so great that preserving the option of license renewal for energy planning decision makers would be unreasonable.

10.0 LIST OF PREPARERS

This supplemental EIS was prepared by members of the Office of Nuclear Reactor Regulation, with assistance from other NRC organizations and contract support from AECOM.

Table 10-1. List of Preparers. *AECOM provided contract support for preparing the SEIS. Pacific Northwest National Laboratories (PNNL) provided contract support for preparing the severe accident mitigation alternatives (SAMA) analysis, presented in Chapter 5 and Appendix F.*

Name	Affiliation	Function or Expertise
	Nuclear Regulatory Commission	
Dennis Beissel	Nuclear Reactor Regulation	Hydrology
Rich Bulanevitz	Nuclear Reactor Regulation	Terrestrial Ecology
Charles Eccleston	Nuclear Reactor Regulation	Project Manager
Ray Gallucci	Nuclear Reactor Regulation	Severe Accident Mitigation Alternatives
Tina Ghosh	Nuclear Reactor Regulation	Severe Accident Mitigation Alternatives
Stephen Klementowicz	Nuclear Reactor Regulation	Radiation Protection; Human Health; Radiological Waste
Dennis Logan	Nuclear Reactor Regulation	Aquatic Ecology
Robert Palla	Nuclear Reactor Regulation	Severe Accident Mitigation Alternatives
Jeffrey Rikhoff	Nuclear Reactor Regulation	Socioeconomics; Land Use; Environmental Justice
Allison Travers	Nuclear Reactor Regulation	Cultural Resources
	SEIS Contractor	
Katie Broom	AECOM	Project Support
Steve Dillard	AECOM	Aquatic and Terrestrial Ecology
Robert Dover	AECOM	Hydrology; Air Quality; Alternatives
Bonnie Freeman	AECOM	Administrative Support
Carol Freeman	AECOM	Project Support; Environmental Justice
Roberta Hurley	AECOM	Project Manager
Susan Provenzano	AECOM	Socioeconomics; Land Use; Environmental Justice; Cultural Resources
Evelyn Rogers	AECOM	Technical Editor
Erika Schreiber	AECOM	Project Support; Ecology
Nicole Spangler	AECOM	Project Coordinator
Kevin Taylor	AECOM	Radiation Protection; Human Health; Radiological Waste

SAMA Contractors[a]		
Garill Coles	PNNL	Severe Accidents Mitigation Alternatives
Bob Schmidt	PNNL	Severe Accidents Mitigation Alternatives
Bruce Schmitt	PNNL	Severe Accident Mitigation Alternatives
Steve Short	PNNL	Severe Accidents Mitigation Alternatives

[a] Pacific Northwest National Laboratory is operated by Batelle for the U.S. Department of Energy

11.0 LIST OF AGENCIES, ORGANIZATIONS, AND PERSONS TO WHOM COPIES OF THE SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT ARE SENT

Name and Title	Company and Address
Reid Nelson Director, Office of Federal Agency Programs	Advisory Council on Historic Preservation 1100 Pennsylvania Ave NW, Ste 803 Old Post Office Bldg Washington, DC 20004
Timothy A. Slavin State Historic Preservation Officer	Delaware Division of Historical and Cultural Affairs 21 The Green Dover, DE 19901-3611
J. Rodney Little Director and State Historic Preservation Officer	Maryland Historical Trust 100 Community Place, 3rd Floor Crownsville, MD 21032-2023
Daniel Saunders Deputy State Historic Preservation Officer	New Jersey Historic Preservation Office 401 East State Street PO Box 304 Trenton, NJ 08625-0404
Jean Cutler Deputy State Historic Preservation Officer	Pennsylvania Bureau for Historic Preservation Commonwealth Keystone Bldg, 2nd Floor 400 North St Harrisburg, PA 17120-0093
EIS Filing Section	U.S. Environmental Protection Agency 1200 Pennsylvania Ave NW Washington, DC 20004
Environmental Review Section	U.S. Environmental Protection Agency, Region 2 290 Broadway New York, NY 10007-1866
Annette Scherer Senior Fish & Wildlife Biologist (Endangered Species)	U.S. Fish and Wildlife Service New Jersey Field Office 927 N Main St Heritage Square, Building D Pleasantville, NJ 08232
Patricia Kurkul Regional Administrator	National Marine Fisheries Service Northeast Regional Office 55 Great Republic Dr Gloucester, MA 01930-2276
Stanley W. Gorski Field Offices Supervisor	National Marine Fisheries Service Habitat Conservation Division James J. Howard Marine Sciences Laboratory 74 Magruder Rd Highlands, NJ 07732

Name and Title	Company and Address
Thomas McCloy Administrator	New Jersey Department of Environmental Protection Division of Fish and Wildlife Marine Fisheries Administration PO Box 400 Trenton, NJ 08625-0400
Christopher Dolphin Section Chief, Bureau of Coastal Regulation	New Jersey Department of Environmental Protection Division of Land Use Regulation PO Box 439 Trenton, NJ 08625
KarenTuccillo	New Jersey Department of Environmental Protection
Paul Bauldauf Assistant Director, Radiation Protection Programs	New Jersey Department of Environmental Protection PO Box 415 Trenton, NJ 08625-0415
Chad Pindar Supervisor, Project Review Section	Delaware River Basin Commission – New Jersey 25 State Police Dr PO Box 7360 West Trenton, NJ 08628-0360
Chairman Mark Gould	Nanticoke Lenni-Lenape Indians of New Jersey 18 East Commerce Street Bridgeton, NJ 08302
Julie Acton Chairman, Public Services Committee	Salem County Freeholders Court House 94 Market St Salem, NJ 08079
Jamie Turner Director	Delaware Emergency Management Agency 165 Brick Store Landing Rd Smyrna, DE 19977
Cheryl Reardon Project Director	Association of New Jersey Environmental Commissions PO Box 157 Mendham, NJ 07945
Tanya Baker	Office of Senator Kaufman 1105 N. Market St Suite 2000 Wilmington, DE 19801-1233
Kate Roher Kent/Sussex Director	Office of Representative Mike Castle 300 South New Street Dover, DE 19904
Jane Nogaki	New Jersey Environmental Federation 223 Park Avenue Marlton, NJ 08053
Tom Figlio	Township of Pittsgrove 989 Centerton Road Pittsgrove, NJ 08318
Kathryn Sutton	Morgan Lewis 1111 Pennsylvania Avenue, NW Washington, DC 20004-2541

Name and Title	Company and Address
Jerry Humphreys	New Jersey Bureau of Nuclear Engineering 33 Artic Parkway P.O. Box 415 Trenton, NJ 08625
Rich Pinney	New Jersey Department of Environmental Protection 33 Artic Parkway P.O. Box 415 Trenton, NJ 08625
Nancy Ranek License Renewal Environmental Lead	Exelon 200 Exelon Way, KSA/2-E Kennett Square, PA 19348
Al Fulvio Manager License Renewal	Exelon 200 ExelonWay Kennett Square, PA 19348
Joseph Sindoni	PSEG Nuclear, LLC P.O. Box 236 Hancocks Bridge, NJ 08038
Michael Tuosto	PSEG Nuclear, LLC 1640 Miriam Drive Brunswick, NJ 08902
James Stavely	PSEG Nuclear, LLC One Alloway Creek Neck Road Hancocks Bridge, NJ 08038
Township Clerk	Lower Alloways Creek Township Municipal Building PO Box 157 Hancocks Bridge, NJ 08038
Senior Resident Inspector, Salem Nuclear Generating Station	U.S. Nuclear Regulatory Commission Drawer 0509 Hancocks Bridge, NJ 08038
Senior Resident Inspector, Hope Creek Generating Station	U.S. Nuclear Regulatory Commission Drawer 0509 Hancocks Bridge, NJ 08038
Regional Administrator	U.S. Nuclear Regulatory Commission Region I 475 Allendale Rd King of Prussia, PA 19406

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Docket Nos. 50-272, 50-311, 50-354

11. ABSTRACT *(200 words or less)*

This draft supplemental environmental impact statement (SEIS) has been prepared in response to an application submitted by PSEG Nuclear, LLC (PSEG) to renew the operating licenses for Hope Creek Generating Station (HCGS) and Salem Nuclear Generating Station, Units 1 and 2 (Salem) for an additional 20 years. The SEIS includes the NRC staff's analysis that considers and weighs the environmental impacts of the proposed action, the environmental impacts of alternatives to the proposed action, and mitigation measures for reducing or avoiding adverse impacts. It also includes the staff's preliminary recommendation regarding the proposed action.

The NRC staff's preliminary recommendation is that the Commission determine that the adverse environmental impacts of license renewal for HCGS and Salem are not so great that preserving the option of license renewal for energy-planning decision makers would be unreasonable. The recommendation is based on (1) the analysis and findings in the GEIS; (2) the Environmental Reports submitted by PSEG; (3) consultation with Federal, State, and local agencies; (4) the staff's own independent review; and (5) the staff's consideration of public comments.

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Supplement 45

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

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

NUREG-1437, Vol. 2
Supplement 45

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

Draft Report for Comment Appendices

Manuscript Completed: October 2010
Date Published: October 2010

Office of Nuclear Reactor Regulation

Proposed Action	Issuance of renewed operating license NPF-57 for Hope Creek Generating Station and operating licenses DPR-70 and DPR-75 for Salem Nuclear Generating Station, Units 1 and 2 in Lower Alloway Creek Township, Salem County, New Jersey.
Type of Statement	Draft Supplemental Environmental Impact Statement
Agency Contact	Leslie Perkins U.S. Nuclear Regulatory Commission Office of Nuclear Reactor Regulation Mail Stop O-11F1 Washington, D.C. 20555-0001 Phone: 301-415-2375 Email: Leslie.Perkins@nrc.gov
Comments	Any interested party may submit comments on this supplemental environmental impact statement. Please specify NUREG-1437, Supplement 45, draft, in your comments. Comments must be received by December 17, 2010. Comments received after the expiration of the comment period will be considered if it is practical to do so, but assurance of consideration of late comments will not be given. Comments may be emailed to HopeCreekEIS@nrc.gov, SalemEIS@nrc.gov, or mailed to: Chief, Rulemaking, Directives, and Editing Branch U.S. Nuclear Regulatory Commission Mail Stop T6-D59 Washington, D.C. 20555-0001 Please be aware that any comments that you submit to the NRC will be considered a public record and entered into the Agencywide Documents Access and Management System (ADAMS). Do not provide information you would not want to be publicly available.

ABSTRACT

This draft supplemental environmental impact statement (SEIS) has been prepared in response to an application submitted by PSEG Nuclear, LLC (PSEG) to renew the operating licenses for Hope Creek Generating Station (HCGS) and Salem Nuclear Generating Station, Units 1 and 2 (Salem) for an additional 20 years.

This draft SEIS provides a preliminary analysis that evaluates the environmental impacts of the proposed action and alternatives to the proposed action. Alternatives considered include replacement power from a new supercritical coal-fired generation and natural gas combined-cycle generation plant; a combination of alternatives that includes natural gas combined-cycle generation, energy conservation/energy efficiency, and wind power; and not renewing the operating licenses (the no-action alternative).

The preliminary recommendation is that the Commission determined that the adverse environmental impacts of license renewal for Salem and HCGS are not so great that preserving the option of license renewal for energy-planning decision makers would be unreasonable.

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Appendix A

Comments Received on the Environmental Review

A. Comments Received on the Environmental Review

A.1 Comments Received During Scoping

The scoping process began on October 23, 2009 with the publication of the Nuclear Regulatory Commission's (NRC's) Notice of Intent to conduct scoping in the *Federal Register* (74 FR 54859). The scoping process included two public meetings held at Salem County Emergency Services Building in Woodstown, New Jersey on November 5, 2009. Approximately 70 people attended the meetings. After the NRC staff delivered prepared statements pertaining to the license renewal process, the meetings were open for public comments. Attendees provided oral statements that were recorded and transcribed by a certified court reporter. Transcripts for the afternoon and evening meetings are available using the NRC's Agencywide Documents Access and Management System (ADAMS). The ADAMS Public Electronic Reading Room is accessible at http://www.nrc.gov/reading-rm/adams.html. Transcripts for the afternoon and evening meetings are available in ADAMS under Accession Nos. ML093240195 and ML100471177, respectively (NRC, 2009a; NRC, 2009b). Persons who do not have access to ADAMS or who encounter problems in accessing the documents located in ADAMS, should contact the NRC's Public Document Room reference staff by telephone at 800-397-4209 or 301-415-4737, or by e-mail at pdr.resource@nrc.gov. In addition to the comments received during the public meetings, comments were received through mail and email and were addressed by the staff.

Each commenter was given a unique identifier so that every comment could be traced back to its author. Table A-1 identifies the individuals who provided comments and the Commenter ID associated with each person's set of comments. To maintain consistency with the Scoping Summary Report (NRC, 2010), the unique identifier for each set of comments used in that report is retained in this appendix. The Scoping Summary Report also contains full text versions of all the comments received at the public meetings, in the mail, and through email.

Specific comments were categorized and consolidated by topic. Comments with similar specific objectives were combined to capture the common essential issues raised by participants. Comments fall into one of the following general groups:

- Specific comments that address environmental issues within the purview of the NRC environmental regulations related to license renewal. These comments address Category 1 (generic) issues, Category 2 (site-specific) issues, or issues not addressed in the GEIS or Category 2 (site-specific) issues. They also address alternatives to license renewal and related Federal actions.
- General comments that are (1) in support of or opposed to nuclear power or license renewal or (2) on the renewal process, the NRC's regulations, and the regulatory process. These comments may or may not be specifically related to this license renewal application.
- Comments that do not identify new information for the NRC to analyze as part of its environmental review.
- Comments that address issues that do not to fall within or are specifically excluded from the purview of NRC environmental regulations related to license renewal. These comments typically address issues such as the need for power, emergency

preparedness, security, current operational safety issues, and safety issues related to operation during the renewal period.

Table A-1. Individuals Providing Comments during Scoping Comment Period

Commenter ID	Commenter Name	Affiliation (If Stated)	Comment Source
SHC-1	Lee Ware	Salem County Freeholders Board	Afternoon Scoping Meeting
SHC-2	Greg Gross	Delaware State Chamber of Commerce	Afternoon Scoping Meeting
SHC-3	Brian Duffey	Salem County Chamber of Commerce	Afternoon Scoping Meeting
SHC-4	Fred Stein	Delaware Riverkeeper Network	Afternoon Scoping Meeting, Written
SHC-5	Charles Hassler	IBEW Local Union 94	Afternoon and Evening Scoping Meetings
SHC-6	Carl Fricker	PSEG Nuclear, LLC	Afternoon and Evening Scoping Meetings
SHC-7	Dr. Peter Contini	Salem Community College	Afternoon Scoping Meeting
SHC-8	David Bailey Jr.	Ranch Hope, Inc	Afternoon Scoping Meeting
SHC-9	Kelly Wichman	PSEG Nuclear, LLC	Afternoon Scoping Meeting
SHC-10	Jane Nagaki	New Jersey Environmental Federation	Afternoon Scoping Meeting
SHC-11	Roland Wall	Center for Environmental Policy, Academy of Natural Sciences, Philadelphia	Afternoon Scoping Meeting
SHC-12	Julie Acton	Salem County Freeholder	Evening Scoping Meeting
SHC-13	Frieda Berryhill	Not stated	Evening Scoping Meeting
SHC-14	Nancy Willing	Not stated	Evening Scoping Meeting
SHC-15	Monica Beistline	Salem Generating Station	Evening Scoping Meeting
SHC-16	Fran Grenier	Woodstown Borough Councilman	Evening Scoping Meeting
SHC-17	Gina Carola	Sierra Club	Written Comments
SHC-18	John Greenhill	Not stated	Written Comments
SHC-19	Sidney Goodman	Not stated	Written Comments
SHC-20	William Dunn	Not stated	Written Comments
SHC-21	David Rickards	Instream Energy, LLC	Written Comments
SHC-22	Ellen Pompper	Lower Alloways Creek Township	Written Comments
SHC-23	Norm Cohen	The Unplug Salem Campaign	Written Comments

The comments received during the public meetings or as part of the scoping process are documented in this section, and the disposition of each comment is discussed thereafter. The formatting of the comment found in the source document in not necessarily maintained. Each comment has a unique identifier after the comment. For example, identifier SHC-20-2 corresponds to the second comment made by William Dunn, and identifier SCH-19-7 corresponds to the seventh comment made by Sidney Goodman.

The comments have been grouped by general categories. The categories are as follows:

1. Comments Concerning License Renewal and Its Processes
2. Comments in Support of License Renewal, PSEG, and Nuclear Power
3. Comments Concerning Aquatic Ecology and Related Issues
4. Comments Concerning Postulated Accidents
5. Comments Concerning Uranium Fuel Cycle and Waste Management
6. Comments Concerning Socioeconomics
7. Comments Concerning the Safety Issues and Aging Management of Plant Systems
8. Comments Concerning Alternatives to License Renewal
9. Comments Concerning Human Health
10. Comments Outside the Scope of License Renewal

To the extent practical, preparation of the draft Supplemental Environmental Impact Statement (SEIS) takes into account all the reasonable and relevant issues raised during the scoping process. The draft SEIS addresses both Category 1 and 2 issues, along with any new and significant information identified during the scoping process. The draft SEIS relies on conclusions supported by information in the Generic Environmental Impact Statement (GEIS; NRC, 1996; NRC, 1999) for Category 1 issues and includes the analysis of Category 2 issues, including any new and significant information identified.

A.1.1 Comments Concerning License Renewal and Its Processes

Comment: Now, you made a great deal about respecting public input. You had 20 license renewals approved now. None have been refused. I just wonder how much public input has really worked in these cases. None have been disapproved.

And some of them, by my estimate, should not have been approved. I have been to the NRC reading room in Washington, and there are records of every plant in there. Does Salem County have as complete a file as I would find it at the NRC reading room? Salem County library? Everything is in there? SHC-13-8

Comment: This letter concerns the proposed relicensing of Hope Creek. We oppose extending the license of this nuclear plant. We also oppose the process by which decisions on relicensing are made. This process makes it virtually impossible for most individuals and many organizations to participate. In addition, because only certain issues are deemed acceptable by the NRC for submission as contentions, many issues of safety and health are not even looked at by NRC in making their decision. We also oppose relicensing a nuclear plant twenty years before its license is up for renewal. SHC-23-1

Comment: However, it is important to put our concerns on the record, even though we do not expect NRC to act on any of them. SHC-23-3

Response: *The purpose and need for issuance of a renewed license is to provide an option that allows for power generation capability beyond the term of a current nuclear power plant operating license to meet future system generating needs, which may be determined by other energy-planning decision-makers. This definition of purpose and need reflects the Commission's recognition that a renewed license will be issued unless there are findings in the safety review or the National Environmental Policy Act (NEPA) environmental analysis that would lead the NRC to not grant a license renewal. The NRC does not have an energy-planning role in determining if a plant will be allowed to operate under the renewed license. If a renewed license is issued, energy-planning decision-makers and the applicant will ultimately decide whether a plant will continue to operate based on factors such as the need for power or other matters within the purview of the appropriate decision makers.*

The NRC has established an open process to permit all members of the public to participate in the environmental scoping process. The public is invited and encouraged to participate throughout the environmental review process. Input is specifically requested during the scoping period and during the draft SEIS review period. All comments received are evaluated and considered in the preparation of the draft and final SEIS. Finally members of the public and organizations are free to seek leave to intervene in the license renewal process and propose contentions within the scope of license renewal.

Copies of the license renewal applications and draft and final SEISs are made available for public review at the Commission's Public Document Room (One White Flint North, 11555 Rockville Pike, Rockville, MD 20852) as well as electronically on the NRC Web site at http://www.nrc.gov/reactors/operating/licensing/renewal/application.html, as they become available. The applications, as well as many of the supporting documents are also available from the NRC's ADAMS that is accessible from the NRC

ADAMS Web site at http://www.nrc.gov/reading-rm/adams.html. A copy of the applications for Salem Nuclear Generating Station (Salem)and Hope Creek Generating Station (HCGS), draft SEIS, and final SEIS are also available, or will be made available, at the Salem County Library.

These comments provide no new and significant information and will not be evaluated further in development of the SEIS.

Comment: If the NRC can give Oyster Creek a 20 year extension, even though that nuclear plant could not be built under today's standards, and is a meltdown waiting to happen, it is clear that the relicensing process for Hope Creek will be nothing more than paperwork and rubber stamping. SHC-23-2

Response: *The NRC performs a comprehensive review of each License Renewal application submitted. The NRC's review of each application for license renewal has four components: (1) a safety review,(2) an environmental review, (3) onsite inspections and audits, and (4) an independent review by the Advisory Committee on Reactor Safeguards (ACRS). The NRC staff performs a safety review of the information provided in the application, with additional* *information provided by the applicant at the NRC's request, and information elicited during audits and inspection. The results of the staff's safety review are documented in a publicly available safety evaluation report. The NRC staff's environmental review results in the publication of this document, a site-specific draft SEIS on license renewal. The public is invited to comment on the draft SEIS. Then, after considering all public comments, the NRC staff issues the final SEIS. Teams of inspectors with experience in nuclear plant safety visit the site and verify that the applicant has implemented its aging management plans as committed to in the application. The results of plant inspection(s) conducted as part of the license renewal process are made publicly available. The ACRS is an independent panel of experts that advises the Commission on matters related to nuclear safety. The ACRS reviews the applicant's application, the staff's safety evaluation report, and the results of the on-site audits and inspection(s) and makes its recommendation to the Commission regarding issuance of the renewed license. Only after all of these steps are satisfactorily completed will the NRC decide whether or not to renew a plant's operating license.*

This comment provides no new and significant information and will not be evaluated further in development of the SEIS.

A.1.2 Comments in Support of License Renewal, PSEG, and Nuclear Power

Comments: These comments can be located in Section A.2 with the alpha numeric comment identifiers: SHC-1-1, SHC-2-2, SHC-3-2, SHC-5-1, SHC-5-2, SHC-6-1, SHC-6-4, SHC-6-5, SHC-6-8, SHC-7-1, SHC-7-3, SHC-8-2, SHC-9-1, SHC-12-1, SHC-12-3, SHC-15-1, SHC-16-1, SHC-20-2, SHC-20-5, SHC-22-1

***Response**: These comments are general in nature and are primarily supportive of PSEG, nuclear power, and license renewal for Salem and HCGS. The comments provide no new and significant information and will not be evaluated further in development of the SEIS.*

A.1.3 Comments Concerning Aquatic Ecology and Related Issues

Comment: Speaking now directly to the environmental impact study, the Delaware Riverkeeper Network calls on the NRC and other reviewing agencies to hold the applicant to the highest scientific and regulatory standards as they prepare the EIS. Previous permits issued to PSE&G were based on data which were found to be faulty, misleading, biased and incomplete. In 1999 for instance, when PSE&G's permit came up for renewal, the company submitted over 150 volumes of information, data and arguments to support its case that it should be allowed to continue to kill Delaware River fish unimpeded.

Every year the Salem Nuclear Generating Station kills over 3 billion Delaware River fish including: Over 59 million Blueback Herring; Over 77 million Weakfish; Over 134 million Atlantic Croaker; Over 412 million White Perch; Over 448 million Striped Bass; and over 2 billion Bay Anchovy. Even NJDEP's own expert agrees that PSE&G assertions were not credible and were not backed by the data and studies PSE&G had presented. In fact according to ESSA consultants hired by NJDEP, PSE&G had greatly underestimated its impacts on Delaware River fish. According to ESSA, PSE&G "underestimates biomass lost from the ecosystem by perhaps greater than 2-fold." (ESA report p. xi) And "… the actual total biomass of fish lost to the ecosystem … is at least 2.2 times greater than that listed" by PSE&G. (ESSA Report p. 75)

ESSA Technologies' 154-page review of PSE&G's permit application documented ongoing problems with PSE&G assertions and findings including bias, misleading conclusions, data gaps, inaccuracies, and misrepresentations of their findings and damage. Some examples of ESSA's findings: With regards to fisheries data and population trends, ESSA said "The conclusions of the analyses generally overextend the data or results." (p. ix); PSE&G "underestimates biomass lost from the ecosystem by perhaps greater than 2-fold." (p. xi) "… the actual total biomass of fish lost to the ecosystem … is at least 2.2 times greater than that listed in the Application" (p. 75); "Inconsistency in the use of terminology, poorly defined terms, and a tendency to draw conclusions that are not supported by the information presented detract from the rigor of this section and raises skepticism about the results. In particular, there is a tendency to draw subjective and unsupported conclusions about the importance of Salem's impact on RIS finish species." (p. 77); and Referring to PSE&G's discussion and presentation of entrainment mortality rates, ESSA found PSE&G's "discussion in the section of the Application to be misleading." (p. 13).

The ESSA report contained no less than 51 recommendations for citations which PSE&G needed to take on its 2001 permit application before DEP made its decision, but that did not happen. It is our understanding that while NJDEP pursued some of these (which ones we do not know because it was not referenced in the draft permit documents) many of them were never addressed, and still others were turned into permit requirements to be dealt with over the next 5 years.

In addition to ESSA recommendations, NJDEP received comment from the State of Delaware and USF&W, both of whom conducted independent expert review of the permit application materials and found important problems with sampling, data, analyses and conclusions.

While we are urging you today to hold the applicant to high standards, I conclude by re-stating the fact that because Salem is clearly having an adverse environmental impact on the living resources of the Delaware Estuary and River, regardless of PSE&G's self-serving claims based on faulty scientific studies, the Clean Water Act requires "that the location, design, construction, and capacity of cooling water intake structures reflect the best technology available for minimizing adverse environmental impact." SHC-4-4; SHC-4-2

Comment: Not only that, but deceitful testimony has been given in support of the environmental impact of the existing nuclear plants. The statement for renewal states that the existing plants had no adverse effects on the Delaware Estuary. In fact, Salem kills 3 billion fish annually. Environmental expert Robert F. Kennedy Jr. sued the EPA in 1993. He revealed that Salem alone killed more than 3 billion Delaware River fish each year, according to the plant's own consultant. Fish kills are illegal and represent criminal acts. SHC-19-2

Response: *The comments are related to aquatic ecology and the quality and quantity of aquatic ecology data. As part of the staff's environmental review and subsequent SEIS development, the data generated by the plant owners, as well as other available data, will be reviewed and assessed. The Staff's evaluation of aquatic resources is presented in Chapters 2 and 4 (Sections 2.2.5 and 4.5, respectively) of the SEIS.*

Comment: [T]he Delaware Riverkeeper Network wants to reaffirm our long-standing position and call to convert the Salem Generating Station to closed-cycle cooling as mandated by Section 316(b) of the Clean Water Act. The Act states that generating plants such as Salem "shall be required that the location, design, construction, and capacity of cooling water intake structures reflect the best technology available for minimizing adverse environmental impact." The application before the NRC does not call for the compliance of the Clean Water Act as it relates to best technology available. According to a study conducted by a NJDEP hired expert in 1989 as well as experiences at other facilities, installation of closed cycle cooling towers at Salem would reduce their fish kills by 95%. And dry cooling at Salem could reduce their fish kills by 99%. SHC-4-3; SHC-4-1

Comment: [T]he Environmental Federation is, also, very firmly committed to the idea that if the relicensing goes forward, on Salem 1 and 2, that best available technology should be applied at those plants, which would be cooling towers to offset the millions of gallons of water that cycle through that plant every day. There has been a lot of talk, today, about how nuclear energy produces no air emissions. And, generally, when we think about environmental impacts we are thinking air, releases to the air, releases to the water, and releases to the land. And while it is true that there may be no air emissions, from the plant, there certainly is a consumptive use of millions of gallons of water a day, run through the cooling cycle, and then discharged back into the Delaware Bay, with a concurrent loss, as Fred mentioned of billions of fish per year, in all stages of life, from larval stage, to small stage, to large scale fish that are impinged on the once-through cooling system, which I have toured, by the way, and witnessed the huge structure that takes through millions of gallons of water a day. So if there is one environmental issue that I would like to highlight today, is the impact of the Salem Nuclear Plant on water in the Delaware Bay, and the concurrent fish and wildlife that that water, the Delaware Bay supports. We talked about nuclear energy as being a major employer in this area, and I'm certainly respectful of the workers that work there, that keep the plant safe every day, and the niche in the economy that it provides. But there is, also, a huge other economy in the Delaware Bay that is the fishing industry, that is severely affected by the operation of this plant. And so if I were to say the huge, the most huge, environmental impact of this plant, is the impact of water, in that once through cooling system. That needs to be addressed in the environmental impact statement. SHC-10-1

Comment: Now, also, actually these plants were operating against the law, with more than three billion fish killed, annually, from the Delaware River; [and] anything under three inches is taken up through the intake structure. The NEPA Act, which you have mentioned, which was passed in 1969, was passed just because this kind of damage. On December 18th, 2001, Congress allowed these once-through cooling systems to continue as long as they restored the fish killed. SHC-13-5

Comment: Enclosed is a resolution, passed by the New Jersey Chapter of Sierra, requesting that the Nuclear Regulatory Commission and the New Jersey Department of Environmental Protection require PSE&G to erect cooling towers at the Salem Nuclear Plants as a requirement to renewing the operating licenses. The Executive Board of the New Jersey Chapter is making this request on behalf of over 20,000 members of the New Jersey Chapter. Thank you for your consideration in this very important matter. SHC-17-1

Comment: Every Power Plant currently using intakes, either for once through operations or to replenish water lost from evaporation, should be required to partner with the most local municipality and pipe their treated wastewater to the power plant to eliminate intakes.

Intakes kill millions of fish annually and once through operations adversely modifies the environment surrounding the outflow area. Municipalities need to dispose of their treated wastewater and to pipe this affluent to a facility that can use it is a least expensive and obviously the most environmentally friendly method.

All power plants should upgrade to a cooling tower technology. If too much heat in generated to recycle the water, cooling units can be added to the outflow troughs to reduce the temperature of the water prior to reuse.

The kinetic energy available in cooling tower outflows can be tapped with UEK turbine technology to generate enough electricity to run cooling coil units. ENERGY RECOVERED = GOOD MANAGEMENT. SHC-21-1

Response: *These comments relate to the impact on aquatic ecology associated with Salem's once-through cooling systems and call for the installation of cooling towers at Salem. The impacts of impingement and entrainment from Salem's once-through cooling system is discussed in Section 4.5 of the SEIS. However, with respect to the comments regarding mandating a closed-cycle cooling system at Salem, the New Jersey Department of Environmental Planning (NJDEP) Division of Water Quality is the regulatory authority that mandates alterations to a plant's cooling system. The NJDEP accomplishes this through its review and approval of the New Jersey Pollution Discharge Elimination System (NJPDES) permit for each facility. In 2006, PSEG submitted to the NJDEP an application for renewal of its 2001 NJPDES permit for Salem, which included a Section 316(b) determination under the Clean Water Act (33 U.S.C 1251 et seq.). Until that request is reviewed and approved by the NJDEP, the 2001 NJPDES remains in effect. In accordance with the 2001 NJPDES permit, PSEG has not been required to replace its once-through cooling system at Salem with cooling towers. (See Appendix B of PSEG, 2009 for Salem's 2001 NJPDES permit.)*

The staff's evaluation of Salem and HCGS's effect on aquatic ecology is discussed in Chapter 2 and 4 (Sections 2.2.5 and 4.5, respectively) of the SEIS.

Comment: This [Estuary Enhancement Program] involves ongoing restoration, enhancement, and preservation of more than 20,000 acres of degraded salt marsh, and adjacent uplands within the estuary.

The estuary enhancement program is the largest privately funded wetlands restoration project in the country. More importantly, it was created with extensive public participation, and open communication with regulatory agencies and the public.

As a result all the estuary enhancement program sites are open to the public, and offer boardwalks, nature trails, outdoor education, and classroom facilities.

Studies show that the overall health of the estuary continues to improve. In addition, analysis of long-term fish populations in the estuary show that, in most cases, the populations are stable or increasing.

And that fish population trends are similar through the other areas along the coast. We also recognize our important role and impact to the local community. SHC-6-2; SHC-6-6

Comment: So going back to another impact, and the result of the Salem 1 and 2 plants not having cooling towers is that PSEG Nuclear entered into a very large estuary enhancement program, which was referred to earlier, preserving 20,000 acres of wetlands. And I would be remiss if I didn't mention a concern that environmental groups raised at the beginning of the restoration project, because many of the acres of wetlands were restored simply by breaching dikes of old salt hay farms, and allowing inundation of phragmites by salt water. And thus controlling the phragmites and growing a more beneficial kind of vegetation, called Spartana. But there are acres and acres of phragmites, you know what they are, the tall waiving foxtails, as they are often called, which were considered nuisance vegetation, or not favorable vegetation in the wetland restoration. And so in order to control that phragmites, massive aerial herbicide event took place starting in 1995 and '96, over 2000 acres were really sprayed with a pesticide called Glyphesate. And it was thought that one, maybe two applications of that herbicide would take care of the problem. But, to this day, in the year 2009, and continuing on until at least 2013, annual applications by herbicide by aircraft are made to wetlands, as part of this project. The acreage is down now, to around 120 acre realm. But it has been as high as thousands of pounds of a year. And so one of the environmental issue raised by this is, is there going to be continued applications of an herbicide in wetland areas as part of this restoration project, which was meant to offset the impacts caused by the lack of cooling towers. The reason we are concerned about this application of herbicides is that it actually triggered an increase in the use of this herbicide, state-wide. PSEG kind of became the model for how to restore wetlands. And so many other wetland restoration projects began utilizing this methodology. And the result has been a nine-fold increase in the use of Glyphesate in the state of New Jersey. And so while the use at this particular Alloways creek area is decreasing, not over yet, but still decreasing, the increase in the use, state-wide, is of concern because as you know pesticides generally have a habit of infiltrating our groundwater and surface water. They become part of our drinking water, part of our surface water. And the effect of this herbicide has been linked to cancer effects, birth defect effects, effects on fish, insect populations, and so forth. So we certainly raise this as an issue that needs to be addressed, because nobody has really looked at the cumulative impact of this year after year application of herbicide to control a nuisance plant, all in the name of restoring wetlands. SHC-10-4

Comment: My comments today are based on observations of Academy scientists, particularly those of our senior fishery scientist, Dr. Rich Horowitz, who is unable to be here today. The estuary enhancement program began in 1994. And, since that time, [there] has been a large scale effort to restore and preserve portions of the Delaware estuary, in both New Jersey and Delaware, encompassing more than 32 square miles, as you heard earlier, it is the nation's largest privately-funded wetlands restoration project. Restoration efforts have included the goal of replacing former salt hay farms, as you heard. And also to remove marshes that are dominated by the invasive phragmites, with saltcord grass dominated marsh. This has required a substantial effort to control phragmites, and to change drainage patterns to foster topography and tidal flow typical of Delaware Bay salt marshes.

The Academy has studied many of these sites, prior to restoration and a number of them following restoration. Yes, the enhancement program has been successful in restoring typical salt marsh conditions at these sites, with most sites being targets for reduction of phragmites, and establishment of salt cordgrass. At the remainder of sites where goals have been partially met, the estuary enhancement program continues to work to further improve marsh conditions. The EP has also preserved open space, as at the bayside track. Among other improvements at the restored sites, tidal flow and development of tidal channels have increased, allowing for re-colonization of salt cordgrass and other species. The restored marshes support large numbers of targeted fish species, as well as number of other fishes and invertebrates. These populations continue to contribute to bay productivity, most notably, at the salt hay farms. The restoration sites also provide important habitat for terrapins, birds, and mammals, and several of the sites are now part of New Jersey's Audubon designated important bird areas. SHC-11-1

Comment: The basic restoration activities, particularly controlling phragmites and fostering development of tidal marsh topography and hydrology, have advanced the field of ecological restoration. The ecological engineering technique of forming primary channels, and then using estuarian processes to further develop channels and topography, is especially notable. And in that way the estuarian enhancement program does provide an important model for marshland restoration. PSEG has also installed fish passage structures at dams in Delaware and New Jersey. These fish ladders have established river herring spawning in nursery areas, and several impoundments, increasing bay-wide populations of these species. PSEG has continued to conduct monitoring programs of Delaware fish populations, which greatly increase our knowledge of Delaware Bay fisheries.

To conclude, the Academy would like to commend PSEG on its demonstrated initiative, and long-term commitment to restoring the critical wetlands of the Delaware estuary. The estuary enhancement program has had numerous positive impacts on the ecology and biodiversity of the region, and has made important contributions to the recreational and educational opportunities available to local communities. The scale and scope of this effort has supported large scale scientific research, has improved our understanding of the process of environmental restoration. The Academy of Natural Sciences has been pleased to have the opportunity to participate in, and to contribute, to our scientific expertise to this project. SHC-11-3

Comment: Now, I saw that you had a display back there about that Habitation Restoration Act of 2001. But are you really raising fish? Twenty-thousand tons of poison was spread to kill the phragmite. You can't kill that phragmite. I looked at the picture that you had back there, that phragmite keeps coming up. How many tons of poisons are you going to spray over there? Now, I was just told, a while ago, that you are replacing the fish. I would like to know how many fish that you are replacing, and what the story is on that. SHC-13-5

Response: *These comments address the estuary enhancement program currently being conducted by PSEG. The estuary enhancement program is a provision of the Salem's 2001 NJPDES permit. (See Appendix B of PSEG, 2009 for Salem's 2001 NJPDES permit.) The impacts of the estuary enhancement program will be discussed, as appropriate, in Chapter 4 (Section 4.5.5) of the SEIS.*

Comment: Hope Creek has leaked hydrazine into the Delaware Bay. SHC-23-4

Response: *There have been two recent hydrazine discharges at Salem reported to the NJDEP. These events are summarized below:*

In June of 2006, PSEG submitted a Discharge Confirmation Report to the NJDEP for the discharge of approximately 2000 gallons of water containing hydrazine and ammonium hydroxide from the Salem Unit 1 Condensate Polisher System to the ground, with an additional discharge of 2000 gallons to the Delaware River through a permitted outfall. The discharge, which occurred on May 10, 2006, was reported to the NJDEP hotline (case number 06-05-10-0235-20) and to the NRC. The source of the discharge was a lifted relief valve within the Salem Unit 1 Condensate Polisher Building. It was terminated immediately upon discovery. It was reported that 8.3 ounces, or 3 parts per million (ppm), of hydrazine was discharged to the

Delaware River and 8.3 ounces, or 3 ppm, was discharged to the ground without recovery. The Department issued a fine in the amount of $8250.00 which was paid in full. (NJDEP, 2009)

On June 25, 2007, PSEG submitted a Discharge Confirmation Report to the NJDEP for the release of approximately 20,000 gallons of water, containing hydrazine, from a catastrophic failure of the 24 Demineralizer Vessel sight glass in the condensate polisher system at Salem Unit 2. In this event, condensate water had discharged into the yard area east of the Salem Unit 2 Condensate Polisher Building. The discharge, which occurred on May 24, 2007, was reported to the NJDEP hotline (case number 07-05-24-0259-32) and to the NRC. The discharge to land was managed in accordance with PSEG Discharge Prevention, Containment, and Countermeasure Plan. Sampling and analyses were performed that demonstrated there was no discharge to surface water as a result of this event. (NJDEP, 2009)

To date, there has not been a reported discharge of Hydrazine into the Delaware Bay by HCGS. Minor chemical spills and their effect on water quality have been previously considered in the GEIS as a Category 1 issue. The NRC found the impact from these types of spills to be SMALL over the period of extended operations, as the effects are readily controlled through New Jersey's NJPDES permit process (as demonstrated above) and are not expected to have a significant impact on water quality. The comments do not provide new and significant information and will not be evaluated further in development of the SEIS.

A.1.4 Comments Concerning Postulated Accidents

Comment: What is unique about our community? What is unique about Artificial Island is that it is an island that was constructed of dredge spoil material. It is not an island that existed before the geology of the time. So one of the concerns, environmental concerns would be how stable is the structure of the island to support this plant for another 20 years. Or three plants, actually. I think that issue will be addressed, more specifically, tonight by another environmental group. What is the effect of sea level rise? We talked about global warming and how nuclear power doesn't produce the kinds of emissions that contribute to global warming. But there is global warming going on, and there is sea level rise. What is the effect of sea level rise on the plant's artificial island? You know, is the island going to be inundated with water, how much over the next few years? Does more infrastructures need to be built there to support the plant? We know that salt water and the effects of the salinity of the bay have contributed to the rusting out of parts of the plant. We know that there has been extensive replacement of structures, and underground piping at the plant. And that is both, you know, that is an environmental impact, the salinity of the area, on the integrity of the structure of the plant. And that is an environmental issue that needs to be integrated into the safety and the aging issues of the plant. SHC-10-3

Comment: I have been involved with Salem before it was licensed to operate, for the simple reason that Delmarva Power and Light, at the time, also planned to build a nuclear power plant right across the river from here, which would have made this area the largest nuclear complex in the world. I was an intervener, a case I couldn't lose, because they ordered a high temperature gas-cooled reactor, and you know what happened to that. I'm very concerned about this. I attended many hearings on the subject, ever since 1970. These plants should never have gotten a building permit. Upon examining the documents I found, to my shock, clearly described in detail, on the large map, the soil condition of Artificial Island.

You see, there was no land here. It is called Artificial Island, because the island is built from dredgings of the Delaware River. And in the documents you will find that the borings of 35 feet are essentially nothing but mud and sand. The next 35 feet are gravel and sand. The last 35 feet are described as Vincentown Formation, which is a different kind of gravel and sand. Borings up to 100 feet have not revealed rock bottom. There is no rock bottom under these plants. The spent fuel pools, the auxiliary buildings, all of it, is sitting perched on cement pilings, I call them stilts, going 75 feet into the mud. And that is what is holding these plants up. Now I have with me pictures of toppled buildings that have simply collapsed with the pilings still sticking to them. And I am deeply concerned to have a fourth reactor on that island. SHC-13-1

Comment: Liquefaction is discussed in the documents. Liquefaction is the phenomenon when there is an earthquake, not a major earthquake, the sand is liquefies, and the building -- the hundreds of examples all over the world, where you can find that. And you can find some of it even on Google. And I have made statements to that effect before the Delaware House Energy Committee, and other agencies. It doesn't seem to really matter what citizens say. Yes, there was an earthquake up in Morris County. It was, actually, quite sizeable. But there is an earthquake fault, also, on the Delaware River. And, really, it scares me to think that it is only a matter of time, really, that an earthquake could happen here. The Morris earthquake threw people out of the house; they thought there was a big explosion somewhere. It was not just a minor shaking or rattling. Now, as to what could happen, I would like to just go back to the Rasmussen report, which was produced in 1970, as to the safety of nuclear power plants. That wasn't satisfactory, so they commissioned another report in 1985, called “Consequences of Reactor Accident”, called the “[CRAC] Report”. To just -- the numbers are just staggering. The [CRAC] Report for Salem reads as follows: Early peak fatalities, 100,000 Salem, 100,000 Salem 2. Early peak injuries, 70,000 for Salem 1, 75,000 for Salem 2. Peak cancer deaths, Salem 1 40,000, Salem 2, 40,000. Damages, Salem 1, 140 billion, Salem 2, 135 billion. This is not fantasy, this is the government report. SHC-13-2

Comment: While speaking with the state official from the [New Jersey] Bureau of Nuclear Energy…., before the evaluation hearing had started I asked about having heard that Salem was built on swamp land. And the gentleman, whose name I don't have here, he said of course not, and he proceeded to claim that the pilings went on through the sand, and gravel on Artificial Island, and were drilled securely into the bedrock. So that was the opinion stated at that meeting, to me, by an official from the Bureau of Nuclear Energy here in New Jersey. So I took the question to the record, when I had a chance to speak, and formally ask the question, about Artificial Island structures, do they actually secure into bedrock, or don’t they? Because Frieda Berryhill had told me that in her investigations, that they had not. So I asked, for the record, and the officials promised me that they would investigate that discrepancy, and give it back to me in writing, which they never did, I never got anything from them.

My concern was based on having heard that yet one more unit was planned to be constructed at the Salem complex. For the structures to be floating on a bed of gravel, and sand, and the result of a significant earthquake, six or seven on the Richter scale, would mean that the base of the structures, containing this nuclear material, would likely experience liquefaction, which Frieda got into a little bit.

That is the changing from compression of the earthquake, of the gravel and sand mix, into a jelly-like material. Liquefaction of the ground underneath causes structures to tip, slide, collapse, and otherwise break apart. It was an unhappy coincidence that the evacuation hearing was on the same day as the earthquake. So it was an interesting experience. Another earthquake was centered a few miles away from the Salem plant. And although it wasn't more than maybe two on the Richter scale, I'm not sure what it was, it isn't unheard of to think that we would have a more significant earthquake. The officials told me, that day, that the structures are built to withstand up to six or so on the Richter scale. But would that prevent a significant earthquake, maybe not up to that, would that prevent the leaks and cracks of an aging plant that is floating on a bed of gravel and sand, so to speak, should another earthquake occur. So the scope of the licensing process, here today, I think should be investigating that these are drilled into bed rock, that they are subject to liquefaction, and that would the aging of structures, brittle…would the aging, basically, have an impact on potential earthquake activity and contamination of the environment? And I think that is, hopefully that would be in your scope, some serious study of that. SHC-14-3

Comment: To renew the license for these nuclear plants represents extreme neglect of the public safety and welfare. It was incredibly poor judgment that these plants were built on "Artificial Island" in the first place. These plants should be shut down, with operation not allowed to continue, much less have their operation greatly extended. Incredibly, PSE&G is considering putting another nuclear plant on this island in this earthquake prone region. None of the nuclear plants are built on solid rock. They are filled in land. The letter I received from Bruce A. Boger (August 24) confirmed that these plants are not on solid rock. They rest on compacted engineering fill material or concrete, which have a depth of approximately 70 feet. Concrete pilings are used. The NRC presumes that this will enable them to resist the worst assault that an earthquake can deliver. SHC-19-1

Comment: What can happen from building on unstable land was exemplified in Shanghai, China. At around 5:30 AM on June 27, 2009 an unoccupied building, still under construction at Lianhuanan Road in the Mining district of Shanghai City toppled. Just before toppling, there were reports of cracks on the flood-prevention wall near the buildings and "special geological conditions" in the water bank area. In Japan, seven reactors at the Kashiwasz-Kariwa nuclear power plant in Japan were shut down due to an earthquake, fire and nuclear leak. People were killed and injured by the 6.8 magnitude earthquake, which struck in July, 2007. A new fire at the still shut down plant occurred in March, 2009. 600,000 residents signed a petition opposing restart of the plant. The arrogance of building nuclear plants in an earthquake prone area is almost unbelievable. Believe it! This arrogance is also invested in the other Nuclear Regulatory Commission rules. SHC-19-3

Comment: Hope Creek is vulnerable to a severe earthquake because Artificial Island is built on compacted mud, and its pilings do not reach bedrock. SHC-23-6

Response: *These comments address the formation and stability of the land on which Salem and HCGS are built and the susceptibility of the area to natural disasters such as earthquakes and a resulting liquefaction scenario.*

The potential for liquefaction was previously evaluated by the NRC in NUREG-1048, "Safety Evaluation Report Related to the Operation of Hope Creek Generating Station" (NRC, 1984). The report concluded that the river bottom sand will be stable under safe shutdown earthquake conditions that the plant is designed to withstand. In addition, issues related to the impacts of *natural disasters on the plant and the plant's ability to continue operating under its current license are addressed on an ongoing basis as part of the NRC's day-to-day oversight process.*

With respect to the commenter's concern regarding calculations from the CRAC report, the NRC has devoted considerable research resources, both in the past and currently, to evaluating accidents and the possible public consequences of severe reactor accidents. The NRC's most recent studies have confirmed that early research into the topic led to extremely conservative consequence analyses that generate invalid results for attempting to quantify the possible effects of very unlikely severe accidents. In particular, these previous studies did not reflect current plant design, operation, accident management strategies or security enhancements. They often used unnecessarily conservative estimates or assumptions concerning possible damage to the reactor core, the possible radioactive contamination that could be released, and possible failures of the reactor vessel and containment buildings. These previous studies also failed to realistically model the effect of emergency preparedness. The NRC staff is currently pursuing a new state-of-the-art assessment of possible severe accidents as part of its ongoing effort to evaluate the consequences of such accidents.

These comments do not provide new and significant information and will not be evaluated further in development of the SEIS.

Comment: I am unable to attend the hearings on 11/15/09 but would like to submit the following questions. There were incidents on 03/13/1989 and 9/19/1989 at the Salem 1 and 2 Nuclear Plants sites when geomagnetic storms caused damage to the single phase, generator step-up transformers which caused them to be taken out of service. The damages were due to geomagnetically induced currents caused by the geomagnetic storms.

Questions:

1. Is there a publically available report that describes these incidents?
2. What was the magnitude of the currents that caused the damage?
3. How long did the damaging currents persist?
4. What was the protective relay system in place at that time such as the IEEE Std C37.91 1985?
5. Where there any modifications to the transformer protective system put into effect?
6. How will the step-up transformers at Salem and hope Creek sites be protected if a super geomagnetic storm (10 times the size of the 1989 storms) occurs during the 20 year extension?
7. Do the sites have spare step-up transformers?

An initial cursory look shows a possible problem with the draft EIS when one examines table 5-2. The probability of a super solar storm of the 1859 or 1921 size is about 1/100 years or 1 % year. This size storm leads to a continental long term (many months) grid outage because of damage to all the U.S. step-up transformers similar to the damage that occurred at Salem New Jersey in 1989 during a fairly mild solar storm. With such an outage the emergency generators (that drive the cooling pumps) fuel supply would run out and could not be replaced because the commercial fuel suppliers would be out of fuel as well. Without fuel for the cooling pumps, the core damage frequency (CDF) appears to be several orders larger that the CDF given in the table 5-2. Perhaps a solar storm initiating event should be included in all the final EIS documents including the Salem and Hope Creek. SHC-18-1; SHC-18-2; SHC-18-3

Response: *The seven questions listed in the comment above have been provided to the appropriate NRC Region I staff and a separate response was provided to the commenter. These questions raise concerns that are related to current operational issues at the plant but do not fall within the scope of the license renewal environmental review and, therefore, will not be evaluated in development of the SEIS.*

With respect to the comment's suggestion that solar storms should be included as an initiating event for severe accident mitigation alternatives (SAMA), the staff considers the issue as follows: The SAMA analysis considers potential ways to further reduce the risk from severe reactor accidents in a cost-beneficial manner. The process for identifying and evaluating potential plant enhancements involves use of the latest plant-specific, peer-reviewed probabilistic risk assessment (PRA) study. These risk assessment studies typically show that loss of offsite power (LOSP) and station blackout (SBO) sequences are among the dominant contributors to core damage frequency (CDF) for nuclear power plants and account for about 20 to 50 percent of the CDF. As a result, enhancements to mitigate SBO events initiated by a LOSP are routinely identified and evaluated in the SAMA analysis. Consideration of SBO events initiated by a solar storm would not be expected to result in identification of additional SAMAs to mitigate LOSP and SBO events since license renewal applicants already perform a search for potential means to mitigate these risk contributors.

Consideration of solar storms would not be expected to substantially impact the CDF for LOSP/SBO events because postulated damage to generator step-up transformers would not affect the operation of the emergency diesel generators (EDGs). The EDGs would function to cool the reactor core until connections to the electrical grid are reestablished or alternative means of core cooling are established. Onsite fuel storage is typically sufficient to provide for at least 7 days of EDG operation and would be replenished during this period, as demonstrated at the Turkey Point plant following Hurricane Andrew in 1992 (NRC, 1992). Even with a major disruption in the supply chain, the 7-day period is sufficient for alternative arrangements to be made to resupply fuel for nuclear power plant EDGs in accordance with the National Response Framework (see National Response Framework, Emergency Support Function #12 – Energy Annex, www.fema.gov/pdf/emergency/nrf/nrf-esf-12.pdf). Alternative means of core cooling would be viable in the longer term, given that core cooling requirements (e.g., required pumped flow rates) would be substantially reduced days and weeks after reactor shutdown, and given the substantial industry and Federal resources that would be available to facilitate these measures.

If there is incompleteness in current PRAs with respect to an underestimate of the frequency or consequence of solar storm-initiated LOSP/SBO events, the sensitivity analysis performed on the SAMA benefit calculation would capture the increased benefit that might result from a more explicit consideration of solar storm-induced events. This analysis typically involves increasing the estimated benefits for all SAMAs by an uncertainty multiplier of approximately 2 to determine whether any additional SAMA(s) would become cost-beneficial and retaining any such SAMA(s) for possible implementation. In summary, the consideration of solar storm-initiated events would not be expected to alter the results of the SAMA analysis since *enhancements that address these types of events are already considered in the applicants' search for SAMAs to mitigate SBO/LOSP events, and any potential underestimate of the benefit of these SAMAs would be captured in existing applications by the use of the uncertainty multiplier on the SAMA benefits.*

A.1.5 Comments Concerning Uranium Fuel Cycle and Waste Management

Comment: Has the company made any request for dry-cask storage? …With Yucca Mountain canceled you will have to, eventually, go the dry cask storage, I just want to know how soon, or whether you have made any plans, and who is producing them. You don't know that? SHC-13-7

Comment: Because Yucca Mountain, the national depository for spent nuclear fuel, will not be operative, Lower Alloways Creek will become, and actually is now, a long term nuclear waste dump, which violates the zoning board agreement between PSEG and Lower Alloways. SHC-23-7

Response: *The safety and environmental effects of long-term storage of spent fuel onsite have been assessed by the NRC, and, as set forth in its Waste Confidence Decision (codified at 10 CFR 51.23), the Commission generically determined that such storage could be accomplished without significant environmental impact. In the Waste Confidence Decision, the Commission determined that spent fuel can be stored onsite for at least 30 years beyond the license operating life, which may include the term of a renewed license. At or before the end of that period, the fuel would be removed to a permanent repository. In its Statement of Consideration for the 1990 update of the Waste Confidence Decision (55 FR 38472), the Commission addressed the impacts of both license renewal and potential new reactors. In its December 6, 1999, review of the Waste Confidence Decision (64 FR 68005), the Commission reaffirmed the findings in the rule. In addition to the conclusion regarding safe onsite storage of spent fuel, the Commission states in the rule that there is reasonable assurance that at least one geologic repository will be available within the first quarter of the 21st century, and sufficient repository capacity for the spent fuel will be available within 30 years beyond the licensed life for operation of any reactor. Accordingly under 10 CFR 51.23(b), no site-specific discussion of any environmental impact of spent fuel storage in reactor facility storage pools or ISFSIs is required in an environmental impact statement associated with license renewal. These comments do not provide new and significant information and will not be evaluated further in development of the SEIS.*

Comment: As far as, there is no radiation produced at this plant, there is some radiation produced at this plant. It meets limits, so called acceptable limits. There is waste that is stored on-site. And so another environmental issue, that the environmental impact statement should address, is how much more waste is going to be generated and stored at the plant, at those enclosures that currently keep all the waste, ever produced at that plant, on the site forever. So, waste production concurrent with the relicensing is another very major environmental issue. SHC-10-2

Comment: Third, based on my research on the emerging nuclear fusion technology, the disposal of nuclear waste will one day be safely transmuted to useful isotopes. Nuclear fusion and fission will be paired to provide almost unlimited power without the issue of residual radioactivity. SHC-20-3

Response: *The GEIS considered a variety of spent fuel and waste storage scenarios, including onsite storage of these materials for up to 30 years following expiration of the operating license, transfer of these materials to a different plant, and transfer of these materials to an ISFSI. For each potential scenario, the GEIS determined that existing regulatory requirements, operating practices, and radiological monitoring programs were sufficient to ensure that impacts resulting from spent fuel and waste storage practices would be SMALL, and therefore, were a Category 1 issue. These comments do not provide new and significant information and will not be evaluated further in development of the SEIS.*

A.1.6 Comments Concerning Socioeconomics

Comment: I didn't realize that we have about in excess of three hundred employees, from Delaware, that come across that bridge each day. But it is not just about the 300 folks that come across that bridge, it is also about the families they support. SHC-2-1

Comment: Approximately 400 businesses and community organizations are members of the Salem County Chamber of Commerce, and this includes PSEG Nuclear, who is a long-time member.

On behalf of the Chamber, I would like the NRC to know that PSEG Nuclear plays a leading role in our community. They have supported the Chamber's efforts to build relationships, within the community, and to make Salem County a premier place to live, work, and conduct business.

They purchase goods and services from dozens of local businesses, and Chamber members, and with our support they are helping to drive the local economy.

Earlier this year PSEG Nuclear, hosted the Chamber Board of Directors for a tour of the Salem and Hope Creek facilities. It became very clear, to the Board of Directors that PSEG operates in a culture of safety and security.

That visit also reinforced the Board's belief that PSEG Nuclear operations provide a safe and clean source of energy. We also believe that nuclear power can help to combat climate change, and that PSEG's operations will continue to play a positive role in Salem County's future.

Without these plants hundreds of people would be left without jobs, dozens of local businesses would struggle, and our local economy would suffer a great loss. SHC-3-1

Comment: As such we have looked to partner with local communities, with our local community, to meet our needs to providing good paying local jobs. We have launched innovative partnerships with the Salem County Community College, and the Salem County Vocational Technical schools, to develop specialized training programs.

Both have been overwhelmingly successful, and will lead to a skilled workforce that will only strengthen the local economy. In Salem County we provide more than 1.4 million dollars, each year, to the local economy through local property taxes.

This funding is vital to supporting local schools and projects. From an economic development point of view, we have also helped to drive the local economic development through projects like revitalization of downtown Salem, and the construction of the Gateway Business Park in Oldmans Township.

We are also active partners in the Salem Main Street Program, and the Salem County Chamber of Commerce. Our support also goes well beyond dollars. Many of our employees are active participants and supporters within the local community. SHC-6-3; SHC-6-7

Comment: Their support is not just verbal. Their support is certainly implementing. And as you know, and you heard Carl say, there is going to be a growing need for employees, as certainly portions of the workforce ages out, and we hope, also, the expansion of opportunity in the future.

As a result we work collaboratively with PSE&G Nuclear, in focusing on a particular area that we think is of great need, an energy, nuclear energy technician position.

We were able to couple with them, and partner at the national level with the Nuclear Energy Institute. And we were selected as one of six community colleges, across the country, that are working on standardizing the curriculum to ensure that educational experience that our students have, will not only prepare them, but certainly ensure safety and security in the future in this field.

And you also heard about the center that has been revitalized in Salem City. Well, I'm proud to tell you that a portion of that center will be hosting a portion of our program.

And through a high tech classroom, as well as laboratory facilities, our students will be working with state of the art equipment. And, most importantly, be supportive both in scholarships, as well as internships.

So we see this as a real win-win. Thinking about this, that we have only, in less than one year, been able to implement this program, we now have a fully accredited nuclear energy technician program, technology program, what we refer to as NET, we now have over 50 students in that program.

The corresponding program, Sustainable Energy, is also working at about 20 students. We see that balance, and PSE&G Nuclear sees that balance, also. And they have been very collaborative in working with Energy Freedom Pioneers, as we look for other alternatives to energy in addition to nuclear.

These are important things, they are important things for our community and, certainly, for our students. But they also go beyond. Two years ago we had an emergency in our Salem center, hosting our one-stop career center. A fire, a fire that immediately caused the dislocation of over 30 workers, and 200 clients a day.

Within two hours we had a commitment from PSE&G Nuclear to relocate that entire program to the former training center. And within two days we were fully operational for the next four months. SHC-7-2

Comment: Ranch Hope, Inc., is a 501c(3) non-profit organization, founded in 1964. Again, our Alloway headquarters are within minutes of the Salem and Hope Creek facilities. Our mission is to provide behavioral health care, educational, and adventure-based environments for children and families from throughout the state of New Jersey, and within the Delaware Valley.

Through its generosity and support of local organizations, such as Ranch Hope, PSE&G Nuclear has touched the lives of thousands of residents, making our community a better place to live.

At Ranch Hope's Alloway campus PSE&G Nuclear supports our efforts to create a green community for children with treatment and educational facilities, not only environmental responsible, but energy efficient, and healthy for children and staff to live and work.

This unique collaboration with PSEG Nuclear not only focuses on changing the lives of children and families, but also energy efficiency, two topics you don't normally see together. SHC-8-1

Comment: In addition to ecological restoration, the enhancement program has developed increased opportunities for human use and experience, to interact with the estuary.

Public use areas were designed to meet the general education, public access, and ecotourism interest of each community hosting an EEP site.

This has included improved access to many of the sites by land and water, with boat access and parking areas, in turn, supporting extensive recreational activities.

The public use areas have become important settings for numerous formal and informal educational programs. The restored areas have also become significant research sites, and research by EEP, and other organizations, including the Academy, has advanced our knowledge of tidal marsh ecology. SHC-11-2

Comment: Not only are they a great community partner, but they are the county's largest employer. A majority of their employees are local residents, who live in our community.

In tough economic times PSEG Nuclear provides an example of integrity and commitment to positive growth that we all need to see.

PSEG Nuclear takes a very proactive role in developing positive relationships with members of the Salem County community, whether it is providing funding and support to local community groups, or attending their events. SHC-12-2

Response: *These comments, in general, are supportive of the applicant and also address the socioeconomic benefits of Salem and HCGS on local/regional communities and economy, including other related issues such as employment, taxes, education, and philanthropy. The staff addresses the socioeconomic impact of renewing the Salem and HCGS operating licenses in Chapter 2 and 4 (Sections 2.2.8 and 4.9, respectively) of the SEIS. In addition, the socioeconomic impact of not renewing the operating licenses of these generating stations is discussed in Chapter 8.*

A.1.7 Comments Concerning Safety Issues and Aging Management of Plant Systems

Comment: But I do want to say that some of the safety concerns, and environmental concerns, are related mainly to this issue of the aging of the plant, the salinity, the lack of a firm under-structure to the plant, all make the plant more vulnerable to failures of structure that could lead to an environmental release of radiation, which is the ultimate disaster that everybody fears at this plant. And so while the radiation leakage issue, and emissions issue, is not a day to day concern, you know, when the plant is operating optimally, if there isn't an aggressive strategy for preventive maintenance, that not just waits for something to happen, and then addresses it, but actually anticipates and replaces structures as they age, before they age. This vulnerability will continue, you know, to be of great concern. SHC-10-5

Comment: Clearly this plant should have never received a building permit, and surely it should not receive a license to operate for another 20 years. They were originally licensed for 40 years. You are dealing with embrittlement, and all sorts of problems with that. There was a reason for it. SHC-13-4

Comment: I don't agree with the renewal of the 20 year licenses for the 40 year old structures that exist here today. I don't think it is a wise and reasonable choice for the citizens. We do enjoy the energy that comes out of them, but we also have to expect to live our full lives here in this area. A 40 year life span pretty much says it all, it is a 40 year life span, and the thought of another 20 year service from the Salem and Hope Creek structures seems to be asking too much, and offering uncertainty and trepidation to the public. With age come leaks and cracks. The life span of potential contamination isn't worth that bargain, in my view. SHC-14-2

Comment: The environmental impact appears to be minimal for granting an extension of the facilities license and there is certainly a justified need to upgrade portions of nuclear power generating operations to replace aging equipment that will improve the power generating capabilities and mitigate safety issues of an aging plant. SHC-20-1

Comment: The electrical system that connects Hope Creek to the grid is old and has had a number of failures, including transformer failures.

PSEG has a spotty record when it comes to keeping diesel generators working. This is a concern because all three nuclear plants rely on diesel generators if offsite power is interrupted.

PSEG has a serious Safety Conscious Work Environment (SCWE) and Safety Culture problem. This has been a chronic problem at all 3 of PSEG's plants, and continues to show up in NRC inspections under “cross-cutting issues of human performance.” One key example at Hope Creek was the loss of 5000 gallons of cooling water, due to human error. This event could have escalated into a TMI-type of situation. SHC-23-5

Comment: Hope Creek has buried pipes and electrical conduits that have not been inspected and, based on other nuclear plants, may be leaking tritium or in danger of electrical shorts happening. SHC-23-8

Response: *NEPA focuses on the environmental impacts of a major Federal action (such as license renewal) rather than on issues related to the safety of an operation. Safety issues become important to the environmental review when they could result in environmental impacts, which is why the environmental effects of postulated accidents will be considered in the SEIS. Because the Council on Environmental Quality (CEQ) regulations implementing NEPA do not include a safety review, the NRC has codified regulations for conducting an environmental impact statement separate from the regulations for reviewing safety issues during its review of a license renewal application. The regulations governing the environmental review are contained in 10 CFR Part 51, and the regulations covering the safety review, including the aging management issues discussed in most of these comments, are contained in 10 CFR Part 54. For this reason, the license renewal review process includes an environmental review that is distinct and separate from the safety review. Because the two reviews are separate, operational safety issues and safety issues related to aging are considered outside the scope for the environmental review, just as the environmental issues are not considered as part of the safety review.*

With respect to the safety aspect of such systems and components being able to operate for another 20 years, the staff makes that determination as part of its license renewal safety review, which focuses on the programs and processes that are designed to ensure adequate protection of the public health and safety during the 20-year license renewal period through management of aging components. As part of the license renewal safety review, PSEG Nuclear, LCC is required to demonstrate that the effects of aging will be adequately managed. For example, regarding buried piping, NRC staff performing the safety review are incorporating recent industry operating experience into aging management programs proposed by the applicant.

These comments are not within the scope of the license renewal environmental review and will not be evaluated further in development of the SEIS.

A.1.8 Comments Concerning Alternatives to License Renewal

Comment: Fourth, the option of purchasing more electricity by decommissioning these facilities will likely require modifying and building additional transmission lines to support this option. This will have a far more deleterious effect on the environment and communities where these lines will be constructed that continuing to operating these nuclear facilities. Furthermore, importing electricity will likely originate from either coal or gas fired units that produced the greenhouse gases CO2 (and other pollutants) as compared to nuclear power that generates zero greenhouse gas. SHC-20-4

Comment*:* Hope Creek should be decommissioned at the end of its 40 year license. Affected employees should be relocated and retrained by PSEG. Artificial Island should be turned into a wind power and solar power "park" to produce some of the electrical energy formerly produced by the nuclear plants. SHC-23-12

Response: *These comments refer to the alternatives to license renewal, including the alternative of not renewing the operating licenses for Salem and HCGS, also known as the "no-action" alternative. The staff has evaluated all reasonable alternatives in Chapter 8 of the SEIS.*

A.1.9 Comments Concerning Human Health

Comment: Hope Creek emits continual amounts of low level radiation and radionuclides, which contribute to the cancer cases and immune system disorders in the 50 mile zone around Artificial Island. SHC-23-10

Response: *Although radiation may cause cancers at high doses, currently there are no reputable scientifically conclusive data that unequivocally establish the occurrence of cancer following exposure to low doses, below about 10 roentgen equivalent man (rem; 0.1 sievert [Sv]). However, radiation protection experts conservatively assume that any amount of radiation may pose some risk of causing cancer or a severe hereditary effect and that the risk is higher for higher radiation exposures. Therefore, a linear, no-threshold dose response relationship is used to describe the relationship between radiation dose and detriments, such as cancer induction. Simply stated, any increase in dose, no matter how small, results in an incremental increase in health risk. This theory is accepted by the NRC as a conservative model for estimating health risks from radiation exposure, recognizing that the model probably over-estimates those risks. Based on this theory, the NRC conservatively establishes limits for radioactive effluents and radiation exposures for workers and members of the public. While the* *public dose limit in 10 CFR Part 20 is 100 millirem (mrem; 1 millisievert [mSv]) for all facilities licensed by the NRC, the NRC has imposed additional constraints on nuclear power reactors. Each nuclear power reactor, including Salem and HCGS, has enforceable license conditions that limit the cumulative annual whole body dose to a member of the public from all radioactive emissions in the offsite environment to 25 mrem (0.25 mSv). In addition, there are license conditions to further limit the dose to a member of the public from radioactive gaseous effluents to an annual dose of 5 mrem (0.05 mSv) to the whole body and 15 mrem (0.15 mSv) to any organ. For radioactive liquid effluents, the dose standard is 3 mrem (0.03 mSv) to the whole body and 10 mrem (0.1 mSv) to any organ.*

Nuclear power reactors were licensed with the knowledge that they would release radioactive materials into the environment. NRC regulations require that the radioactive material released from nuclear power facilities be controlled, monitored, and reported in publically available documents. The amount of radioactive effluents released into the environment is known to be small. The radiation exposure received by members of the public from commercial nuclear power reactors is so low (i.e., less than a few mrem) that resulting cancers attributed to the radiation have not been observed and would not be expected. To put this in perspective, each person in this country receives a total annual dose of about 300 mrem (3 mSv) from natural sources of radiation (e.g., 200 mrem from naturally occurring radon, 27 mrem from cosmic rays, 28 mrem from soil and rocks, and 39 mrem from radiation within our body) and about 63 mrem (0.63 mSv) from man-made sources (e.g., 39 mrem from medical x-rays, 14 mrem from nuclear medicine, 10 mrem from consumer products, 0.9 mrem from occupations, less than 1 mrem from the nuclear fuel cycle, and less than 1 mrem from fallout due to weapons testing).

Although a number of studies of cancer incidence in the vicinity of nuclear power facilities have been conducted, there are no studies to date that are accepted by the scientific community showing a correlation between radiation dose from nuclear power facilities and cancer incidence in the general public. The following is a listing of studies recognized by the Staff:

- *In 1990, at the request of Congress, the National Cancer Institute (NCI) conducted a study of cancer mortality rates around 52 nuclear power plants and 10 other nuclear facilities. The study covered the period from 1950 to 1984 and evaluated the change in mortality rates before and during facility operations. The study concluded there was no evidence that nuclear facilities may be linked causally with excess deaths from leukemia or from other cancers in populations living nearby (NCI, 1990).*

- *In June 2000, investigators from the University of Pittsburgh found no link between radiation released during the 1979 accident at the Three Mile Island power plant and cancer deaths among nearby residents. Their study followed 32,000 people who lived within 5 miles of the plant at the time of the accident (Talbot et al., 2003).*

- *The Connecticut Academy of Sciences and Engineering, in January 2001, issued a report on a study around the Haddam Neck nuclear power plant in Connecticut and concluded radiation emissions were so low as to be negligible and found no meaningful associations to the cancers studied (CASE, 2001).*

- *Also in 2001, the Florida Bureau of Environmental Epidemiology reviewed claims that there are striking increases in cancer rates in southeastern Florida counties caused by increased radiation exposures from nuclear power plants. However, using the same* *data to reconstruct the calculations, on which the claims were based, Florida officials were not able to identify unusually high rates of cancers in these counties compared with the rest of the State of Florida and the nation (Bureau of Environmental Epidemiology, 2001).*

- *In 2000, the Illinois Public Health Department compared childhood cancer statistics for counties with nuclear power plants to similar counties without nuclear plants and found no statistically significant difference (Illinois Public Department of Health, 2000).*
- *The American Cancer Society in 2004 concluded that although reports about cancer clusters in some communities have raised public concern, studies show that clusters do not occur more often near nuclear plants than they do by chance elsewhere in the population. Likewise, there is no evidence that links strontium-90 with increases in breast cancer, prostate cancer, or childhood cancer rates. Radiation emissions from nuclear power plants are closely controlled and involve negligible levels of exposure for nearby communities (ACS, 2004).*

In April 2010, the NRC asked the National Academy of Sciences (NAS) to perform a state-of-the-art study on cancer risk for populations surrounding nuclear power facilities. The NAS study will update the 1990 U.S. National Institutes of Health - NCI report, "Cancer in Populations Living Near Nuclear Facilities" (NCI, 1990). The study is expected to be completed within 4 years. Information from the report will be considered for incorporation into future updates of the NRC's guidance and regulations, as appropriate.

To ensure that U.S. nuclear power plants are operated safely, the NRC licenses the nuclear power plants to operate, licenses the plant operators, and establishes license conditions for the safe operation of each plant. The NRC provides continuous oversight of plants through its Reactor Oversight Process to verify that they are being operated in accordance with NRC regulations. The NRC has full authority to take whatever action is necessary to protect public health and safety and the environment and may demand immediate licensee actions, up to and including a plant shutdown.

The impact on human health of renewing the operating licenses for Salem and HCGS will be evaluated in Section 4.8 of the SEIS.

A.1.10 Comments Outside the Scope of License Renewal

Comment: I was at the 2009 emergency evacuation public hearing, here in New Jersey. And it was an interesting meeting for me because although Delaware is at risk, or in the 50 mile radius, we don't get this kind of attention, we don't have public hearings. And I imagine that -- I was told, as I got here today, that some feelers went out to see if Delaware wanted to have a meeting similar to this, and it was not -- that didn't happen. But that the emergency evacuation public meeting the state held, I didn't -- well, I will just go right to this. SHC-14-1

Comment: The NRC is still satisfied with a mere ten-mile evacuation zone around a nuke when poisons from Three Mile Island were blown hundreds of miles. Poisons from Chernobyl were blown around the world? … The NRC continues support for the Price Anderson Act. This federal law limits liability of a disaster to a microscopic fraction of the potential damage which will be incurred? The act reduces concerns of operating utilities, a very risky effect. This federal law abolishes the property rights of Americans in order to protect the property rights of nuclear plant owners. This atrociously unfair law is nothing less than fascist. The NRC continues to support the distribution of potassium iodide pills as an assurance that no one will be harmed from a disaster? These pills only protect against radioactive iodine. The pills must be taken immediately and continue to be used for as long as radioactive iodine lingers in the environment. The pills do nothing to project against all of the other radioactive poisons, which are released. This is no real assurance to anyone who is informed. The NRC continues to support ridiculously inadequate evacuation plans following a fuming meltdown at a nuke. SHC-19-4

Comments: The Evacuation Plan for Salem/Hope Creek is based on faulty assumptions and would not work under many scenarios, including a fast acting radiation release and multiple releases. Under worst case scenarios, thousands of people within the 10 and 50 mile zones would die from radiation exposure. SHC-23-9

Response: *Emergency planning is not within the scope of the license renewal as set forth in 10 CFR Parts 51 and 54, as it is addressed as a current licensing issue on an ongoing basis. The NRC has regulatory requirements in place under 10 CFR Part 50 to ensure that licensees have adequate emergency planning and evacuation programs in place in case of an accident/emergency scenario. Such plans are evaluated by the NRC and coordinated with the Federal Emergency Management Agency (FEMA) and local authorities for implementation. Drills and exercises are conducted periodically to verify the adequacy of the plans. Issues identified during such exercises are resolved within the context of the current operating license and are not reevaluated as part of license renewal.*

In addition, the Commission issued a Final Rule on potassium iodide (KI) in the Federal Register on January 19, 2001 (66 FR 5427). The NRC does not require use of KI by the general public because the NRC believes that current emergency planning and protective measures (i.e., evacuation and sheltering) are adequate and protective of public health and safety. However, the NRC recognizes the supplemental value of KI and the prerogative of the states to decide the appropriateness of the use of KI by its citizens. At this time, the NRC has made KI available to States that wish to include thyroid prophylaxis in their range of public protective actions to be implemented in the event of a serious accident at a nuclear power plant that would be accompanied by a release of radioactive iodine. Both New Jersey and Delaware have programs for issuing the KI pills. The KI pills are for the individuals living within the 10-mile emergency planning zone (EPZ). In addition, schools and emergency workers also have a cache of pills in case of an emergency.

These comments are not within the scope of this environmental review and will not be evaluated further in development of the SEIS.

Comment: I would like to interject, recently I wrote an article as to the soil conditions of this thing. And in that article I mentioned the Price-Anderson Act, that nuclear power plants could never be built without the protection of the Price-Anderson Act. And some gentleman from the NRC felt compelled to write an answer to the local Wilmington paper saying, we don't depend on the Price-Anderson Act, we have 9 billion dollars in reserve for whatever damages we cause.

It makes me laugh, because there is no comparison to the damages that could be caused. Nine billion dollars is pocket change. SHC-13-3

Comment: Incredibly, though, that PSEG announced that it planned to spend another 50 million between 2007 and 2011 to explore the potential to construct a new reactor on the island, a fourth reactor. I think not. I would like to ask a few questions, if I may. Nine billion dollars somewhere in the reserve? Can anybody, at the NRC, tell me who is holding this nine billion dollars? I have a letter written to the editor, don't worry about Price-Anderson, we have nine billion dollars. Who would have that nine billion? Well, I will see if I can find out another way. SHC-13-6

Response: *The Price-Anderson Nuclear Industries Indemnity Act (Price-Anderson Act; 42 U.S.C. 2210) is a federal law that governs liability-related issues for all non-military nuclear facilities constructed in the United States before 2026. The main purpose of the Act is to partially indemnify the nuclear industry against liability claims arising from nuclear incidents while still ensuring compensation coverage for the general public. The Act establishes a no fault insurance-type system in which the first $10 billion is industry-funded and any claims above the $10 billion would be covered by the Federal government.*

Licensees are required by the Act to obtain the maximum amount of insurance against nuclear-related incidents that is available in the insurance market. Currently this insurance amount is approximately $375 million per plant. Monetary claims that fall within this insurance coverage are paid by the insurer. The Price-Anderson fund would then be used to make up the difference. Each reactor company is obliged to contribute up to $111.9 million in the event of an accident, amounting to approximately $11 billion if all of the reactor companies were required to pay their full obligation into the fund. However, this fund is not paid into unless an accident occurs.

If a coverable incident occurs, the NRC is required to submit a report on the cost of the incident. if claims are likely to exceed the maximum Price-Anderson fund value, the President must submit a proposal to Congress that details the costs of the accident, recommends how funds would be raised, and includes plans for compensation to those affected.

These comments regarding the Price-Anderson Act and the commenter's opinion regarding allocation of funds are not within the scope of this environmental review and will not be evaluated further in the development of the SEIS.

Comment: Hope Creek remains a prime terrorist target, and there are many ways terrorists could prevail, only one of which will I list here.

Hope Creek's Spent Fuel Pool is above ground and not protected by containment.

It is a prime terrorist's target. If the water in the Pool drains out, there would be massive radiation releases. SHC-23-11

Response: *The NRC and other Federal agencies have heightened vigilance and implemented initiatives to evaluate and respond to possible threats posed by terrorists, including the use of aircraft against commercial nuclear power facilities and spent fuel storage installations. The NRC routinely assesses threats and other information provided by other Federal agencies and sources. The NRC also ensures that licensees meet appropriate security-level requirements. The NRC will continue to focus on prevention of terrorist acts for all nuclear facilities and will not focus on site-specific evaluations of speculative environmental impacts resulting from terrorist acts. While these are legitimate matters of concern, they will continue to be addressed through* *the ongoing regulatory process as a current and generic regulatory issue that affects all nuclear facilities and many of the activities conducted at nuclear facilities. The issue of security and risk from malevolent acts at nuclear power facilities is not unique to facilities that have requested a renewal to their licenses because these issues are being addressed on an ongoing basis for all nuclear facilities.*

With respect to the commenter's concern regarding the spent fuel pool (SFP) accident, previous studies show that the risk associated with spent fuel pool accidents and dry cask storage accidents is considerably less than that for reactor accidents (e.g., NUREG-1738 and NUREG-1864). Further, additional mitigation strategies implemented subsequent to September 11, 2001, further reduce the risk from SFP fires by enhancing spent fuel coolability and the ability to recover SFP water level and cooling prior to a potential SFP fire.

These comments are not within the scope of this environmental review and will not be evaluated further in development of the SEIS.

A.2 Full Text Versions of the Scoping Comments

The following pages contain full text versions of the scoping comments received at the public meetings, in the mail, and via email along with their accompanying identifiers.

MR. WARE: Thank you, Lance. My name is Lee Ware, Director of Salem County Freeholders Board, starting my tenth year as a Freeholder. I'm a little down today because my beloved Phillies went down.

And I guess it is only appropriate, since I was a baseball coach, for 38 years, I will be the lead-off hitter here today, Lance.

I'm coming before you, today, to let you know that PSEG Nuclear is a valuable asset to our county. Not only are they great community partners, but they are the county's largest employer.

They have been good neighbors, and good partners. A majority of their employees are local residents, who live in our community. PSEG takes a very proactive role in developing positive relationships with members of Salem County community.

Whether it is providing funding and support to local community groups, or attending every community event. A lot of members here can attest to that. We see each other quite a bit.

They are always demonstrating their commitment to Salem County's proud heritage and bright future. We understand

SHC-1-1

the hesitation of those within and surrounding our county, towards PSEG Nuclear.

Their concerns regarding safety, and plant performance, are valid. However, PSEG Nuclear has consistently demonstrated its commitment to safety, and excellence, through proper planning and transparency.

As life-long residents of Salem County, six miles as the crow flies from the reactors, I feel safe around the power plant, I have raised my children here, and they still reside here. SHC-1-1

We have seen no negative impact to our environment, or community. I support PSEG Nuclear and license renewal for the Salem and Hope Creek stations. Their continued success is our success. Thank you.

MR. GROSS: Good afternoon. I'm Greg Gross, I'm director of government affairs with the Delaware State Chamber of Commerce, and we represent about 1,700 plus members of the business and corporate communities in the Delaware, throughout Delaware.

And when I was invited, and I want to thank you for the opportunity to come here and speak in support of one of our most valued partners. And, quite frankly, when I was invited to come speak in support, I knew about it, I wasn't totally educated about it, but I took a few minutes yesterday, and educated myself about what it means to the Delaware community.

I didn't realize that we have about in excess of three hundred employees, from Delaware, that come across that bridge each day. But it is not just about the 300 folks that come across that bridge, it is also about the families they support. SHC-2-1

About the economic structure in our community that it supports. And also, too, I took a few minutes to query a few of our elected officials that are very involved, and plugged into the environmental community and said, you know what, Greg? We don't worry about them, we don't worry, because they are safe, because they have gone that extra mile to be safe. SHC-2-2

If there is something there that they know may be troublesome, they address it before it happens. So that means something. I said, we don't worry.

There always will be, I'm sure, apprehensions to what goes on, and there always will be fear, I'm sure. But as each year goes by I'm sure that that fear will slowly dissipate as things often do, with such things of this nature.

But we are happy that we do have such a strong partner involved in every facet of our community in Delaware. As I said, I didn't realize how much, until I went back and I looked over some things.

And I was saying, wow, I mean it is just incredible what a strong partner. And when you are going down the years of 2016, I think the other one was 2026, I don't know if I will be around in 2026.

I'm hoping I will be around in 2026. But I hope that I am, and I hope I am back even more educated, and being able to speak more passionately about what I believe is the great work that is done.

And, most importantly, the safety and just preparing for what we are going to be facing in the years, as far as what we

SHC-2-2

are going to need for our energy, and our needs. It doesn't get any easier.

And, Lord knows, the need doesn't get any smaller, it gets even larger. So with that said, you know, we give our total support in any way we possibly can, whether we -- whether in a letter, from our President, or any folks that are needed, within our community there, please don't hesitate to let us know.

Thank you, again, for allowing me to take a few minutes of your time to be here with you today, and I look forward to hearing additional comments, thank you.

SHC-2-2

MR. DUFFEY: Good afternoon. I'm the current vice-chair, and the 2010 incoming chair of the Salem County Chamber of Commerce.

Approximately 400 businesses and community organizations are members of the Salem County Chamber of Commerce, and this includes PSEG Nuclear, who is a long-time member.

On behalf of the Chamber, I would like the NRC to know that PSEG Nuclear plays a leading role in our community. They have supported the Chamber's efforts to build relationships, within the community, and to make Salem County a premier place to live, work, and conduct business.

They purchase goods and services from dozens of local businesses, and Chamber members, and with our support they are helping to drive the local economy.

Earlier this year PSEG Nuclear, hosted the Chamber Board of Directors for a tour of the Salem and Hope Creek facilities. It became very clear, to the Board of Directors that PSEG operates in a culture of safety and security.

That visit also reinforced the Board's belief that PSEG Nuclear operations provide a safe and clean source of energy. We also believe that nuclear power can help to combat climate

SHC-3-1

change, and that PSEG's operations will continue to play a positive role in Salem County's future.

Without these plants hundreds of people would be left without jobs, dozens of local businesses would struggle, and our local economy would suffer a great loss. SHC-3-1

The Salem County Chamber of Commerce supports PSEG Nuclear, and its plans for license renewal, for an additional 20 years of operation for Salem and Hope Creek. Thank you for your time. SHC-3-2

MR. STEIN: Thank you very much. My name is Fred Stein, I work with the Delaware Riverkeeper Network, it is a non-profit environmental advocacy organization.

I would like to thank the NRC for the opportunity to speak to the license renewal application submitted by PSEG and Exelon. We understand the purpose of today's meeting, of the dual meetings, today, is to discuss the process around the license renewal and the requisite EIS scoping.

And I will speak directly to that. But, first, the Delaware Riverkeeper Network wants to reaffirm our long-standing position, and call to convert the Salem generating station to a closed cycle cooling system, as mandated by the Section 316(b) of the Clean Water Act.

The Act states that generating plants, such as Salem, shall be required that the location, design, construction, and capacity of cooling water intake structures reflect the best technology available for minimizing the adverse environmental impacts.

The application before the NRC does not call for the compliance of the Clean Water Act, as it relates to the best technology available. And it should.

SHC-4-1

According to our study, conducted by New Jersey DEP hired expert in 1989, as well as experiences at other facilities, installations of a closed cycle cooling towers, at Salem, would reduce the fish kills from the Delaware river by 95 percent.

And dry cooling systems, at Salem, would reduce it even further, to 99 percent.

SHC-4-1

Speaking now, directly to the Environmental Impact Study, the Delaware Riverkeeper Network calls on NRC, and other reviewing agencies, to hold the Applicant to the highest scientific and regulatory standards as they prepare the EIS.

Previous permits issued to PSEG were based on data that were found to be faulty, misleading, biased, and incomplete. In 1999, for instance, when the data and arguments to support its case, that it should be allowed to continue to kill the Delaware River fish unimpeded.

Every year the Salem Nuclear Power Plant kills over three billion fish in the Delaware River. That includes over 59 million blue-backed herring, 77 million weak fish, over 134 million arctic croakers, over 412 million white perch, over 448 million striped bass, and over 2 billion bay anchovies.

Even DEP's own experts agree that PSEG's assertions were not credible, and were not backed by the data and studies

SHC-4-2

PSEG had presented. In fact, according to an ESSA Consultant hired by New Jersey DEP, PSEG had greatly underestimated its impact on the Delaware river fish resources.

According to ESSA, PSEG underestimated biomass loss from the ecosystem by, perhaps, as many as two-fold. And the actual total biomass of fish loss to the ecosystem is at least 2.2 times greater than was listed by PSE&G.

ESSA technologies' 154 page review of PSE&G's permit application, documented ongoing problems with PSE&G's assertions and findings, including biased, misleading conclusions, data gaps, inaccuracies and misrepresentation of their findings and damage.

Some of the examples of the EESA findings were with regards to the fisheries data and population trends, ESSA said the conclusions of the analysis generally overextended the data or results.

PSE&G underestimated biomass loss from the ecosystem by, perhaps, as many as two-fold. Inconsistency in the use of terminology, poorly defined terms and tendency to draw conclusions that are not supported by the information presented detract from the rigor of this section and raises skepticism about the results.

SHC-4-2

In particular there is a tendency to draw subjective and unsupported conclusions about the importance of Salem's impact on the fish species in the river.

And, finally, referring to PSE&G's discussions, and presentations of entrainment, mortality rates, ESSA found PSE&G's discussion in this section of the application, to be misleading.

The ESSA report contained no less than 51 recommendations for actions which PSE&G needed to take, on its 2001 permit application before DEP. But that didn't happen, none of those happened.

It is our understanding that while DEP pursued some of these, many of them were never addressed, and still others were turned into permanent requirements to deal with over the next permit cycle.

SHC-4-2

In addition to ESSA recommendations, New Jersey DEP received comment from the State of Delaware, and the U.S. Fish and Wildlife Services, both of whom conducted independent expert review of the permit application materials.

And found important problems with sampling, data analysis, and conclusions. While we are urging you today, NRC, while we are urging you today to hold PSE&G as they go through this EIS process, to the highest standards, I want to reinforce our belief that I started my comment with, that -- I'm sorry, I jumped ahead.

I conclude by restating the fact that because Salem is clearly having an adverse environmental impact on the living resources of the Delaware river, and estuary, regarding PSE&G, we encourage you to hold them to the highest standards possible. I'm sorry, I lost my place here.

We feel that it is important that, through the EIS process, that the data that PSE&G and its consultants bring to you, is complete, and unbiased, and that it is thoroughly looked at by the NRC, and it will be by the general public, too.

In a Philadelphia Enquirer editorial today, there was an article about nuclear energy, talking about that the NRC believes that it is the most regulated industry, and the most regulated government agency. And it should be.

And we hope that those regulations are there to protect the natural resources of the river and that we, again, hold PSE&G as they go through this process, to the highest standards possible. Thank you very much.

SHC-4-2

DELAWARE RIVERKEEPER

Testimony
Fred Stine, Citizen Action Coordinator for the
Delaware Riverkeeper Network
11/5/2009

I would like to thank the NRC for this opportunity to speak to the license renewal application submitted by PSE&G and Excelon. We understand the purpose of today's duel public meetings is to discuss the processes around the license renewal and requisite EIS scoping and I will speak directly to that.

But first, the Delaware Riverkeeper Network wants to reaffirm our long-standing position and call to convert the Salem Generating Station to closed cycle cooling as mandated by Section 316(b) of the Clean Water Act. The Act states that generating plants such as Salem "shall be required that the location, design, construction, and capacity of cooling water intake structures reflect the best technology available for minimizing adverse environmental impact." The application before the NRC does not call for the compliance of the Clean Water Act as it relates to best technology available.

According to a study conducted by a NJDEP hired expert in 1989 as well as experiences at other facilities, installation of closed cycle cooling towers at Salem would reduce their fish kills by 95%. And dry cooling at Salem could reduce their fish kills by 99%. SHC-4-3

Speaking now directly to the environmental impact study, the Delaware Riverkeeper Network calls on the NRC and other reviewing agencies to hold the applicant to the highest scientific and regulatory standards as they prepare the EIS. Previous permits issued to PSE&G were based on data which were found to be faulty, misleading, biased and incomplete. In 1999 for instance, when PSE&G's permit came up for renewal, the company submitted over 150 volumes of information, data and arguments to support its case that it should be allowed to continue to kill Delaware River fish unimpeded.

Every year the Salem Nuclear Generating Station kills over 3 billion Delaware River fish including:

Over 59 million Blueback Herring
Over 77 million Weakfish
Over 134 million Atlantic Croaker
Over 412 million White Perch

SHC-4-4

Delaware Riverkeeper Network
300 Pond Street, Second Floor
Bristol, PA 19007
tel: (215) 369-1188
fax: (215) 369-1181
drkn@delawareriverkeeper.org
www.delawareriverkeeper.org

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Over 448 million Striped Bass
Over 2 billion Bay Anchovy

Even NJDEP's own expert agrees that PSE&G's assertions were not credible and were not backed by the data and studies PSE&G had presented. In fact, according to ESSA consultants, hired by NJDEP, PSE&G had greatly underestimated its impacts on Delaware River fish. According to ESSA, PSE&G "underestimated biomass lost from the ecosystem by perhaps greater than 2-fold." (ESSA report p. xi) And "... the actual total biomass of fish lost to the ecosystem ... is at least 2.2 times greater than that listed" by PSE&G. (ESSA Report p. 75)

ESSA Technologies' 154 page review of PSE&G's permit application documented ongoing problems with PSE&G's assertions and findings including bias, misleading conclusions, data gaps, inaccuracies, and misrepresentations of their findings and damage. Some examples of ESSA's findings:

- With regards to fisheries data and population trends, ESSA said "The conclusions of the analyses generally overextend the data or results." (p. ix)

- PSE&G "underestimates biomass lost from the ecosystem by perhaps greater than 2-fold." (p. xi) "... the actual total biomass of fish lost to the ecosystem ... is at least 2.2 times greater than that listed in the Application." (p. 75)

- "Inconsistency in the use of terminology, poorly defined terms, and a tendency to draw conclusions that are not supported by the information presented detract from the rigor of this section and raises skepticism about the results. In particular, there is a tendency to draw subjective and unsupported conclusions about the importance of Salem's impact on RIS finfish species." (p. 77)

- Referring to PSE&G's discussion and presentation of entrainment mortality rates ESSA found PSE&G's "discussion in this section of the Application to be misleading." (p. 13)

The ESSA report contained no less than 51 recommendations for actions which PSE&G needed to take on its 2001 permit application before DEP made its decision, but that did not happen. It is our understanding that while NJDEP pursued some of these (which ones we do not know because it was not referenced in the draft permit documents) many of them were never addressed, and still others were turned into permit requirements to be dealt with over the next 5 years.

In addition to ESSA recommendations, NJDEP received comment from the State of Delaware and USF&W, both of whom conducted independent expert review of the permit application materials and found important problems with sampling, data, analyses and conclusions.

While we are urging you today to hold the applicant to high standards, I conclude be re-stating the fact that because Salem is clearly having an adverse environmental impact on the living resources of the Delaware Estuary and River, regardless of PSE&G's self-serving claims based on faulty scientific studies, the Clean Water Act requires "that the location, design, construction, and capacity of cooling water intake structures reflect the best technology available for minimizing adverse environmental impact."

END

SHC-4-4

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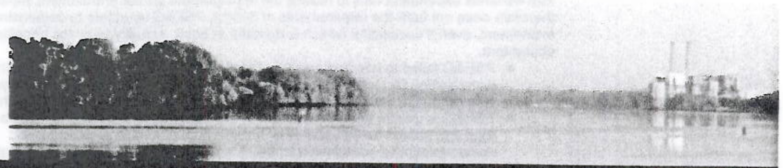
DELAWARE RIVERKEEPER



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Fact Sheet

Largest Predator in the Delaware Estuary

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Salem kills over 3 billion RIS fish a year.

Every year the Salem Nuclear Generating Station kills over 3 billion Delaware River fish including:

- Over 59 million Blueback Herring
- Over 77 million Weakfish
- Over 134 million Atlantic Croaker
- Over 412 million White Perch
- Over 448 million Striped Bass
- Over 2 billion Bay Anchovy

(Figures provided are numbers of fish killed. Source: correspondence from US Fish & Wildlife Service to NJDEP, June 30, 2000 relying on PSE&G permit application data)

The permit issued was based on data which is faulty, misleading, biased and missing information and data provided by PSE&G.

In 1999, when PSE&G's permit came up for renewal, the company submitted over 150 volumes of information, data and arguments to support its case that it should be allowed to continue to kill Delaware River fish unimpeded. To its credit, NJDEP took the advice of environmental groups including Delaware Riverkeeper Network, ALS, NJEF, EAGLE, COA and the Coalition for Peace and Justice, and hired an independent expert to help them review PSE&G's materials. But, to its discredit, NJDEP did not require PSE&G to address the many shortcomings and DEP apparently ignored their expert's findings, just as they did with Versar in 1994.

ESSA Technologies' 154 page review of PSE&G's permit application documented ongoing problems with PSE&G's assertions and findings including bias, misleading conclusions, data gaps, inaccuracies, and misrepresentations of their findings and damage. Some examples of ESSA's findings:

- With regards to fisheries data and population trends, ESSA said "The conclusions of the analyses generally overextend the data or results." (p. ix)
- PSE&G "underestimates biomass lost from the ecosystem by perhaps greater than 2-fold." (p. xi) "... the actual total biomass of fish lost to the ecosystem ... is at least 2.2 times greater than that listed in the Application." (p. 75)
- "Inconsistency in the use of terminology, poorly defined terms, and a tendency to draw conclusions that are not supported by the information presented detract from the rigor of this section and raises skepticism about the results. In particular, there is a tendency to draw subjective and unsupported conclusions about the importance of Salem's impact on RIS finfish species." (p. 77)
- Referring to PSE&G's discussion and presentation of entrainment mortality rates ESSA found PSE&G's "discussion in this section of the Application to be misleading." (p. 13)

The ESSA report contains no less than 51 recommendations for actions which PSE&G needed to take on its 2001 permit application before DEP made its decision, but that did not happen. It is our understanding that while NJDEP pursued some of these (which ones we do not know because it was not referenced in the draft permit documents) many of them were never addressed, and still others were turned into permit requirements to be dealt with over the next 5 years.

In addition, NJDEP received comment from the State of Delaware and USF&W, both of whom conducted independent expert review of the permit application materials and found important problems with sampling, data, analyses and conclusions.

PSE&G Continues to Poison Sensitive Marshlands Annually and Does Not Mitigation Salem's Fish Kills

To date, PSE&G has applied over 22,000 pounds of herbicides, aerially and by hand, to 2,500 acres of sensitive marsh land. *(Source: NJEF 2003 glyphosate analysis)* The loss of food, shelter and habitat are unacceptable.

http://www.delawareriverkeeper.org/newsresources/factsheet.asp?ID=11 11/5/2009

The wetlands experiment fails to reduce the impingement and/or entrainment impacts of Salem and therefore does not fulfill the requirements of 316(b), PSE&G is unable to demonstrate that their wetlands experiment, even if successful (which is doubtful at best), actually provides benefits to the estuary ecosystem.

- PSE&G failed to conduct any baseline data that would demonstrate whether or not food and habitat were limiting factors for the aquatic communities of the Delaware River system and therefore whether or not wetlands restoration could have contributed positively to their numbers.
- PSE&G is unable to demonstrate that the wetlands it is seeking to restore are superior, in terms of food and habitat for fish and other aquatic populations, than *phragmites*. Scientific studies are documenting that *phragmites* in fact is not of inferior value to *spartina*, that it does provide usable and used food, shelter and cover to both aquatic and terrestrial species. Therefore, PSE&G's entire wetlands experiment is based on a false premise.
- The sustainability of the wetlands *phragmites* reduction is dependent on annual herbicide treatment.
- PSE&G has failed to demonstrate that even if it is successful at replacing the existing *phragmites* in the Cohansey and Alloway sites with other species of plants, that this change in vegetation is sustainable and will not be overrun by neighboring stands of *phragmites* within a matter of years.
- At the Alloways site the interim goal was met through the removal of approximately 1,000 acres of *Phragmites* dominated wetlands from the restoration program—an action which then skewed the perceived results by removing from the program a problematic site
- Actions by PSE&G in the *phragmites* dominated sites is not increasing fish utilization of those areas. PSE&G monitoring at Alloway Creek includes sites (a) dominated by *Phragmites*, (b) dominated by *Spartina* or (c) under treatment for *phragmites* removal ("*Treated*" sites). PSE&G 2000 monitoring showed that within the Alloway Creek study area, fish abundance was similar at all three types of sites. In 2002, fish abundance at the *phragmites* dominated site at Alloway Creek was approximately twice as great as that seen at *Spartina* dominated site and the treated site at Alloway Creek. Reproduction of mummichog and Atlantic silverside was seen in the *phragmites* dominated sites both prior to and following the treatment of *phragmites* andgrowth patterns were seen to be similar for mummichog and Atlantic silverside both pre and post treatment as well. Studies also indicate that mummichog use *phragmites* as a food source in *phragmites* dominated sites. These results indicate that *Phragmites* eradication has not demonstrated an increased utilization of the site by fish and/or increased fish production.
- Tidal flow has successfully returned to the New Jersey salt hay farms. Not all sites have attained percent coverage goals for *spartina* coverage but *spartina* and other target species do dominate the three sites. The restored salt hay farms that were originally dominated by *Spartina* have reached the set goal of marsh coverage after repeated herbicide applications (Dennis Township and Maurice River) but the one farm that was dominated by *phragmites* (Commercial Township) has not yet reached the interim goal of 45% *spartina* coverage and doesn't come close to the vegetative coverage of the reference marsh at Moores Beach.
- Young of the year fish assemblages in the salt hay farms were similar between the restored salt marshes and the reference marshes including size composition, seasonal patterns of occurrence and species composition. While predator species such as striped bass and white fish were found to be utilizing the restored salt hay farm marshes with a higher diversity of species and a higher density of predator fish as compared to the reference marshes, forage studies indicated that food habits of the fish were similar between the restored salt marshes and the reference marshes.
- According to PSE&G data 2000-2002 there has been little to no usage of fish ladders installed at Garrison Lake or Coopers Lake. While evidence of spawning was seen in all sites except Garrison Lake, it does not appear that the stocking efforts have been successful in establishing the return of offspring to the fish ladder sites. Three of the four sites with large numbers of fish utilizing the ladders received limited stocking, indicating that the fish utilizing the fish ladders are most likely pioneers, rather than either returning stocked fish or offspring of stocked fish. The sites that have received the largest numbers of stocked fish continue to show limited use of the fish ladders by adults.

PSE&G's mitigation/restoration efforts are not mitigating the impingement and entrainment impacts of the Salem facility.
PSE&G data and analysis on the record as of 2003 does not demonstrate an increase in baywide abundance values of the representative important species or Atlantic silverside since PSEG completed the marsh restoration and fish ladder installations. Striped bass data is difficult to interpret as the abundance numbers in the Delaware are apparently linked to abundance in Chesapeake Bay. Overall, it appears that striped bass have increased, although this increase is not statistically significant. Weakfish and white perch declined in numbers after 1997, although the decline was not statistically significant. A decline was also seen for spot, bay anchovy, Atlantic silverside (1994-2001), and American shad, with the decline being statistically significant for American shad when comparing 1991-1994 data to 1997-2001 data. Increases have been seen in blueback herring, although these increases are not statistically significant. PSE&G's mitigation/restoration efforts are not mitigating the impingement and entrainment impacts of the Salem facility.

The costs of closed cycle cooling at Salem has not been demonstrated to outweigh its benefits.
It would cost only about $13 a year per rate-payer (assuming an average electric bill of $100 a month) to install closed cycle cooling at Salem. This $13 would benefit the health of our fisheries as well as commercial and recreational fishing organizations and businesses.

PSE&G has been given over a decade to carry out its alternative strategy for "mitigating" the impacts of Salem. It has been unable to demonstrate this program is beneficial to the environment and residents of New Jersey. It is time to hold PSE&G accountable and to require implementation of closed cycle cooling at Salem

http://www.delawareriverkeeper.org/newsresources/factsheet.asp?ID=11 11/5/2009

MR. HASSLER (AFTERNOON): Good afternoon. My name is Charlie Hassler, and I came here to speak in support of the PSE&G licensing for the Salem and Hope Creek units.

I'm a lifelong-resident of Salem City, and I work down at the Salem Hope Creek nuclear facility for the past approximately 34 years. I'm currently a business agent for the International Brotherhood of Electrical Workers, Local Union 94, which represents the organized labor who are employed permanently at the facility.

Additionally I'm a member of the New Jersey IBEW, the umbrella organization, with about 35,000 members. New Jersey IBEW is also on record as supporting the relicensing efforts of the Salem and Hope Creek stations.

SHC-5-1

Our support is based upon understanding of how the NRC proceeds with the relicensing effort. It is an informed rational support, and comes only with our belief that the safety of our members, and the public at large, will be assured by the continued operation of these plants.

The three units have been operating at capacity of about 90 to 95 percent in the past several years. Prior to the outages now in progress at Salem unit 2, that unit ran for 515 consecutive days at a capacity factor of one hundred percent.

This type of performance can only be achieved through diligent processes, procedural adherence, while maintaining and operating the plants. The personal standards of all workers are very high. What other industry has improved the standards and operating capacities the way it has been done in nuclear? This is truly the most watched, from the outside, and scrutinized from within.

The Institute of Nuclear Power Operators, The Nuclear Management and Resource Council, and the NRC itself, does more internal evaluations than to groups in any other industry.

This is an industry that if you are not bumping the top quartile in performance, you had better have a better plan, or you are in trouble. The output of the three stations supplies New Jersey with about 52 percent of its electric needs.

SHC-5-1

Producing this electricity is done without creating green house gases, which is an important and critical component to this discussion, given the global warming situation.

Without these plants, the reliability of the electric delivery to meet demand would be put at risk. Next, American's reliance on foreign energy imports continues to stress our economy, costing Americans jobs, and putting the middle class, itself, at risk.

A sound energy policy is our nation's best interest, and nuclear energy must play an important role in that policy. Finally, we must all recognize, that license renewal does not come open-ended, without ongoing monitoring.

Safety and performance standards, just as they are today, will continue for the entirety of the time the plant operates. If the plant falls below the acceptable standards, myself and the members of my union, will be the first to speak out. SHC-5-1

If a major issue, safety-wise arises in the future, you can all rest assured that the NRC has the ultimate power to come in, take away the keys, shut the doors, and close the plant down.

Thank you for the opportunity to speak.

MR. HASSLER (EVENING): Good evening. My name is Charles Hassler, and I'm here tonight to speak in support of the PSEG's relicensing of the Salem and Hope Creek nuclear facility.

I have been on the facility, as a worker, for 34 years. Right now I'm currently a business agent for the International Brotherhood of Electrical Workers, Local Union 94.

Additionally I'm a member of the New Jersey IBEW, which is the umbrella group in New Jersey that has an organization of about 35,000 members. New Jersey IBEW also is on record as supporting the relicensing of the Salem and Hope Creek stations.

As I said, we represent the organized labor who are permanently employed on the island, at the facility. Our support is based on our understanding of how the NRC proceeds with this relicensing effort.

It is an informed, rational, support. And it comes only with our belief that the safety of our members, and the public at large, will be assured by the continued operation of the plants.

The three units have been operating at a capacity factor of about 90 to 95 percent for the past several years. Prior to the outage that is going on right now at Salem unit 2,

SHC-5-2

that unit ran for 515 consecutive days at a capacity of over 100 percent.

This type of performance can only be achieved through diligent processes, and procedure adherence, while maintaining and operating the plant.

The personnel standards are high for all workers.

What other industry has improved the standards and operating capacity the way that it has been done in nuclear? This is truly the most watched, from the outside, and scrutinized from within.

The Institute of Nuclear Power Operators, the Nuclear Management and Resource Council, and the NRC itself do more internal evaluations than groups in any other industry.

This is an industry that if you are not bumping at the top quartile, you had better have a plan ready and in place or you will be in trouble. The output of the three stations supply New Jersey with about 52 percent of its electric needs.

Producing this electricity is done without creating greenhouse gases, which is an important and critical component to this discussion, given the global warming situation.

Without these plants the reliability of electric delivery, to meet demand, would also be at risk. Next, Americans

SHC-5-2

reliance on foreign energy imports continues to stress our economy, costing Americans jobs, and putting the middle class, itself, at risk.

A sound energy policy is in our nation's best interest, and nuclear energy must plan an important role in that policy. Finally, we must all recognize that license renewal does not come open-ended, and without ongoing monitoring.

Safety and performance standards, just as they are today, will continue for the entirety of the time the plant operates. If the plant falls below acceptable standards, myself and the members of this union, will be the first to speak out.

If a major safety issue arises in the future, we can all be assured that the NRC has the ultimate power to come in, take the keys, shut the doors, and close the plants down.

Thank you for your time.

SHC-5-2

MR. FRICKER (AFTERNOON): Good afternoon, and thank you for giving me the opportunity to make a comment regarding the license renewal application of Salem and Hope Creek.

My name is Carl Fricker, and I'm the vice president of operations and support for PSE&G Nuclear, and I am part of the leadership team that is responsible for the safe and reliable operation of our plants.

I have over 25 years of both military and commercial nuclear power plant experience. And I have worked at PSE&G Nuclear for the past 14 years. I have had positions in operations, maintenance, quality assessment, and for the last four years, prior to my current job, I was the plant manager at Salem.

At PSE&G we understand our obligation to the local community, to the environment, to our friends, families, and coworkers, to provide safe, reliable, economic, and green energy.

In New Jersey over 50 percent of the state's electricity comes from nuclear power. In fact PSE&G Salem and Hope Creek Nuclear Plants, is the second largest nuclear facility in the country.

Each day those plants generate enough electricity to supply three million homes. In addition we are able to meet the region's energy needs without emitting any green house gases.

SHC-6-1

Today nuclear power produces over 70 percent of our nation's carbon-free electricity. We take great pride in that and recognize our important role in fighting climate change now and in the future.

As you hear earlier, our current operating licenses expire in 2016 for Salem unit 1, 2020 for Salem unit 2, and 2026 for Hope Creek. In 2006 we made the decision to pursue license renewal.

We formed a dedicated team that worked for over two and a half years, or about 122,000 person hours, to prepare our application. That was about 4,000 pages of application.

This review involved a review of thousands of documents, a detailed review of our equipment, and component performance, and a rigorous review of the existing maintenance and engineering programs, to ensure that Salem and Hope Creek will safely operate for an additional 20 years.

Over the past 10 years we have invested over 1.2 billion dollars in our plants, including last year's steam generator replacements at Salem unit 2, and the various upgrades that supported Hope Creek's extended power uprate.

SHC-6-1

As part of license renewal we also reviewed any environmental impacts that, by continuing to operate, the Salem and Hope Creek nuclear plants for 20 years, would cause.

We consider ourselves environmental stewards, and since this is an environmental scoping meeting, I want to touch on this subject.

In addition to producing no green house gases, PSE&G has no adverse radiological impacts on our environment. The NRC requires PSE&G Nuclear, and all U.S. nuclear plants, to maintain an environmental monitoring program, to monitor local radiation levels. Annually we perform over 1,200 analysis on over 850 environmental samples, including air, water, soil, and food products like milk, and farm crops. All analyses samples are cross-checked with other laboratories to ensure precision and accuracy.

We are also closely monitored by the New Jersey Department of Environmental Protection's Bureau of Nuclear Engineering. The Bureau of Nuclear Engineering independently monitors the local environmental around PSE&G Nuclear, through a remote monitoring system that provides real time readings.

The sampling and monitoring has shown that there is no adverse impact to the environment. We are also proud stewards of

SHC-6-1

the Delaware river and estuary, through our estuary enhancement program.

This program involves ongoing restoration, enhancement, and preservation of more than 20,000 acres of degraded salt marsh, and adjacent uplands within the estuary.

The estuary enhancement program is the largest privately funded wetlands restoration project in the country. More importantly, it was created with extensive public participation, and open communication with regulatory agencies and the public.

As a result all the estuary enhancement program sites are open to the public, and offer boardwalks, nature trails, outdoor education, and classroom facilities.

Studies show that the overall health of the estuary continues to improve. In addition, analysis of long-term fish populations in the estuary show that, in most cases, the populations are stable or increasing.

And that fish population trends are similar through the other areas along the coast. We also recognize our important role and impact to the local community.

SHC-6-2

PSE&G Nuclear is Salem County's largest employer with over 1,500 employees. Some members of our workforce, as with all companies, are preparing to retire in the next few years.

As such we have looked to partner with local communities, with our local community, to meet our needs to providing good paying local jobs. We have launched innovative partnerships with the Salem County Community College, and the Salem County Vocational Technical schools, to develop specialized training programs.

Both have been overwhelmingly successful, and will lead to a skilled workforce that will only strengthen the local economy. In Salem County we provide more than 1.4 million dollars, each year, to the local economy through local property taxes.

SHC-6-3

This funding is vital to supporting local schools and projects. From an economic development point of view, we have also helped to drive the local economic development through projects like revitalization of downtown Salem, and the construction of the Gateway Business Park in Oldmans Township.

We are also active partners in the Salem Main Street Program, and the Salem County Chamber of Commerce. Our support also goes well beyond dollars.

Many of our employees are active participants and supporters within the local community. SHC-6-3

In addition to being a good neighbor, being transparent is an important aspect of building trust. We are fortunate to have an excellent relationship with our local stakeholders, and that is not something we take for granted.

With them there is no surprises. We are proactive and engage them when challenges arise, so that they have an understanding of the challenges and have their questions answered.

This year we have provided more than 30 site tours for key stakeholder groups, close to 500 elected officials, educators, students, community and trade groups, have been given an inside look at PSE&G Nuclear. SHC-6-4

What better way to answer their questions than to let people see, first-hand, the important role of nuclear power. By the end of this year we will also open the doors to our new energy and environmental resource center, that is housed at our old training center, on Chestnut Street in Salem.

This new information center will be used as an interactive display to educate the public about climate change, and the various ways we can all have a positive impact on our environment.

The center will be open to groups for tours, and provide meeting spaces for local organizations. In closing, PSE&G Nuclear looks forward to working with the NRC, and the public, as you review our license renewal application.

We have worked hard to provide safe, reliable, economic, and green energy for the past 30 years, and look forward to the opportunity to build on this success in the future. Thank you.

SHC-6-4

MR. FRICKER (EVENING): Good evening. Thank you for the opportunity to make a comment regarding the Salem and Hope Creek Nuclear license renewals.

My name is Carl Fricker, and I'm the vice president of operation support for PSEG Nuclear. I'm part of the leadership team that is responsible for the safe and reliable operations of the plants.

I have 25 years of experience, both in commercial and Navy nuclear power programs. And I have worked at PSEG for 14 years. I have had positions in operations, maintenance, quality assessment, and my last job for the last four years, prior to my current job, was the Salem plant manager.

At PSEG we understand our obligation to the local community, to the environment, our friends, families, co-workers, to provide safe, reliable, economic and green energy. SHC-6-5

In New Jersey, as was mentioned, over 50 percent of the state's electric generation comes from nuclear power. In fact, PSEG Nuclear at Salem and Hope Creek is the second largest nuclear facility in the country.

Each day they generate enough electricity to supply three million homes. In addition, we are able to meet the region's energy needs without generating any greenhouse gases.

Today nuclear power produces over 70 percent of our nation's carbon-free electricity. We take great pride in this, and recognize our importance and our ongoing role in fighting global climate change now and in the future.

As was mentioned, our current operating licenses expire for Salem unit 1 in 2016, Salem unit 2 in 2020, and Hope Creek in 2026. In 2006 we decided to pursue license renewal.

We established a dedicated team that worked for two and a half years, or 122,000 person hours, to prepare the station's application that is approximately 4,000 pages.

This involved the review of thousands of documents, a detailed review of equipment, components, and a rigorous review of existing maintenance and engineering programs to ensure that Salem and Hope Creek will safely operate for an additional 20 years.

Over the past ten years we have invested more than 1.2 billion dollars in equipment upgrades, which included, last year, a steam generator replacement at Salem unit 2, and various upgrades that supported Hope Creek's power uprate.

As part of license renewal we also reviewed any environmental impacts that would occur having the plants operate for another 20 years. We consider ourselves environmental stewards.

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And since this is an environmental scoping meeting, I want to touch on the subject. In addition to producing no greenhouse gases, PSEG has no adverse radiological impacts on the environment.

The NRC requires PSEG Nuclear and all U.S. nuclear plants, to have an environmental monitoring program to monitor local radiation levels. Annually we perform over 1,200 analyses on more than 850 environmental samples, including air, water, soil, and food products, such as milk and farm crops.

All analyzed samples are cross checked with other laboratories to ensure precision and accuracy. We are also closely monitored by the New Jersey Department of Environmental Protections, Bureau of Nuclear Engineering.

The Bureau of Nuclear Engineering independently monitors the local environment around PSEG Nuclear through remote monitoring systems, that provide real time readings.

This sampling and monitoring has shown that there is no adverse impact to the environment. We are also proud stewards of the Delaware Estuary, through our estuary enhancement program.

SHC-6-5

This program includes ongoing restoration, enhancement, and preservation of more than 20,000 acres of degraded salt marsh and adjacent uplands in the estuary.

SHC-6-6

The estuary enhancement program is the largest privately-funded wetlands restoration project in the country. More importantly it was created with extensive public participation, and open communications with regulatory agencies and the public.

As a result all estuary enhancement program sites are open to the public, and offer boardwalks, nature trails, outdoor education, and classroom facilities.

Studies have shown that the overall health of the estuary continues to improve. In addition, analysis of long-term fish populations in the estuary show that most cases populations are stable or increasing, and that the fish population in this area trends are similar to other areas along the coast.

SHC-6-6

We also recognize our impact to the local community. It was mentioned earlier that PSEG Nuclear is Salem County's largest employer. We have over 1,500 employees. As many companies are experiencing, some members of our work force are preparing to retire in the next few years.

As such, we have looked to partner with the local community to meet our needs and provide good paying local jobs. We have launched an innovative partnership with the Salem County

SHC-6-7

Community College, and the Salem County Vocational Technical Schools, to develop specialized training programs.

Both have been overwhelmingly successful, and will lead to a skilled work force that will only strengthen our local economy. In Salem County we provide more than 1.4 million dollars, each year, to the local economy through property taxes.

This funding is vital to the supporting of local schools and projects. From an economic development point of view, we have also helped drive the local economic development projects, like the revitalization of Salem, and the construction of the Gateway Business Park, in Oldmans Township.

We are active participants and partners in the Salem Main Street Program, and the Salem County Chamber of Commerce. Our support goes well beyond dollars. Many of our employees are active participants and supporters within the local community.

SHC-6-7

In addition to being a good neighbor, transparency is an important aspect of building trust. We are fortunate that we have an excellent relationship with our stakeholders, and it is not something that we take for granted.

With them we make sure that there are no surprises. We are proactive, and engage them when a challenge arises, so they

SHC-6-8

understand the challenge, and have the opportunity to ask their questions, and have answers.

This year we provided more than 30 site tours for key stakeholder groups. Close to 500 elected officials, educators, students, community and trade groups have been on-site to get an inside look at PSEG Nuclear.

What better way to answer questions than to let people see, first-hand, the important role of nuclear power? By the end of this year we will also open our new energy resource and environmental center, housed at our old training center, which is on Chestnut Street in Salem.

SHC-6-8

This new information center will use interactive displays to educate the public about climate change, and the various ways we can all have a positive impact on our environment.

The center will be open to groups for tours, and provide meeting spaces for local organizations.

In closing, PSEG Nuclear looks forward to working with the NRC, and the public, as you review our license renewal application. We have worked hard to provide safe, reliable, economic and green energy, for more than 30 years, and look forward to the opportunity to build on this success in the future. Thank you.

DR. CONTINI: Good afternoon, thank you. I am Dr. Peter Contini, president of Salem Community College, a position that I have held for the past 12 years.

And in that capacity I'm here to acknowledge the support of the college for the license renewal of PSE&G for Salem 1 and 2, as well as Hope Creek.

We base that on our knowledge and experience. And you have already heard that PSE&G Nuclear is certainly well regarded as a corporate leader in our county.

Certainly through their community leadership, both participating on groups, and supporting groups, they have directly affected the quality of life in our county.

Additionally we have seen, first-hand, the highly professional organization that they are, focused on safety, and security. And, certainly, generating a most valuable renewable energy source, one that we think directly addresses New Jersey's energy plan 2020, as well as the potential growth in this county, and throughout the state.

We view them as, certainly, an economic development and workforce driver. And we know, first-hand, how that happens. You just heard Carl speak about a wonderful opportunity that came about as a result of that level of partnership.

SHC-7-1

We received, this past February, a 1.7 million dollar three year grant from the U.S. Department of Labor, Community Based Job Training. It has two focuses. One, nuclear energy and, two, sustainable energy.

SHC-7-1

And the partners in that grant are PSE&G Nuclear as well as Energy Freedom Pioneers, working very collaboratively with our vocational school, Ranch Hope, Calgary Redevelopment, the New Jersey Department of Labor as well as Workforce development and, certainly, our one stop center.

Their support is not just verbal. Their support is certainly implementing. And as you know, and you heard Carl say, there is going to be a growing need for employees, as certainly portions of the workforce ages out, and we hope, also, the expansion of opportunity in the future.

SHC-7-2

As a result we work collaboratively with PSE&G Nuclear, in focusing on a particular area that we think is of great need, an energy, nuclear energy technician position.

We were able to couple with them, and partner at the national level with the Nuclear Energy Institute. And we were selected as one of six community colleges, across the country, that are working on standardizing the curriculum to ensure that educational experience that our students have, will not only prepare them, but certainly ensure safety and security in the future in this field.

And you also heard about the center that has been revitalized in Salem City. Well, I'm proud to tell you that a portion of that center will be hosting a portion of our program.

And through a high tech classroom, as well as laboratory facilities, our students will be working with state of the art equipment. And, most importantly, be supportive both in scholarships, as well as internships.

So we see this as a real win-win. Thinking about this, that we have only, in less than one year, been able to implement this program, we now have a fully accredited nuclear energy technician program, technology program, what we refer to as NET, we now have over 50 students in that program.

The corresponding program, Sustainable Energy, is also working at about 20 students. We see that balance, and PSE&G Nuclear sees that balance, also. And they have been very collaborative in working with Energy Freedom Pioneers, as we look for other alternatives to energy in addition to nuclear.

These are important things, they are important things for our community and, certainly, for our students. But they also go beyond. Two years ago we had an emergency in our Salem center,

SHC-7-2

hosting our one-stop career center. A fire, a fire that immediately caused the dislocation of over 30 workers, and 200 clients a day.

Within two hours we had a commitment from PSE&G Nuclear to relocate that entire program to the former training center. And within two days we were fully operational for the next four months. SHC-7-2

It is an organization that understands their role in the community, certainly puts safety and security as a top priority. But, more importantly, understand the value to our community. SHC-7-3

And, for that reason, we fully support their relicensing. Thank you.

MR. BAILEY: Good afternoon, my name is David L. Bailey, Jr. I am the chief executive officer of Ranch Hope, Incorporated. And, personally, I'm a lifelong resident, growing up within minutes of the Salem and Hope Creek in Alloway township, and now raising my family here, as well.

Ranch Hope, Inc., is a 501C(3) non-profit organization, founded in 1964. Again, our Alloway headquarters are within minutes of the Salem and Hope Creek facilities. Our mission is to provide behavioral health care, educational, and adventure-based environments for children and families from throughout the state of New Jersey, and within the Delaware Valley.

Through its generosity and support of local organizations, such as Ranch Hope, PSE&G Nuclear has touched the lives of thousands of residents, making our community a better place to live.

At Ranch Hope's Alloway campus PSE&G Nuclear supports our efforts to create a green community for children with treatment and educational facilities, not only environmental responsible, but energy efficient, and healthy for children and staff to live and work.

SHC-8-1

This unique collaboration with PSEG Nuclear not only focuses on changing the lives of children and families, but also energy efficiency, two topics you don't normally see together. SHC-8-1

Just as importantly, PSEG Nuclear demonstrates a level of transparency within our community here in Salem County. Nuclear power represents a mystique that many of us will never fully understand.

However, PSEG Nuclear has taken the time to keep the local community informed. Groups of key stakeholders, which I was humbled to be one myself, including elected officials, educators, business and community leaders, recently toured the Salem and Hope Creek facilities, and we learned, first-hand, the importance of nuclear power. SHC-8-2

As someone who was fortunate enough to visit these two generating stations, I feel even more comfortable, having seen the safety and security measures they take to provide us with clean, reliable energy, on an every day basis.

This being the case, Ranch Hope, and the families and the communities that we support, fully support the license renewal applications for PSEG Salem and Hope Creek nuclear facilities. Thank you.

MS. WICHMAN: Hi, my name is Kelly Wichman, and I'm an employee of PSEG Nuclear in the nuclear fuels department. I'm a safety analysis engineer, and this is my first full-time job.

Both my husband and I moved to Woodstown, New Jersey, just down the road, from the midwest a year and a half ago, to take positions at the Salem and Hope Creek site, and we bought a house here, with the intentions of staying for some time.

I came here today because I believe that Salem and Hope Creek should be granted operating license extensions. I chose a position in the nuclear industry because I think it has staying power.

I majored in engineering in college, with the intention of coming into this industry. And, as I progressed in my education, I found more and more reasons why nuclear power is really a great option for electricity production. SHC-9-1

From an engineer's standpoint, nuclear fuel is one of the most efficient fuels producing thousands of times more energy than a chemical reaction with the same amount of material. Say, for example, coal, oil or gas.

In addition, the land footprint is small, compared to other generating options which, to me, makes nuclear power an obvious choice in a world where finite resources are available.

My position at PSEG Nuclear has provided me an opportunity to explore new parts of the country, and I have taken advantage of living within a few hours of so many cities.

I have also taken advantage of all the career-related opportunities offered by my job. I have joined two professional organizations, the North American Young Generation in Nuclear, and the American Nuclear Society.

With Young Generation in Nuclear, I formed relationships with more of my coworkers, attended professional development conferences, participated in charity drives, and taught kids in the area about power generation at the Salem Votech.

With those organizations I have seen the positive influence that the plants have on the area, and on the people. I work there because I feel that the opportunities are great, and I feel that I'm doing something meaningful, by helping produce electricity that everyone uses.

I believe the plant's continued operating presence in the area will only be of benefit to the community. Thanks.

SHC-9-1

MS. NAGAKI: So my name is Jane Nagaki, and I'm vice-chair of the New Jersey Environmental Federation, which is the state's largest non-profit environmental organization.

And we raise several environmental issues regarding the relicensing. First I would like to support the comments of Fred Stein, from the Riverkeeper.

And I won't repeat everything that he said, but the Environmental Federation is, also, very firmly committed to the idea that if the relicensing goes forward, on Salem 1 and 2, that best available technology should be applied at those plants, which would be cooling towers to offset the millions of gallons of water that cycle through that plant every day.

There has been a lot of talk, today, about how nuclear energy produces no air emissions. And, generally, when we think about environmental impacts we are thinking air, releases to the air, releases to the water, releases to the land.

And while it is true that there may be no air emissions, from the plant, there certainly is a consumptive use of millions of gallons of water a day, run through the cooling cycle, and then discharged back into the Delaware Bay, with a concurrent loss, as Fred mentioned of billions of fish per year, in all

SHC-10-1

stages of life, from larval stage, to small stage, to large scale fish that are impinged on the once-through cooling system.

Which I have toured, by the way, and witnessed the huge structure that takes through millions of gallons of water a day.

So if there is one environmental issue that I would like to highlight today, is the impact of the Salem Nuclear Plant on water in the Delaware Bay, and the concurrent fish and wildlife that that water, the Delaware Bay supports.

We talked about nuclear energy as being a major employer in this area, and I'm certainly respectful of the workers that work there, that keep the plant safe every day, and the niche in the economy that it provides.

But there is, also, a huge other economy in the Delaware Bay that is the fishing industry, that is severely affected by the operation of this plant.

And so if I were to say the huge, the most huge environmental impact of this plant, is the impact of water, in that once through cooling system. That needs to be addressed in the Environmental Impact Statement.

SHC-10-1

As far as, you know, there is no radiation produced at this plant, there is some radiation produced at this plant. It meets limits, so called acceptable limits.

There is waste that is stored on-site. And so another environmental issue, that the Environmental Impact Statement should address, is how much more waste is going to be generated and stored at the plant, at those enclosures that currently keep all the waste, ever produced at that plant, on the site forever.

So waste production concurrent with the relicensing is another very major environmental issue.

SHC-10-2

What is unique about our community? What is unique about artificial island, is that it is an island that was constructed of dredge spoil material.

It is not an island that existed before the geology of the time. So one of the concerns, environmental concerns would be how stable is the structure of the island to support this plant for another 20 years. Or three plants, actually.

I think that issue will be addressed, more specifically, tonight by another environmental group. What is the effect of sea level rise? We talked about global warming and how nuclear power doesn't produce the kinds of emissions that contribute to global warming.

SHC-10-3

But there is global warming going on, and there is sea level rise. What is the effect of sea level rise on the plant's artificial island? You know, is the island going to be inundated with water, how much over the next few years?

Does more infrastructure need to be built there to support the plant? We know that salt water, and the effects of the salinity of the bay have contributed to the rusting out of parts of the plant. We know that there has been extensive replacement of structures, and underground piping at the plant. And that is both, you know, that is an environmental impact, the salinity of the area, on the integrity of the structure of the plant.

And that is an environmental issue that needs to be integrated into the safety and the aging issues of the plant.

SHC-10-3

Let's see. So going back to another impact, and the result of the Salem 1 and 2 plants, not having cooling towers is that PSEG Nuclear entered into a very large estuary enhancement program, which was referred to earlier, preserving 20,000 acres of wetlands.

And I would be remiss if I didn't mention a concern that environmental groups raised at the beginning of the restoration project, because many of the acres of wetlands were

SHC-10-4

restored simply by breaching dikes of old salt hay farms, and allowing inundation of phragmites by salt water.

And thus controlling the phragmites, and growing a more beneficial kind of vegetation, called Spartana. But there are acres and acres of phragmites, you know what they are, the tall waiving foxtails, as they are often called, which were considered nuisance vegetation, or not favorable vegetation in the wetland restoration.

And so in order to control that phragmites, massive aerial herbicide event took place starting in 1995 and '96, over 2000 acres were really sprayed with a pesticide called Glyphesate. And it was thought that one, maybe two applications of that herbicide would take care of the problem.

But, to this day, in the year 2009, and continuing on until at least 2013, annual applications by herbicide by aircraft are made to wetlands, as part of this project.

The acreage is down now, to around 120 acre realm. But it has been as high as thousands of pounds of a year. And so one of the environmental issue raised by this is, is there going to be continued applications of an herbicide, in wetland areas, as part of this restoration project, which was meant to offset the impacts caused by the lack of cooling towers.

SHC-10-4

The reason we are concerned about this application of herbicides is that it actually triggered an increase in the use of this herbicide, state-wide.

PSEG kind of became the model for how to restore wetlands. And so many other wetland restoration projects began utilizing this methodology. And the result has been a nine-fold increase in the use of Glyphesate in the state of New Jersey.

And so while the use at this particular Alloways creek area is decreasing, not over yet, but still decreasing, the increase in the use, state-wide, is of concern because as you know pesticides generally have a habit of infiltrating our groundwater and surface water.

They become part of our drinking water, part of our surface water. And the effects of this herbicide has been linked to cancer effects, birth defect effects, effects on fish, insect populations, and so forth.

So we certainly raise this as an issue that needs to be addressed, because nobody has really looked at the cumulative impact of this year, after year application of herbicide to control a nuisance plant, all in the name of restoring wetlands. SHC-10-4

So I think that is the extent of the issues I wanted to raise today. But I do want to say that some of the safety SHC-10-5 concerns, and environmental concerns, are related mainly to this issue of the aging of the plant, the salinity, the lack of a firm under-structure to the plant, all make the plant more vulnerable to failures of structure that could lead to an environmental release of radiation, which is the ultimate disaster that everybody fears at this plant.

And so while the radiation leakage issue, and emissions issue, is not a day to day concern, you know, when the plant is operating optimally, if there isn't an aggressive strategy for preventive maintenance, that not just waits for something to happen, and then addresses it, but actually anticipates and replaces structures as they age, before they age.

This vulnerability will continue, you know, to be of great concern. That concludes my remarks, thank you.

SHC-10-5

MR. WALL: Good afternoon, I'm Roland Wall, I'm the Director for the Center for Environmental Policy at the Academy of Natural Sciences in Philadelphia.

On behalf of the Academy, I appreciate the opportunity to comment, specifically, on the environmental protection and restoration demonstrated in PSEG's estuary enhancement program.

Just a little context as to why the Philadelphia Museum is down here making these comments today. The Academy of Natural Sciences is the oldest natural history museum in North America but has also been engaged, for over 60 years, in research on ecological sciences, particularly on understanding human impacts on aquatic and estuarian systems.

It is in that role that we have had extensive research on the physical and biological characteristics of the Delaware estuary, including components of the estuary enhancement program. SHC-11-1

My comments today are based on observations of Academy scientists, particularly those of our senior fishery scientist, Dr. Rich Horowitz, who is unable to be here today.

The estuary enhancement program began in 1994. And, since that time, has been a large scale effort to restore and preserve portions of the Delaware estuary, in both New Jersey and Delaware, encompassing more than 32 square miles, as you heard earlier, it is the nation's largest privately-funded wetlands restoration project.

Restoration efforts have included the goal of replacing former salt hay farms, as you heard. And also to remove marshes that are dominated by the invasive phragmites, with saltcord grass dominated marsh.

This has required a substantial effort to control phragmites, and to change drainage patterns to foster topography and tidal flow typical of Delaware Bay salt marshes.

The Academy has studied many of these sites, prior to restoration and a number of them following restoration. Yes, the enhancement program has been successful in restoring typical salt marsh conditions at these sites, with most sites being targets for reduction of phragmites, and establishment of salt cordgrass.

At the remainder of sites where goals have been partially met, the estuary enhancement program continues to work to further improve marsh conditions.

The EP has also preserved open space, as at the bayside track. Among other improvements at the restored sites, tidal flow and development of tidal channels have increased, allowing for re-colonization of salt cordgrass and other species.

SHC-11-1

The restored marshes support large numbers of targeted fish species, as well as number of other fishes and invertebrates. These populations continue to -- excuse me, contribute to bay productivity, most notably, at the salt hay farms.

The restoration sites also provide important habitat for terrapins, birds, and mammals, and several of the sites are now part of New Jersey's Audubon designated important bird areas.

SHC-11-1

In addition to ecological restoration, the enhancement program has developed increased opportunities for human use and experience, to interact with the estuary.

Public use areas were designed to meet the general education, public access, and ecotourism interest of each community hosting an EEP site.

This has included improved access to many of the sites by land and water, with boat access and parking areas, in turn, supporting extensive recreational activities.

The public use areas have become important settings for numerous formal and informal educational programs. The restored areas have also become significant research sites, and research by EEP, and other organizations, including the Academy, has advanced our knowledge of tidal marsh ecology.

SHC-11-2

The basic restoration activities, particularly controlling phragmites and fostering development of tidal marsh topography and hydrology, have advanced the field of ecological restoration.

The ecological engineering technique of forming primary channels, and then using estuarian processes to further develop channels and topography, is especially notable.

And in that way the estuarian enhancement program does provide an important model for marshland restoration. PSEG has also installed fish passage structures at dams in Delaware and New Jersey.

These fish ladders have established river herring spawning in nursery areas, and several impoundments, increasing bay-wide populations of these species.

PSEG has continued to conduct monitoring programs of Delaware fish populations, which greatly increase our knowledge of Delaware Bay fisheries.

To conclude, the Academy would like to commend PSEG on its demonstrated initiative, and long-term commitment to restoring the critical wetlands of the Delaware estuary.

The estuary enhancement program has had numerous positive impacts on the ecology and biodiversity of the region,

SHC-11-3

and has made important contributions to the recreational and educational opportunities available to local communities.

The scale and scope of this effort has supported large scale scientific research, has improved our understanding of the process of environmental restoration.

The Academy of Natural Sciences has been pleased to have the opportunity to participate in, and to contribute, to our scientific expertise to this project. Thank you for the opportunity to speak on this.

SHC-11-3

MS. ACTON: Good evening. My name is Julie Acton, I'm a Salem County Freeholder. For those who do not live in New Jersey, I'm equal to a county commissioner. New Jersey is the only state to have freeholders.

I am also a member of the Dupont Advisory Committee. I am a volunteer for Meals on Wheels, and United Way. I'm a member of the Salem Community College, the Salem County Vocational Technical Advisory Board, and I'm very involved in my community.

So I pretty much have the pulse of the community at my fingertips. I am coming before you, this evening, to let you know that PSEG Nuclear is a valuable asset to our county. SHC-12-1

Not only are they a great community partner, but they are the county's largest employer. A majority of their employees are local residents, who live in our community.

In tough economic times PSEG Nuclear provides an example of integrity and commitment to positive growth that we all need to see. SHC-12-2

PSEG Nuclear takes a very proactive role in developing positive relationships with members of the Salem County community, whether it is providing funding and support to local community groups, or attending their events.

They are always demonstrating their commitment to Salem County. And they acknowledge our proud heritage, and recognize our bright future. We understand the hesitation of those within, and surrounding our county, towards PSEG Nuclear.

Their concern regarding safety and plant performance are valid. However, PSEG Nuclear has consistently demonstrated its commitment to safety and excellence through proper planning and transparency.

As a life-long resident of Salem County, and having raised my children here, I feel safe around the power plant. We have not seen any adverse impact to our environment, or our community.

I wholeheartedly support PSEG Nuclear and their license renewal for their Salem and Hope Creek stations. Thank you very much for your time.

SHC-12-3

MS. BERRYHILL: Well, this is a little different. My name is Frieda Berryhill, I'm from Wilmington, Delaware. I have been involved with Salem before it was licensed to operate, for the simple reason that Delmarva Power and Light, at the time, also planned to build a nuclear power plant right across the river from here, which would have made this area the largest nuclear complex in the world.

I was an intervenor, a case I couldn't lose, because they ordered a high temperature gas-cooled reactor, and you know what happened to that.

I'm very concerned about this.

I attended many hearings on the subject, ever since 1970. These plants should never have gotten a building permit. Upon examining the documents I found, to my shock, clearly described in detail, on the large map, the soil condition of artificial island. SHC-13-1

You see, there was no land here. It is called Artificial Island, because the island is built from dredgings of the Delaware River. And in the documents you will find that the borings of 35 feet are essentially nothing but mud and sand.

The next 35 feet are gravel and sand. The last 35 feet are described as Vincentown Formation, which is a different kind of gravel and sand. Borings up to 100 feet have not revealed rock bottom.

There is no rock bottom under these plants. The spent fuel pools, the auxiliary buildings, all of it, is sitting perched on cement pilings, I call them stilts, going 75 feet into the mud. And that is what is holding these plants up. SHC-13-1

Now I have with me pictures of toppled buildings that have simply collapsed with the pilings still sticking to them. And I am deeply concerned to have a fourth reactor on that island.

Liquefaction is discussed in the documents. Liquefaction is the phenomenon when there is an earthquake, not a major earthquake, the sand is liquefies, and the building -- the hundreds of examples all over the world, where you can find that.

And you can find some of it even on Google. And I have made statements to that effect before the Delaware House Energy Committee, and other agencies. It doesn't seem to really matter what citizens say. SHC-13-2

Yes, there was an earthquake up in Morris County. It was, actually, quite sizeable. But there is an earthquake fault, also, on the Delaware River. And, really, it scares me to think that it is only a matter of time, really, that an earthquake could happen here.

The Morris earthquake threw people out of the house, they thought there was a big explosion somewhere. It was not just a minor shaking or rattling.

Now, as to what could happen, I would like to just go back to the Rasmussen report, which was produced in 1970, as to the safety of nuclear power plants.

That wasn't satisfactory, so they commissioned another report in 1985, called "Consequences of Reactor Accident", called the "Crack Report". To just -- the numbers are just staggering.

The Crack Report for Salem reads as follows: Early peak fatalities, 100,000 Salem, 100,000 Salem 2. Early peak injuries, 70,000 for Salem 1, 75,000 for Salem 2.

Peak cancer deaths, Salem 1 40,000, Salem 2, 40,000. Damages, Salem 1, 140 billion, Salem 2, 135 billion. This is not fantasy, this is the government report. SHC-13-2

I would like to interject, recently I wrote an article as to the soil conditions of this thing. And in that article I mentioned the Price-Anderson Act, that nuclear power plants could never be built without the protection of the Price-Anderson Act.

And some gentleman from the NRC felt compelled to write an answer to the local Wilmington paper saying, we don't SHC-13-3 depend on the Price-Anderson Act, we have 9 billion dollars in reserve for whatever damages we cause. It makes me laugh, because there is no comparison to the damages that could be caused. Nine billion dollars is pocket change. SHC-13-3

Clearly this plant should have never received a building permit, and surely it should not receive a license to operate for another 20 years. They were originally licensed for 40 years. SHC-13-4

You are dealing with embrittlement, and all sorts of problems with that. There was a reason for it. Now, also, actually these plants were operating against the law, with more than three billion fish killed, annually, from the Delaware River.

And anything under three inches is taken up through the intake structure. The NEPA Act, which you have mentioned, which was passed in 1969, was passed just because this kind of damage.

On December 18th, 2001, Congress allowed these once-through cooling systems to continue as long as they restored the fish killed. Now, I saw that you had a display back there about that Habitation Restoration Act of 2001. But are you really raising fish? SHC-13-5

Twenty-thousand tons of poison were spread to kill the phragmite. You can't kill that phragmite. I looked at the picture that you had back there, that phragmite keeps coming up. How many tons of poisons are you going to spray over there? Now, I was just told, a while ago, that you are replacing the fish. I would like to know how many fish that you are replacing, and what the story is on that.

SHC-13-5

Incredibly, though, that PSEG announced that it planned to spend another 50 million between 2007 and 2011 to explore the potential to construct a new reactor on the island, a fourth reactor. I think not.

I would like to ask a few questions, if I may. Nine billion dollars somewhere in the reserve. Can anybody, at the NRC, tell me who is holding this nine billion dollars?

I have a letter written to the editor, don't worry about Price-Anderson, we have nine billion dollars.

FACILITATOR BURTON: Ms. Berryhill, unfortunately we don't have the NRC staff here who would really be qualified to answer your question.

MS. BERRYHILL: Who would have that nine billion? Well, I will see if I can find out another way.

SHC-13-6

Has the company made any request for dry-cask storage? SHC-13-7

FACILITATOR BURTON: Again, we really do not have the subject matter experts here to answer that question.

MS. BERRYHILL: All right.

FACILITATOR BURTON: You have one more question?

MS. BERRYHILL: Yes, I do. With Yucca Mountain canceled you will have to, eventually, go the dry cask storage, I just want to know how soon, or whether you have made any plans, and who is producing them. You don't know that? Okay.

SHC-13-7

Now, you made a great deal about respecting public input. You had 20 license renewals approved now. None have been refused. I just wonder how much public input has really worked in these cases. None have been disapproved.

And some of them, by my estimate, should not have been approved. I have been to the NRC reading room in Washington, and there are records of every plant in there. Does Salem County have as complete a file as I would find it at the NRC reading room? Salem County library?

Everything is in there?

MR. ASHLEY: The application is at the library.

FACILITATOR BURTON: Hang on a second, let me give you the microphone here.

SHC-13-8

MR. ASHLEY: The license renewal application is at the Salem Library. But all the other documents are at the reading room at the NRC.

MS. BERRYHILL: At the reading room at the Nuclear Regulatory Commission, okay, thank you very much.

SHC-13-8

MS. WILLING: Hi, my name is Nancy Willing, and I am from Newark, Delaware. I'm a life-long Delawarean. While I have never held elective office, I thought I would respond to Ms. Acton, by maybe saying some of my civic responsibilities as well.

But my dad was a plant manager for the plant here in New Jersey. Growing up he took the ferry in the '50, and got the bridge when it was built, the second bridge.

As a citizen of Newcastle County, I formed up the Friends of Historic Glasgow, interested in preserving historic battle sites. I have been on the board of W3R, Washington Rainbow Route. I was recently on the Board of the Civic League for Newcastle County.

And I'm also a Director of the Board of the Community Center in Wilmington, on the east side of Wilmington. So I have a variety of interests.

I've also ended up in frustration, from what a citizen can do, I ended up writing a political blog. So I also now write the Delaware Way blog with daily input. And I have written about -- Frieda is a contributor to the blog. So a lot of that is googable. And we try to keep the information out there.

I was at the 2009 emergency evacuation public hearing, here in New Jersey. And it was an interesting meeting for me SHC-14-1 because although Delaware is at risk, or in the 50 mile radius, we don't get this kind of attention, we don't have public hearings.

And I imagine that -- I was told, as I got here today, that some feelers went out to see if Delaware wanted to have a meeting similar to this, and it was not -- that didn't happen.

But that the emergency evacuation public meeting the state held, I didn't -- well, I will just go right to this. SHC-14-1

I don't agree with the renewal of the 20 year licenses for the 40 year old structures that exist here today.

I don't think it is a wise and reasonable choice for the citizens. We do enjoy the energy that comes out of them, but we also have to expect to live our full lives here in this area.

A 40 year life span pretty much says it all, it is a 40 year life span, and the thought of another 20 year service from the Salem and Hope Creek structures seems to be asking too much, and offering uncertainty and trepidation to the public.

With age come leaks and cracks. The life span of potential contamination isn't worth that bargain, in my view. SHC-14-2

While speaking with the state official from the Bureau of Nuclear Energy at the New Jersey, before the evaluation hearing had started I asked about having heard that Salem was built on swamp land. SHC-14-3

And the gentleman, whose name I don't have here, he said of course not, and he proceeded to claim that the pilings went on through the sand, and gravel on Artificial Island, and were drilled securely into the bedrock.

So that was the opinion stated at that meeting, to me, by an official from the Bureau of Nuclear Energy here in New Jersey. So I took the question to the record, when I had a chance to speak, and formally ask the question, about Artificial Island structures, do they actually secure into bedrock, or don't they?

Because Frieda Berryhill had told me that in her investigations, that they had not. So I asked, for the record, and the officials promised me that they would investigate that discrepancy, and give it back to me in writing, which they never did, I never got anything from them. SHC-14-3

My concern was based on having heard that yet one more unit was planned to be constructed at the Salem complex. For the structures to be floating on a bed of gravel, and sand, and the result of a significant earthquake, six or seven on the Richter scale, would mean that the base of the structures, containing this nuclear material, would likely experience liquefaction, which Frieda got into a little bit.

That is the changing from compression of the earthquake, of the gravel and sand mix, into a jelly-like material. Liquefaction of the ground underneath causes structures to tip, slide, collapse, and otherwise break apart.

It was an unhappy coincidence that the evacuation hearing was on the same day as the earthquake. So it was an interesting experience. Another earthquake was centered a few miles away from the Salem plant.

And although it wasn't more than maybe two on the Richter scale, I'm not sure what it was, it isn't unheard of to think that we would have a more significant earthquake. The officials told me, that day, that the structures are built to withstand up to six or so on the Richter scale. SHC-14-3

But would that prevent a significant earthquake, maybe not up to that, would that prevent the leaks and cracks of an aging plant that is floating on a bed of gravel and sand, so to speak, should another earthquake occur.

So the scope of the licensing process, here today, I think should be investigating that these are drilled into bed rock, that they are subject to liquefaction, and that would the aging of structures, brittle, -- would the aging, basically, have an impact on potential earthquake activity and contamination of the environment?

And I think that is, hopefully that would be in your scope, some serious study of that. So, thanks. SHC-14-3

MS. BEISTLINE: Hello everyone, good evening. My name is Monica Baseline, I work as a chemical systems engineer at Salem Generating Station. I'm here tonight representing NAYGN, which is the North American Young Generation of Nuclear.

This group unites young professionals who believe in nuclear science and technology, and show the passion for the field. Within this chapter I'm our environmental committee chair, and I enjoy spending my weekends camping, hiking, biking, and my favorite, rock climbing.

I graduated with a chemical engineering degree, which gave me a choice of fields after graduation. After much deliberation and interviewing, I narrowed these choices down to two industries, petroleum refining, and nuclear power.

SHC-15-1

I remember, specifically, at dinner during the interviewing process, for refining jobs, about your ethics matching your company's ethics. Without this you can't ensure happiness and the ability to be passionate about your job.

I saw our country's dependence on fossil fuels diminishing, and I was not secure in my future, in the petroleum industry. I wanted to make sure that I worked for a company that I did not believe had a negative impact on the environment I enjoyed on the weekends.

I worked with PSEG for more than a year and within this year I have received less than three millirem of dose. This is about half as much as you would receive on a cross-country flight, or a dental x-ray.

I believe nuclear is the future of safe and reliable power. And I believe we need support from the public to explore things such as interim waste storage, and reprocessing.

I'm happy to say I love my job, and I'm proud to be with PSEG. Thank you.

SHC-15-1

MR. GRENIER: I'm here, I have a couple of comments. One is the local Woodstown Borough Councilman, and then another as a resident.

I've been a councilman for a couple of years, and I'd like to say on behalf of the borough, thank PSEG for their leadership in our community, community activities.

Also their stewardship toward the environment, from the estuary enhancement program, and Mr. Fricker spoke a little bit about their lack of greenhouse gases and how environmentally friendly our nuclear facility is.

And also, as Mr. Hassler spoke of, creation of a good number of well-paying, long-term jobs. It is not a project that is just here to build a big road, and then it goes away. So the jobs are here to stay for long term. SHC-16-1

As a resident I would like to say that I've been here for 15 years, as long as I have worked at the island. And my wife Patty and I are raising three kids in town.

We do seeing eye puppies, we are in scouts, we are in our local church, try to teach our kids how to be active in the community, something that PSEG encourages all of their employees to do through United Way and other programs.

And they give a good amount of money into the county to promote other activities like that. As I said, I have been employed with PSEG for 15 years, in chemistry, radiation protection, and now in training.

And I have, first-hand, witnessed what we do at the plant through our sampling, and our stewardship to the community through our emergency plan activities, and protection of the public.

So I would ask that the NRC consider the plant life extension request, and I strongly encourage that they accept it, move forward with it, and look at the communities that are around here, and the municipalities, and how they all embrace the plant, and the PSEG facility, supportive of it.

I don't know of any municipalities that are against the site. And I look forward to pursuing, to come to future meetings in the pursuit of the plant life extensions, and also the possibility of a fourth reactor. Thank you.

SHC-16-1

SIERRA CLUB
FOUNDED 1892

New Jersey Chapter
145 West Hanover Street
Trenton, NJ 08618

October 12, 2009

U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Dear Commissioners Jaczko, Klein and Svinicki,

Enclosed is a resolution, passed by the New Jersey Chapter of Sierra, requesting that the Nuclear Regulatory Commission and the New Jersey Department of Environmental Protection require PSE&G to erect cooling towers at the Salem Nuclear Plants as a requirement to renewing the operating licenses. The Executive Board of the New Jersey Chapter is making this request on behalf of over 20,000 members of the New Jersey Chapter.

Thank you for your consideration in this very important matter. SHC-17-1

Very truly yours,

Gina Carola

Gina Carola

Chair, West Jersey Group
New Jersey Chapter of Sierra

printed on recycled paper

SIERRA CLUB
FOUNDED 1892

New Jersey Chapter
145 W. Hanover Street
Trenton, NJ 08618
TEL: (609) 656-7612 FAX: (609) 656-7618
www.newjersey.sierraclub.org

Resolution Requesting that the NJDEP and the NRC Require PSE&G to Erect Cooling Towers at the Salem Nuclear Plants

WHEREAS, the Salem nuclear power plants do not have a closed cooling system (cooling towers); and

WHEREAS, the plants use over 3 billion gallons of Delaware Bay water every day for cooling, causing billions of fish and other marine life to be slaughtered every year as they are ground up in the intake valves; and

WHEREAS, the slaughter of the fish severely impacts the ecosystem of the Delaware River Estuary by taking billions of smaller bait fish per year out of the food chain for larger fish and birds; and

WHEREAS, the billions of game and commercial fish fry that are ground up and destroyed in the intake valves severely impacts both the recreational and the commercial fishing industry; and

WHEREAS, jobs are dependent on both the recreational and the commercial fishing industry.

NOW THEREFORE, BE IT RESOLVED, that the New Jersey Chapter of the Sierra Club requests that the New Jersey Department of Environmental Protection and the Nuclear Regulatory Commission require that PSE&G build a closed cooling system, such as cooling towers, for Salem Units 1 and 2, which would eliminate 90 to 95 percent of the fish slaughter.

BE IT FURTHER RESOLVED, that copies of this resolution be sent to the New Jersey Department of Environmental Protection and the Nuclear Regulatory Commission.

SHC-17-1

Dated: September 12, 2009

SIERRA CLUB, NEW JERSEY CHAPTER

[signature]

Kenneth R. Johanson, Chapter Chair

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Charles Eccleston

From: Greenhill, John [mailto:John.Greenhill@dhs.gov]
Sent: Wednesday, November 04, 2009 7:18 PM
To: Eccleston, Charles
Subject: Salem and Hope Creek Nuclear Plants 20 year license extensions
Importance: High

Dear Mr. Eccleston,

I am unable to attend the hearings on 11/5/09 but would like to submit the following questions.

There were incidents on 3/13/1989 and 9/19/1989 at the Salem 1and 2 Nuclear Plants sites when geomagnetic storms caused damage to the single phase, generator step-up transformers which caused them to be taken out of service.

The damages were due to geomagnetically induced currents caused by the geomagnetic storms.

Questions:

1. Is there a publically available report that describes these incidents?
2. What was the magnitude of the currents that caused the damage?
3. How long did the damaging currents persist?
4. What was the protective relay system in place at that time such as the IEEE Std C37.91-1985?
5. Where there any modifications to the transformer protective system put into effect?
6. How will the step-up transformers at Salem and Hope Creek sites be protected if a super geomagnetic storm (10 times the size of the 1989 storms) occurs during the 20 year extension?
7. Do the sites have spare step-up transformers?

SHC-18-1

John D. Greenhill P.E.
Department of Energy
National Communications System
Department of Homeland Security
E-mail: john.greenhill@dhs.gov
Phone: 703-235-5538

2

Eccleston, Charles

From: Greenhill, John [John.Greenhill@dhs.gov]
Sent: Monday, November 09, 2009 3:46 PM
To: Eccleston, Charles
Subject: RE: Salem and Hope Creek Nuclear Plants 20 year license extensions

Charles,
Many thanks for this information.
An initial cursory look shows a possible problem with this draft EIS when one examines table 5-2

Table 5-2. TMI-1 Internal Events Core Damage Frequency

Initiating Event	CDF (Per Year)	% Contribution to CDF
Loss of Offsite Power	7.73×10^{-6}	32.6
Transients	5.80×10^{-6}	24.5
Small and Very Small LOCA	4.66×10^{-6}	19.7
Loss of Nuclear Service River Water	3.67×10^{-6}	15.5
Steam Generator Tube Rupture	9.93×10^{-7}	4.2
Internal Floods	4.50×10^{-7}	1.9
Large and Medium LOCA	2.06×10^{-7}	< 1
ISLOCA	1.80×10^{-7}	<1
Total CDF (internal events)	$\mathbf{2.37 \times 10^{-5}}$	**100**

The probability of a super solar storm of the 1859 or 1921 size is about 1/100 years or 1 %/year. This size storm leads to a continental long term (many months) grid outage because of damage to all the U.S. step-up transformers similar to the damage that occurred at Salem New Jersey in 1989during a fairly mild solar storm. With such an outage the emergency generators (that drive the cooling pumps) fuel supply would run out and could not be replaced because the commercial fuel suppliers would be out of fuel as well. Without fuel for the the cooling pumps, the core damage frequency (CDF) appears to be several orders larger that the CDF given in the table 5-2. Perhaps s solar storm initiating event should be included in all the final EIS documents.

SHC-18-2

John D. Greenhill P.E.
Department of Energy
National Communications System
Department of Homeland Security
E-mail: john.greenhill@dhs.gov
Phone: 703-235-5538

From: prvs=557c0bb17=Charles.Eccleston@nrc.gov [mailto:prvs=557c0bb17=Charles.Eccleston@nrc.gov] **On Behalf Of** Eccleston, Charles
Sent: Monday, November 09, 2009 3:02 PM
To: Greenhill, John
Subject: RE: Salem and Hope Creek Nuclear Plants 20 year license extensions

John,

Here is a recent draft EIS. You will have to open it as a read-only file. Check out Chapter 5.

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Eccleston, Charles

From: Greenhill, John [John.Greenhill@dhs.gov]
Sent: Saturday, November 21, 2009 9:24 PM
To: SalemEIS; HopeCreek@nrc.gov
Cc: Eccleston, Charles; Warren Udy
Subject: Salem and Hope Creek Nuclear Plants 20 year license extensions

Dears Sirs

There were incidents on 3/13/1989 and 9/19/1989 at the Salem 1,2and Hope Creek nuclear plants sites when geomagnetic storms caused damage to the single phase, generator step-up transformers which caused them to be taken out of service.

The damage was due to geomagnetically induced currents (GIC) caused by the geomagnetic storms.

Questions:
1. Is there a publically available report that describes these incidents?
2. What was the magnitude of the currents that caused the damage?
3. How long did the damaging currents persist?
4. What was the protective relay system in place at that time such as the IEEE Std C37.91-1985?
5. Where there any modifications to the transformer protective system put into effect?
6. How will the step-up transformers at Salem and Hope Creek sites be protected if a super geomagnetic storm (10 times the size of the 1989 storms) occurs during the 20 year extension? The next solar maximum is expected 2013-2014.
7. Do the sites have spare step-up transformers?

The TMI Generic Environmental Impact Statement for License (NUREG-1437 Supplement 37) table 5-2 shows the following

Table 5-2. TMI-1 Internal Events Core Damage Frequency

Initiating Event	CDF (Per Year)	% Contribution to CDF
Loss of Offsite Power	7.73×10^{-6}	32.6
Transients	5.80×10^{-6}	24.5
Small and Very Small LOCA	4.66×10^{-6}	19.7
Loss of Nuclear Service River Water	3.67×10^{-6}	15.5
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Internal Floods	4.50×10^{-7}	1.9
Large and Medium LOCA	2.06×10^{-7}	< 1
ISLOCA	1.80×10^{-7}	<1
Total CDF (internal events)	$\mathbf{2.37 \times 10^{-5}}$	**100**

The probability of a super solar storm of the 1859 or 1921 size is about 1/100 years or 1 %/year. This size storm could lead to a continental wide, long term (many months) outage of the bulk power grid because of damage to all the U.S. step-up transformers. This damaged would be similar to the damage that occurred at Salem New Jersey in 1989 during a fairly mild solar storm. With such an outage, the emergency generators (that drive the cooling pumps) fuel supply could run out and may not be replaced because all the commercial fuel suppliers would be out of fuel as well due to the failure of the electrical pumps. Without fuel for the cooling pumps, the core damage frequency (CDF) appears to be several orders larger that the CDF given in the table 5-2. Perhaps s solar storm initiating event should be included in all the final EIS documents including the Salem and Hope Creek.. SHC-18-3

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John D. Greenhill P.E.
Department of Energy
National Communications System
Department of Homeland Security
E-mail: john.greenhill@dhs.gov
Phone: 703-235-5538

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Eccleston, Charles

From: Frieda Berryhill [frieda302@comcast.net]
Sent: Saturday, November 07, 2009 7:25 PM
To: Eccleston, Charles
Cc: Goodman Sid
Subject: Woodstown N.J.

Dear Mr. Eccleston:
It was truly a pleasure meeting you . The documents you wanted are:

Mr. Goodmans statement to the NRC September 7, 2009
Mr. Goodmans statement to the New Jersey Public Advocate September 23, 09
5 Page letter from the NRC August 24. 2009 Mr. B A Boger fro Eric J. Leeds, Director, Office of Nuclear Reactor Regulation
Essentially confirming the soil condition of Artificial Island and the existence of the 70 ft pilings on which the plants are perched. But you can find it in the document room as I did.

Since these are essentially Mr. Goodmans statements I thought it to be more appropriate for him to send them, I have asked Mr. Goodman to do so.

Mr. Sid Goodman
Mahwah, N.J. 07430
Tel# 327 5158

Sincerely

Frieda Berryhill

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158 Grandview Lane

Mahwah, NJ 07430

September 7, 2009

Donnie Ashley @ the Nuclear Regulatory Commission

Subject: Comment on License Renewal for the Salem and Hope Creek Nuclear Power Plants.

To renew the licenses for these nuclear plants represents extreme neglect of the public safety and welfare. It was incredibly poor judgment that these plants were built on "Artificial Island" in the first place. These plants should be shut down, with operation not allowed to continue, much less have their operation greatly extended. Incredibly, PSE&G is considering putting another nuclear plant on this island in this earthquake prone region. For shame!

None of the nuclear plants are built on solid rock. They are on filled in land. The letter I received from Bruce A. Boger (August 24) confirmed that these plants are not on solid rock. They rest on compacted engineering fill material or concrete, which have a depth of approximately 70 feet. Concrete pilings are used. The NRC presumes that this will enable them to resist the worst assault that an earthquake can deliver. This is wishful thinking, rather than common sense. SHC-19-1

Not only that, but deceitful testimony has been given in support of the environmental impact of the existing nuclear plants. The statement for renewal states that the existing plants had no adverse effects on the Delaware Estuary. In fact, Salem kills 3 billion fish annually. Environmental expert Robert F. Kennedy Jr. sued the EPA in 1993. He revealed that Salem alone killed more than 3 billion Delaware River fish each year, according to the plant's own consultant. Fish kills are illegal and represent criminal acts. SHC-19-2

What can happen from building on unstable land was exemplified in Shanghai, China.

At around 5:30 AM on June 27, 2009 an unoccupied building, still under construction at Lianhuanan Road in the Mining district of Shanghai City toppled.

Just before the toppling, there were reports of cracks on the flood-prevention wall near the buildings and "special geological conditions" in the water bank area. SHC-19-3

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In Japan, seven reactors at the *Kashiwazi-Kariwa* nuclear power plant in Japan were shut down due to an earthquake, fire and nuclear leak. People were killed and injured by the 6.8 magnitude quake, which struck in July, 2007. A new fire at the still shut down plant occurred in March, 2009. 600,000 residents signed a petition opposing restart of the plant.

The arrogance of building nuclear plants in an earthquake prone area is almost unbelievable. Believe it! This arrogance is also invested in other Nuclear Regulatory Commission rules. SHC-19-3

The NRC is still satisfied with a mere ten-mile evacuation zone around a nuke when poisons from Three Mile Island were blown hundreds of miles. Poisons from Chernobyl were blown around the world? This satisfaction is idiotic.

The NRC continues support for the Price Anderson Act. This federal law limits liability of a disaster to a microscopic fraction of the potential damage which will be incurred? This Act reduces concerns of operating utilities, a very risky effect. This federal law abolishes the property rights of Americans in order to protect the property rights of nuclear plant owners. This atrociously unfair law is nothing less than Fascist.

The NRC continues to support the distribution of potassium iodide pills as an assurance that no one will be harmed from a disaster? These pills only protect against radioactive iodine. The pills must be taken immediately and continue to be used for as long as radioactive iodine lingers in the environment. The pills do nothing to protect against all of the other radioactive poisons, which are released. This is no real assurance to anyone who is informed.

The NRC continues to support ridiculously inadequate evacuation plans following a fuming meltdown at a nuke. SHC-19-4

The record of the NRC, including other shameful rulings, has earned it the reputation that the initials **NRC** stand for **Nobody Really Cares**. The automatic relicensing of old and crumbling nuclear plants by the NRC emphasizes the truth of that reputation.

All of the above represents technological prostitution. At least girls of the night are honest in what they do.

Cut the arrogance! Cut the stupidity! Start protecting Americans. An anything for profits paradigm has brought this great nation to the brink of destruction. The NRC's further actions can allow the final destructive blow. It is unpatriotic.

Very truly yours,

S.J. Goodman, P.E.

Sidney J. Goodman, P.E., M.S.M.E. Professional Engineer NJ License 15326.

Home phone (201) 327-5158

Author of "Asleep at the Geiger Counter" - Blue Dolphin Publishing Inc.

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Toppled Building lying flat on the ground.

Pilings that were supposed to assure that the building was stable.

Three New Jersey nuclear power plants are built on unstable ground. These are the Salem I, Salem II, and the Hope Creek plants.

They are on *Artificial Island* in the *Delaware River*. It was named "Artificial" because it was man-made with filled in land. There is a swamp on one side of the island with the river on the other side. There is no solid rock underneath. Borings were made up to 100 feet deep. No rock was found. The reactors are built on pilings similar to the pilings shown in the collapsed Shanghai City building.

See the concrete pilings of the building that collapsed.

Like so many nuclear facilities, these three nukes are close to an earthquake fault. This fault rumbled on February 3, 2009. The noise of geological shocks in February, terrified people in Morris County who thought the shocks were explosions as reported by The Star Ledger,

The Morris County (NJ) quake had an intensity of 3.0. That was a small event according to the *US Geological Survey*. But much more intense earthquakes are due. Earthquakes may occur a few times a year in New Jersey. Some are so small that they are hardly noticed. A biggie can happen in a hundred years or tomorrow.

From: wdunn302@comcast.net
Sent: Thursday, September 03, 2009 11:55 AM
To: Ashley, Donnie
Cc: Bill Dunn
Subject: Comments On Salem and Hope Creek License Application

William R Dunn
Elsmere, Delaware
September 3, 2009

Donnie Ashley, Project Manager
Division of License Renewal
Office o Nuclear Reactor Regulation
U.S. Nuclear regulatory Commission, Mail Stop 011-F1
Washington, DC 20555
301-415-3191

Reference:

LICENSE RENEWAL APPLICATION
Hope Creek Generating Station
Facility Operating License No. NPF-57

LICENSE RENEWAL APPLICATION
Salem Nuclear Generating Station
Unit 1 Facility Operating License No. DPR-70
Unit 2 Facility Operating License No. DPR-75

Dear Mr. Ashely,

As a former management consultant for a number of EPA 208 Water Quality Area-Wide pollution control programs, I am very much interested in reviewing projects that may have a significant impact on the environment as well as the need to sustain a reliable physical infrastructure that supports our economy and standard of living. Having also worked in Haiti as a consultant, I experienced first hand routine electrical blackouts, an unreliable turn-of-the-ninetieth century telephone system, and other infrastructure shortcomings for drinking water and transportation. We take the safety and reliable delivery of these type services for granted in the United States. Electrical generation is the critical infrastructure component that the rest of the economy depends.

I have reviewed the applications for both the Hope Creek and Salem nuclear facilities and would make the following comments:

<u>Hope Creek and Salem Applications</u>

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The environmental impact appears to be minimal for granting an extension of the facilities license and there is certainly a justified need to upgrade portions of nuclear power generating operations to replace aging equipment that will improve the power generating capabilities and mitigate safety issues of an aging plant.

Secondly, nuclear power does not produce greenhouse gas (CO2) and consequently would be a more attractive alternative to burning coal or natural gas.

Third, based on my research on the emerging nuclear fusion technology, the disposal of nuclear waste will be one day be safely transmuted to useful isotopes. Nuclear fusion and fission will be paired to provide almost unlimited power without the issue of residual radioactivity.

Fourth, the option of purchasing more electricity by de-commissioning these facilities will likely require modifying and building additional transmission lines to support this option. This will have a far more deleterious affect on the environment and communities where these lines will be constructed that continuing to operating these nuclear facilities. Furthermore, importing electricity will likely originate from either coal or gas fired units that produced the greenhouse gases CO2 (and other pollutants) as compared to nuclear power that generates zero greenhouse gas.

<u>Recommendation</u>

I endorse the granting of these facilities a license extension for the aforementioned reasons and would further recommend that these sites be replaced with new state of the art nuclear power plants that would have additional electrical generating capacity. Nuclear power has proven to be a reliable and cost-effective source of electricity and would provide the basis for pairing with nuclear fusion technology in approximately 20 years that would meet our countries energy needs as well as safeguard our environment.

Please feel free to contact me if you require additional information or comment.

Very truly yours,

William R Dunn

Hearing Docket

From: dorickards@aol.com
Sent: Saturday, October 24, 2009 2:26 PM
To: Docket, Hearing
Cc: OGCMailCenter Resource
Subject: hearing on Salem/Hope Creek nuclear plant

DOCKETED
USNRC

October 24, 2010 (2:26 p.m.)

OFFICE OF SECRETARY
RULEMAKINGS AND
ADJUDICATIONS STAFF

Secretary of the Commission
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Attention: Rulemaking and Adjudications Staff:

Every Power Plant currently using intakes either for once through operations or to replenish water lost from evaporation should be required to partner with the most local municipality and pipe their treated wastewater to the power plant to eliminate intakes.

Intakes kill millions of fish annually and once through operations adversely modifies the environment surrounding the outflow area. Municipalities need to dispose of their treated wastewater and to pipe this affluent to a facility that can use it is a least expensive and obviously the most environmentally friendly method.

All power plants should upgrade to a cooling tower technology. If too much heat in generated to recycle the water, cooling units can be added to the outflow troughs to reduce the temperature of the water prior to reuse.

The kinetic energy available in cooling tower outflows can be tapped with UEK turbine technology to generate enough electricity to run cooling coil units. ENERGY RECOVERED = GOOD MANAGEMENT.

SHC-21-1

David O. Rickards
Instream Energy LLC
34612 Rickards Road
Frankford, DE 19945-3544
(302)539-9034 Ph
(302)537-2372 Fax

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LOWER ALLOWAYS CREEK TOWNSHIP
PO BOX 157
501 LOCUST ISLAND ROAD
HANCOCK'S BRIDGE, NEW JERSEY 08038
(856) 935-1549 ext #623 (856) 935-7666 Fax
lactwpclerk@yahoo.com

November 3, 2009

US Nuclear Regulatory Commission
Washington, DC

Re: PSEG Nuclear's License Renewal for Salem and Hope Creek Generating Stations

My name is Ellen B. Pompper, and I am the current Mayor of Lower Alloways Creek Township. We are the host municipality for PSEG Nuclear's Salem & Hope Creek stations. I have lived in Lower Alloways Creek Township for over 30 years and served on local government for 12 years, 5 of those years as Mayor.

While some may not want a nuclear plant in their backyard, we welcome PSEG Nuclear, who we consider a good friend and neighbor. PSEG is transparent and open with us. They are quick to call me and let me know of plant issues and news worthy items that affect us. Each Month, I and other Township Officials meet with PSEG Nuclear. We discuss plant operations and other points of interest that impact not only Salem and Hope Creek, but also our community.

As you know, nuclear is a clean source of energy. The plants produce a significant amount of electricity without emitting carbon dioxide and other greenhouse gases. SHC-22-1

Our community is dotted with farms that also have seen no environmental impact. PSEG has an extensive monitoring program that ensures the health and safety of the public especially those in Lower Alloways Creek.

I support the license renewal for Salem and Hope Creek another 20 years and ask that the NRC approve this life extension for these stations.

Thank You

Ellen B. Pompper

Ellen B. Pompper, Mayor Lower Alloways Creek Township

Ebp/rlc

The UNPLUG SALEM Campaign
321 Barr Ave., Linwood NJ 08221
ncohen12@comcast.net
www.unplugsalem.org
609-335-8176

11/30/2009

To: Nuclear Regulatory Commission:

Comments for the environmental review of the relicensing of Hope Creek **Docket No. 50-354 License No. NPF-57 PSEG Nuclear, LLC**

The UNPLUG Salem Campaign is a network of organizations and individuals that act as a public health and nuclear safety watchdog for PSEG's three nuclear power plants.

This letter concerns the proposed relicensing of Hope Creek. We oppose extending the license of this nuclear plant. We also oppose the process by which decisions on relicensing are made. This process makes it virtually impossible for most individuals and many organizations to participate. In addition, because only certain issues are deemed acceptable by the NRC for submission as contentions, many issues of safety and health are not even looked at by NRC in making their decision.

We also oppose relicensing a nuclear plant twenty years before its license is up for renewal. SHC-23-1

If the NRC can give Oyster Creek a 20 year extension, even though that nuclear plant could not be built under today's standards, and is a meltdown waiting to happen, it is clear that the relicensing process for Hope Creek will be nothing more than paperwork and rubber stamping. SHC-23-2

However, it is important to put our concerns on the record, even though we do not expect NRC to act on any of them. SHC-23-3

Here are areas that NRC should look at and then deny Hope Creek a 20 year extension:

(1) Hope Creek has leaked hydrazine into the Delaware Bay. SHC-23-4

(2) The electrical system that connects Hope Creek to the grid is old and has had a SHC-23-5

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number of failures, including transformer failures.

(3) PSEG has a spotty record when it comes to keeping diesel generators working. This is a concern because all three nuclear plants rely on diesel generators if offsite power is interrupted.

(4) PSEG has a serious Safety Conscious Work Environment (SCWE) and Safety Culture problem. This has been a chronic problem at all 3 of PSEG's plants, and continues to show up in NRC inspections under "cross-cutting issues of human performance". One key example at Hope Creek was the loss of 5000 gallons of cooling water, due to human error. This event could have escalated into a TMI-type of situation. SHC-23-5

(5) Hope Creek is vulnerable to a severe earthquake because Artificial Island is built on compacted mud, and its pilings do not reach bedrock. SHC-23-6

(6) Because Yucca Mountain, the national depository for spent nuclear fuel, will not be operative, Lower Alloways Creek will become, and actually is now, a long term nuclear waste dump, which violates the zoning board agreement between PSEG and Lower Alloways. SHC-23-7

(7) Hope Creek has buried pipes and electrical conduits that have not been inspected and, based on other nuclear plants, may be leaking tritium or in danger of electrical shorts happening. SHC-23-8

(8) The Evacuation Plan for Salem/Hope Creek is based on faulty assumptions and would not work under many scenarios, including a fast acting radiation release and multiple releases. Under worst case scenarios, thousands of people within the 10 and 50 mile zones would die from radiation exposure. SHC-23-9

(9) Hope Creek emits continual amounts of low level radiation and radionuclides, which contribute to the cancer cases and immune system disorders in the 50 mile zone around Artificial Island. SHC-23-10

(10) Hope Creek remains a prime terrorist target, and there are many ways terrorists could prevail, only one of which will I list here. SHC-23-11

(11) Hope Creek's Spent Fuel Pool is above ground and not protected by containment. It is a prime terrorists target. If the water in the Pool drains out, there would be massive radiation releases. SHC-23-11

(12) If NRC approves the relicensing of Hope Creek, the people of South Jersey and Delaware will become unwitting guinea pigs in NRC's grand experiment to find out if aging nuclear plants actually can last another 20 years or not.

What should be done:

Hope Creek should be decommissioned at the end of its 40 year license. Affected employees should be relocated and retrained by PSEG. Artificial Island should be turned into a wind power and solar power "park" to produce some of the electrical energy formerly produced by the nuclear plants. SHC-23-12

Sincerely,

Norm Cohen
Coordinator, The UNPLUG Salem Campaign

emailed to NRC 11/29/09

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A.3 References

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

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

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

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NRC. 1992. *Effect of Hurricane Andrew on the Turkey Point Nuclear Generating Station from August 20-30*, NUREG-1474. Washington, D.C.

NRC. 1996. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*, NUREG-1437, Volumes 1 and 2, Washington, D.C. ADAMS Accession Nos. ML040690705 and ML040690738.

NRC. 1999. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Main Report*, "Section 6.3 – Transportation, Table 9.1, Summary of findings on NEPA issues for license renewal of nuclear power plants, Final Report," NUREG-1437, Volume 1, Addendum 1, Washington, D.C. ADAMS Accession No. ML040690720.

NRC. 2009a. "Transcript of Salem and Hope Creek License Renewal Public Meeting". Washington, D.C. ADAMS Accession No. ML093240195. (afternoon meeting)

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Appendix B

NEPA Issues for License Renewal of Nuclear Power Plants

B. NEPA Issues for License Renewal of Nuclear Power Plants

Table B-1. Summary of Issues and Findings. *This table is taken from Table B-1 in Appendix B, Subpart A, to 10 CFR Part 51. Data supporting this table are contained in NUREG-1437, Generic Environmental Impact Statement for License Renewal of Nuclear Plants. Throughout this report, "Generic" issues are also referred to as Category 1 issues, and "Site-specific" issues are also referred to as Category 2 issues.*

Issue	Type of Issue	Finding
Surface Water Quality, Hydrology, and Use		
Altered current patterns at intake and discharge structures	Generic	SMALL. Altered current patterns have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the license renewal term.
Altered salinity gradients	Generic	SMALL. Salinity gradients have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the license renewal term.
Altered thermal stratification of lakes	Generic	SMALL. Generally, lake stratification has not been found to be a problem at operating nuclear power plants and is not expected to be a problem during the license renewal term.
Temperature effects on sediment transport capacity	Generic	SMALL. These effects have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the license renewal term.
Scouring caused by discharged cooling water	Generic	SMALL. Scouring has not been found to be a problem at most operating nuclear power plants and has caused only localized effects at a few plants. It is not expected to be a problem during the license renewal term.
Eutrophication	Generic	SMALL. Eutrophication has not been found to be a problem at operating nuclear power plants and is not expected to be a problem during the license renewal term.
Discharge of chlorine or other biocides	Generic	SMALL. Effects are not a concern among regulatory and resource agencies, and are not expected to be a problem during the license renewal term.
Discharge of sanitary wastes and minor chemical spills	Generic	SMALL. Effects are readily controlled through NPDES permit and periodic modifications, if needed, and are not expected to be a problem during the license renewal term.

Issue	Type of Issue	Finding
Discharge of other metals in wastewater	Generic	SMALL. These discharges have not been found to be a problem at operating nuclear power plants with cooling-tower-based heat dissipation systems and have been satisfactorily mitigated at other plants. They are not expected to be a problem during the license renewal term.
Water use conflicts (plants with once-through cooling systems)	Generic	SMALL. These conflicts have not been found to be a problem at operating nuclear power plants with once-through heat dissipation systems.
Water use conflicts (plants with cooling ponds or cooling towers using make-up water from a small river with low flow)	Site-specific	SMALL OR MODERATE. The issue has been a concern at nuclear power plants with cooling ponds and at plants with cooling towers. Impacts on instream and riparian communities near these plants could be of moderate significance in some situations. See § 51.53(c)(3)(ii)(A).
	Aquatic Ecology	
Accumulation of contaminants in sediments or biota	Generic	SMALL. Accumulation of contaminants has been a concern at a few nuclear power plants but has been satisfactorily mitigated by replacing copper alloy condenser tubes with those of another metal. It is not expected to be a problem during the license renewal term.
Entrainment of phytoplankton and zooplankton	Generic	SMALL. Entrainment of phytoplankton and zooplankton has not been found to be a problem at operating nuclear power plants and is not expected to be a problem during the license renewal term.
Cold shock	Generic	SMALL. Cold shock has been satisfactorily mitigated at operating nuclear plants with once-through cooling systems, has not endangered fish populations or been found to be a problem at operating nuclear power plants with cooling towers or cooling ponds, and is not expected to be a problem during the license renewal term.
Thermal plume barrier to migrating fish	Generic	SMALL. Thermal plumes have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the license renewal term.
Distribution of aquatic organisms	Generic	SMALL. Thermal discharge may have localized effects but is not expected to affect the larger geographical distribution of aquatic organisms.

Issue	Type of Issue	Finding
Premature emergence of aquatic insects	Generic	SMALL. Premature emergence has been found to be a localized effect at some operating nuclear power plants but has not been a problem and is not expected to be a problem during the license renewal term.
Gas supersaturation (gas bubble disease)	Generic	SMALL. Gas supersaturation was a concern at a small number of operating nuclear power plants with once-through cooling systems but has been satisfactorily mitigated. It has not been found to be a problem at operating nuclear power plants with cooling towers or cooling ponds and is not expected to be a problem during the license renewal term.
Low dissolved oxygen in the discharge	Generic	SMALL. Low dissolved oxygen has been a concern at one nuclear power plant with a once-through cooling system but has been effectively mitigated. It has not been found to be a problem at operating nuclear power plants with cooling towers or cooling ponds and is not expected to be a problem during the license renewal term.
Losses from predation, parasitism, and disease among organisms exposed to sublethal stresses	Generic	SMALL. These types of losses have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the license renewal term.
Stimulation of nuisance organisms (e.g., shipworms)	Generic	SMALL. Stimulation of nuisance organisms has been satisfactorily mitigated at the single nuclear power plant with a once-through cooling system where previously it was a problem. It has not been found to be a problem at operating nuclear power plants with cooling towers or cooling ponds and is not expected to be a problem during the license renewal term.
Aquatic Ecology (for plants with once-through and cooling pond heat dissipation systems)		
Entrainment of fish and shellfish in early life stages	Site-specific	SMALL, MODERATE, OR LARGE. The impacts of entrainment are small at many plants but may be moderate or even large at a few plants with once-through and cooling-pond cooling systems. Further, ongoing efforts in the vicinity of these plants to restore fish populations may increase the numbers of fish susceptible to intake effects during the license renewal period, such that entrainment studies conducted in support of the original license may no longer be valid. See § 51.53(c)(3)(ii)(B).

Issue	Type of Issue	Finding
Impingement of fish and shellfish	Site-specific	SMALL, MODERATE, OR LARGE. The impacts of impingement are small at many plants but may be moderate or even large at a few plants with once-through and cooling-pond cooling systems. See § 51.53(c)(3)(ii)(B).
Heat shock	Site-specific	SMALL, MODERATE, OR LARGE. Because of continuing concerns about heat shock and the possible need to modify thermal discharges in response to changing environmental conditions, the impacts may be of moderate or large significance at some plants. See § 51.53(c)(3)(ii)(B).
Aquatic Ecology (for plants with cooling-tower-based heat dissipation systems)		
Entrainment of fish and shellfish in early life stages	Generic	SMALL. Entrainment of fish has not been found to be a problem at operating nuclear power plants with this type of cooling system and is not expected to be a problem during the license renewal term.
Impingement of fish and shellfish	Generic	SMALL. The impingement has not been found to be a problem at operating nuclear power plants with this type of cooling system and is not expected to be a problem during the license renewal term.
Heat shock	Generic	SMALL. Heat shock has not been found to be a problem at operating nuclear power plants with this type of cooling system and is not expected to be a problem during the license renewal term.
Ground Water Use and Quality		
Ground water use conflicts (potable and service water; plants that use <100 gpm)	Generic	SMALL. Plants using less than 100 gpm are not expected to cause any ground water use conflicts.
Ground water use conflicts (potable and service water, and dewatering plants that use >100 gpm)	Site-specific	SMALL, MODERATE, OR LARGE. Plants that use more than 100 gpm may cause ground water use conflicts with nearby ground water users. See § 51.53(c)(3)(ii)(C).
Ground water use conflicts (plants using cooling towers withdrawing make-up water from a small river)	Site-specific	SMALL, MODERATE, OR LARGE. Water use conflicts may result from surface water withdrawals from small water bodies during low flow conditions which may affect aquifer recharge, especially if other ground water or upstream surface water users come on line before the time of license renewal. See § 51.53(c)(3)(ii)(A).

Issue	Type of Issue	Finding
Ground water use conflicts (Ranney wells)	Site-specific	SMALL, MODERATE, OR LARGE. Ranney wells can result in potential ground water depression beyond the site boundary. Impacts of large ground water withdrawal for cooling tower makeup at nuclear power plants using Ranney wells must be evaluated at the time of application for license renewal. See § 51.53(c)(3)(ii)(C).
Ground water quality degradation (Ranney wells)	Generic	SMALL. Ground water quality at river sites may be degraded by induced infiltration of poor-quality river water into an aquifer that supplies large quantities of reactor cooling water. However, the lower quality infiltrating water would not preclude the current uses of ground water and is not expected to be a problem during the license renewal term.
Ground water quality degradation (saltwater intrusion)	Generic	SMALL. Nuclear power plants do not contribute significantly to saltwater intrusion.
Ground water quality degradation (cooling ponds in salt marshes)	Generic	SMALL. Sites with closed-cycle cooling ponds may degrade ground water quality. Because water in salt marshes is brackish, this is not a concern for plants located in salt marshes.
Ground water quality degradation (cooling ponds at inland sites)	Site-specific	SMALL, MODERATE, OR LARGE. Sites with closed-cycle cooling ponds may degrade ground water quality. For plants located inland, the quality of the ground water in the vicinity of the ponds must be shown to be adequate to allow continuation of current uses. See § 51.53(c)(3)(ii)(D).
		Terrestrial Ecology
Cooling tower impacts on crops and ornamental vegetation	Generic	SMALL. Impacts from salt drift, icing, fogging, or increased humidity associated with cooling tower operation have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the license renewal term.
Cooling tower impacts on native plants	Generic	SMALL. Impacts from salt drift, icing, fogging, or increased humidity associated with cooling tower operation have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the license renewal term.
Bird collisions with cooling towers	Generic	SMALL. These collisions have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the license renewal term.

Issue	Type of Issue	Finding
Cooling pond impacts on terrestrial resources	Generic	SMALL. Impacts of cooling ponds on terrestrial ecological resources are considered to be of small significance at all sites.
Power line right of way management (cutting and herbicide application)	Generic	SMALL. The impacts of right-of-way maintenance on wildlife are expected to be of small significance at all sites.
Bird collisions with power lines	Generic	SMALL. Impacts are expected to be of small significance at all sites.
Impacts of electromagnetic fields on flora and fauna	Generic	SMALL. No significant impacts of electromagnetic fields on terrestrial flora and fauna have been identified. Such effects are not expected to be a problem during the license renewal term.
Floodplains and wetland on power line right of way	Generic	SMALL. Periodic vegetation control is necessary in forested wetlands underneath power lines and can be achieved with minimal damage to the wetland. No significant impact is expected at any nuclear power plant during the license renewal term.
Threatened and Endangered Species		
Threatened or endangered species	Site-specific	SMALL, MODERATE, OR LARGE. Generally, plant refurbishment and continued operation are not expected to adversely affect threatened or endangered species. However, consultation with appropriate agencies would be needed at the time of license renewal to determine whether threatened or endangered species are present and whether they would be adversely affected. See § 51.53(c)(3)(ii)(E).
Air Quality		
Air quality effects of transmission lines	Generic	SMALL. Production of ozone and oxides of nitrogen is insignificant and does not contribute measurably to ambient levels of these gases.
Land Use		
Onsite land use	Generic	SMALL. Projected onsite land use changes required during refurbishment and the renewal period would be a small fraction of any nuclear power plant site and would involve land that is controlled by the applicant.
Power line right of way	Generic	SMALL. Ongoing use of power line right of ways would continue with no change in restrictions. The effects of these restrictions are of small significance.

Issue	Type of Issue	Finding
		Human Health
Microbiological organisms (occupational health)	Generic	SMALL. Occupational health impacts are expected to be controlled by continued application of accepted industrial hygiene practices to minimize worker exposures.
Microbiological organisms (public health)(plants using lakes or canals, or cooling towers or cooling ponds that discharge to a small river)	Site-specific	SMALL, MODERATE, OR LARGE. These organisms are not expected to be a problem at most operating plants except possibly at plants using cooling ponds, lakes, or canals that discharge to small rivers. Without site-specific data, it is not possible to predict the effects generically. See § 51.53(c)(3)(ii)(G).
Noise	Generic	SMALL. Noise has not been found to be a problem at operating plants and is not expected to be a problem at any plant during the license renewal term.
Electromagnetic fields – acute effects (electric shock)	Site-specific	SMALL, MODERATE, OR LARGE. Electrical shock resulting from direct access to energized conductors or from induced charges in metallic structures have not been found to be a problem at most operating plants and generally are not expected to be a problem during the license renewal term. However, site-specific review is required to determine the significance of the electric shock potential at the site. See § 51.53(c)(3)(ii)(H).
Electromagnetic fields – chronic effects	Uncategorized	UNCERTAIN. Biological and physical studies of 60-Hz electromagnetic fields have not found consistent evidence linking harmful effects with field exposures. However, research is continuing in this area and a consensus scientific view has not been reached.
Radiation exposures to public (license renewal term)	Generic	SMALL. Radiation doses to the public will continue at current levels associated with normal operations.
Occupational radiation exposures (license renewal term)	Generic	SMALL. Projected maximum occupational doses during the license renewal term are within the range of doses experienced during normal operations and normal maintenance outages, and would be well below regulatory limits.

Issue	Type of Issue	Finding
		Socioeconomic Impacts
Housing impacts	Site-specific	SMALL, MODERATE, OR LARGE. Housing impacts are expected to be of small significance at plants located in a medium or high population area and not in an area where growth control measures that limit housing development are in effect. Moderate or large housing impacts of the workforce associated with refurbishment may be associated with plants located in sparsely populated areas or in areas with growth control measures that limit housing development. See § 51.53(c)(3)(ii)(I).
Public services: public safety, social services, and tourism, and recreation	Generic	SMALL. Impacts to public safety, social services, and tourism and recreation are expected to be of small significance at all sites.
Public services: public utilities	Site-specific	SMALL OR MODERATE. An increased problem with water shortages at some sites may lead to impacts of moderate significance on public water supply availability See § 51.53(c)(3)(ii)(I).
Public services: education (license renewal term)	Generic	SMALL. Only impacts of small significance are expected
Offsite land use (refurbishment)	Site-specific	SMALL OR MODERATE. Impacts may be of moderate significance at plants in low population areas. See § 51.53(c)(3)(ii)(I).
Offsite land use (license renewal term)	Site-specific	SMALL, MODERATE, OR LARGE. Significant changes in land use may be associated with population and tax revenue changes resulting from license renewal. See § 51.53(c)(3)(ii)(I).
Public services: transportation	Site-specific	SMALL, MODERATE, OR LARGE. Transportation impacts (level of service) of highway traffic generated during plant refurbishment and during the term of the renewed license are generally expected to be of small significance. However, the increase in traffic associated with the additional workers and the local road and traffic control conditions may lead to impacts of moderate or large significance at some sites. See § 51.53(c)(3)(ii)(J).

Issue	Type of Issue	Finding
Historic and archaeological resources	Site-specific	SMALL, MODERATE, OR LARGE. Generally, plant refurbishment and continued operation are expected to have no more than small adverse impacts on historic and archaeological resources. However, the National Historic Preservation Act requires the Federal agency to consult with the State Historic Preservation Officer to determine whether there are properties present that require protection. See § 51.53(c)(3)(ii)(K).
Aesthetic impacts (license renewal term)	Generic	SMALL. No significant impacts are expected during the license renewal term.
Aesthetic impacts of transmission lines (license renewal term)	Generic	SMALL. No significant impacts are expected during the license renewal term.
Postulated Accidents		
Design basis accidents	Generic	SMALL. The Staff has concluded that the environmental impacts of design basis accidents are of small significance for all plants.
Severe accidents	Site-specific	SMALL. The probability-weighted consequences of atmospheric releases, fallout onto open bodies of water, releases to ground water, and societal and economic impacts from severe accidents are small for all plants. However, alternatives to mitigate severe accidents must be considered for all plants that have not considered such alternatives. See § 51.53(c)(3)(ii)(L).
Uranium Fuel Cycle and Waste Management		
Offsite radiological impacts (individual effects from other than the disposal of spent fuel and high level waste)	Generic	SMALL. Off-site impacts of the uranium fuel cycle have been considered by the Commission in Table S-3 of this part. Based on information in the GEIS, impacts on individuals from radioactive gaseous and liquid releases including radon-222 and technetium-99 are small.

Issue	Type of Issue	Finding
Offsite radiological impacts (collective effects)	Generic	The 100 year environmental dose commitment to the U.S. population from the fuel cycle, high level waste and spent fuel disposal excepted, is calculated to be about 14,800 person rem, or 12 cancer fatalities, for each additional 20-year power reactor operating term. Much of this, especially the contribution of radon releases from mines and tailing piles, consists of tiny doses summed over large populations. This same dose calculation can theoretically be extended to include many tiny doses over additional thousands of years as well as doses outside the U. S. The result of such a calculation would be thousands of cancer fatalities from the fuel cycle, but this result assumes that even tiny doses have some statistical adverse health effect which will not ever be mitigated (for example, no cancer cure in the next thousand years), and that these doses projected over thousands of years are meaningful. However, these assumptions are questionable. In particular, science cannot rule out the possibility that there will be no cancer fatalities from these tiny doses. For perspective, the doses are very small fractions of regulatory limits, and even smaller fractions of natural background exposure to the same populations. Nevertheless, despite all the uncertainty, some judgment as to the regulatory NEPA implications of these matters should be made and it makes no sense to repeat the same judgment in every case. Even taking the uncertainties into account, the Commission concludes that these impacts are acceptable in that these impacts would not be sufficiently large to require the NEPA conclusion, for any plant, that the option of extended operation under 10 CFR Part 54 should be eliminated. Accordingly, while the commission has not assigned a single level of significance for the collective effects of the fuel cycle, this issue is considered Category 1 [Generic].
Offsite radiological impacts (spent fuel and high level waste disposal)	Generic	For the high level waste and spent fuel disposal component of the fuel cycle, there are no current regulatory limits for offsite releases of radionuclides for the current candidate repository site. However, if we assume that limits are developed along the lines of the 1995 National Academy of Sciences (NAS) report, "Technical Bases for Yucca Mountain Standards," and that in accordance with the Commission's Waste Confidence Decision, 10 CFR 51.23, a repository can and likely will be developed at some site which will comply with such limits, peak doses to virtually all individuals will be 100 millirem per year or less. However, while the Commission has reasonable confidence that these

Issue	Type of Issue	Finding
		assumptions will prove correct, there is considerable uncertainty since the limits are yet to be developed, no repository application has been completed or reviewed, and uncertainty is inherent in the models used to evaluate possible pathways to the human environment. The NAS report indicated that 100 millirem per year should be considered as a starting point for limits for individual doses, but notes that some measure of consensus exists among national and international bodies that the limits should be a fraction of the 100 millirem per year. The lifetime individual risk from 100 millirem annual dose limit is about 3 x 10-3. Estimating cumulative doses to populations over thousands of years is more problematic. The likelihood and consequences of events that could seriously compromise the integrity of a deep geologic repository were evaluated by the Department of Energy in the "Final Environmental Impact Statement: Management of Commercially Generated Radioactive Waste," October 1980. The evaluation estimated the 70-year whole-body dose commitment to the maximum individual and to the regional population resulting from several modes of breaching a reference repository in the year of closure, after 1,000 years, after 100,000 years and after 100,000,000 years. Subsequently, the NRC and other federal agencies have expended considerable effort to develop models for the design and for the licensing of a high level waste repository, especially for the candidate repository at Yucca Mountain. More meaningful estimates of doses to populations may be possible in the future as more is understood about the performance of the proposed Yucca Mountain repository. Such estimates would involve very great uncertainty, especially with respect to cumulative population doses over thousands of years. The standard proposed by the NAS is a limit on maximum individual dose. The relationship of potential new regulatory requirements, based on the NAS report, and cumulative population impacts has not been determined, although the report articulates the view that protection of individuals will adequately protect the population for a repository at Yucca Mountain. However, EPA's generic repository standards in 40 CFR Part 191 generally provide an indication of the order of magnitude of cumulative risk to population that could result from the licensing of a Yucca Mountain repository, assuming the ultimate standards will be within the range of standards

Issue	Type of Issue	Finding
		now under consideration. The standards in 40 CFR Part 191 protect the population by imposing amount of radioactive material released over 10,000 years. The cumulative release limits are based on EPA's population impact goal of 1,000 premature cancer deaths worldwide for a 100,000 metric ton (MTHM) repository. Nevertheless, despite all the uncertainty, some judgment as to the regulatory NEPA implications of these matters should be made and it makes no sense to repeat the same judgment in every case. Even taking the uncertainties into account, the Commission concludes that these impacts are acceptable in that these impacts would not be sufficiently large to require the NEPA conclusion, for any plant, that the option of extended operation under 10 CFR Part 54 should be eliminated. Accordingly, while the Commission has not assigned a single level of significance for the impacts of spent fuel and high level waste disposal, this issue is considered in Category 1 [Generic].
Nonradiological impacts of the uranium fuel cycle	Generic	SMALL. The nonradiological impacts of the uranium fuel cycle resulting from the renewal of an operating license for any plant are found to be small.
	Decommissioning	
Radiation doses	Generic	SMALL. Doses to the public will be well below applicable regulatory standards regardless of which decommissioning method is used. Occupational doses would increase no more than 1 man-rem caused by buildup of long-lived radionuclides during the license renewal term.
Waste management	Generic	SMALL. Decommissioning at the end of a 20-year license renewal period would generate no more solid wastes than at the end of the current license term. No increase in the quantities of Class C or greater than Class C wastes would be expected.
Air quality	Generic	SMALL. Air quality impacts of decommissioning are expected to be negligible either at the end of the current operating term or at the end of the license renewal term.
Water quality	Generic	SMALL. The potential for significant water quality impacts from erosion or spills is no greater whether decommissioning occurs after a 20-year license renewal period or after the original 40-year operation period, and measures are readily available to avoid such impacts.

Issue	Type of Issue	Finding
Ecological resources	Generic	SMALL. Decommissioning after either the initial operating period or after a 20-year license renewal period is not expected to have any direct ecological impacts.
Socioeconomic impacts	Generic	SMALL. Decommissioning would have some short-term socioeconomic impacts. The impacts would not be increased by delaying decommissioning until the end of a 20-year relicense period, but they might be decreased by population and economic growth.
	Environmental Justice	
Environmental Justice	Uncategorized	NONE. The need for and the content of an analysis of environmental justice will be addressed in plant-specific reviews.

Appendix C

Applicable Regulations, Laws, and Agreements

C. Applicable Regulations, Laws, and Agreements

The Atomic Energy Act of 1954 (AEA) authorizes States to establish programs to assume U.S. Nuclear Regulatory Commission (NRC) regulatory authority for certain activities. For example, through section 274b of the AEA, as amended, beginning on September 30, 2009, New Jersey assumes regulatory authority for: (1) byproduct materials as defined in 11e.(1) of the Act; (2) source materials; and (3) special nuclear materials in quantities not sufficient to form a critical mass; and (4) the disposal of low-level radioactive waste at a land disposal site as described in Title 10 of the Code of Federal Regulations (CFR) Part 6.

New Jersey is not seeking authority to: (a) conduct safety evaluations of sealed sources and devices manufactured in New Jersey and distributed in interstate commerce or (b) regulate 11e.(2) byproduct material resulting from the extraction or concentration of source material from ore processed primarily for its source material content, and its management and disposal. The New Jersey Bureau of Environmental Radiation is responsible for implementing State nuclear regulations.

In addition to implementing some Federal programs, State legislatures develop their own laws. State statutes supplement as well as implement Federal laws for protection of air, water quality, and ground water. State legislation may address solid waste management programs, locally rare or endangered species, and historic and cultural resources.

The Clean Water Act (CWA) allows for primary enforcement and administration through State agencies, provided the State program is at least as stringent as the Federal program. The State program must conform to the CWA and to the delegation of authority for the Federal National Pollutant Discharge and Elimination System (NPDES) program from the U.S. Environmental Protection Agency (EPA) to the State. The primary mechanism to control water pollution is the requirement for direct dischargers to obtain an NPDES permit, or in the case of states where the authority has been delegated from the EPA, an SPDES permit, pursuant to the CWA. In New Jersey, the New Jersey Department of Environmental Protection (NJDEP) issues and enforces NPDES permits.

One important difference between Federal regulations and certain State regulations is the definition of waters regulated by the State. Certain state regulations may include underground waters, while the CWA only regulates surface waters.

C.1 State Environmental Requirements

Certain environmental requirements, including some discussed earlier, may have been delegated to State authorities for implementation, enforcement, or oversight. Table C-1 provides a list of representative State environmental requirements that may affect license renewal applications for Salem Nuclear Generating Station (Salem) and Hope Creek Generating Station (HCGS).

Table C-1. State Environmental Requirements. *Salem and HCGS are subject to numerous State requirements regarding their environmental program. Those requirements are briefly described below. See Section 1.9 for Salem's and HCGS's compliance status with these requirements.*

Law/Regulation	Requirements
Air Quality Protection	
Air Pollution Control Act – N.J.S.A. 26:2C et seq. and N.J.A.C. 7:27-22 et seq. - Title V Operating Permit	This permit authorizes a facility to operate its emission units in accordance with all applicable federal and state regulations. The permit specifies the monitoring, record keeping, and reporting requirements to demonstrate compliance with these regulations and permit conditions. NJDEP has a joint preconstruction and Title V program.
Clean Air Interstate Rule (CAIR) Permit (Chapter 106, P.L. 1967 (N.J.S.A. 26:2C-9.2), 42 U.S.C. 7401, 7403, 7410, 7426, 7601, and 7651, *et seq.,* and Title V of the Clean Air Act)	CAIR sets annual state-wide emission budgets for sulfur dioxide (SO_2) and Nitrous Oxides (NO_x) for significant upwind contributors to particulate matter, 2.5 microns or less in diameter ($PM_{2.5}$) nonattainment, and it sets state-wide ozone season budgets (May 1st through September 30th) for contributors to 8-hour ozone nonattainment.
Water Resources Protection	
CWA (33 U.S.C. Section 401) - NJDEP	In accordance with Clean Water Act § 401, an applicant for a permit will obtain a water quality certificate or waiver from the appropriate state agency (NJDEP) prior to permit decision by the federal government.
Water Supply Management Act – N.J.S.A. 58A:1 et seq. and N.J.A.C. 7:20A et seq., Water Supply Laws – N.J.S.A. 58-9.1 et seq. and N.J.A.C. 7:10-10.1 et seq.	Water Allocation Permit - Required for diversion of more than 378,500 liters (100,000 gallons) of water per day (265 liters per minute; 70 gallons per minute [gpm]). Governs the granting of privileges to divert water, the management of water quality and quantity and the response to water supply shortages, drought and other water emergencies.
NJ Water Pollution Control Act of 1977 N.J.S.A. 58:10A-1 et seq. and N.J.A.C. 7:14A-1 et seq.	NJPDES – Discharge to Groundwater, NJPDES – Discharge to Surface Water (Industrial Stormwater Permit)
NJ Water Pollution Control Act of 1977 – N.J.S.A. 58:10A-1 et seq. and N.J.A.C. 7:14A-22 etseq and 7:14A-23 et seq.	Treatment Works Approval – required to build, install, modify, or operate any treatment works (any method or system for preventing, abating, reducing, storing, treating, separating, or disposing of pollutants including stormwater runoff or industrial waste in combined or separate stormwater and sanitary sewer systems).

Law/Regulation	Requirements
NJ Water Pollution Control Act of 1977 – N.J.S.A. 58:10A-1 to 13 – Federal Clean Water Act Amendments of 1977, 33 U.S.C. 1251 Section 401	Water Quality Certification – Ensures consistency with state water quality standards and management policies.
Water Quality Planning Act – N.J.S.A. 58:11A-1 et seq. and N.J.A.C. 7:15-1 et seq.	Prescribes water quality management policies and procedures concerning water quality management planning, including Statewide, areawide, and county water quality management plans and wastewater management plans.
Subsurface and Percolating Waters Act – N.J.S.A. 58:4 A-4.1 et seq.	Under this Act, the NJDEP reviews and issues a permit to drill a well.
NJ Safe Drinking Water Act –N.J.A.C. 7:10 and N.J.S.A. 58:12A-1 et seq	The NJDEP issues and enforces public water supply permits for operation of the plant site drinking water systems.
Coastal Area Facility Review Act (CAFRA) N.J.S.A. 13:19-1 et seq.	CAFRA regulates all development on beaches and dunes and other development within 46 meters (150 feet) of tidal waters, beach, or dune.
Flood Hazard Control Act N.J.S.A. 58:16A et seq. and N.J.A.C. 7:13 et seq.	Permitting standards and procedures for projects to be conducted in flood plains in order to minimize or avoid flood damage. Includes construction standards, standards for protection of near-stream vegetation, and methods of determining flood hazard area along waterways.
Water Pollution Control Act – N.J.S.A. 58:10-1 et seq.,	
Department of Environmental Protection Act – N.J.S.A. 13:1D et seq.	
Waterfront Development N.J.S.A. 12:5-3	Encompasses all development at or below the mean high water line in tidal waters of the state.
Delaware River Basin Commission Docket Approval – P.L. 87-328 (Federal) and N.J.S.A. 58:18-18 et seq.	Stations are within Delaware River Basin Commission (DRBC) regulatory area. The DRBC is responsible for the conservation and management of water resources within this area.
Soil Erosion and Sediment Control Act – P.L. 1975 C. 251, § 1	Projects that are regulated under Chapter 251 (which include projects that disturb greater than 464 square meters [5000 square feet] of land) must obtain a Soil Erosion and Sediment Control Plan Certification from the Soil Conservation District prior to the initiation of land disturbance activities.

Law/Regulation	Requirements
Release Prevention	
Spill Compensation and Control Act, P.L. 1990, c 78 and N.J.A.C. 7:1E et seq.	Discharge Prevention, Containment and Countermeasure and Discharge Cleanup and Removal
Toxic Catastrophe Prevention Act (TCPA), P.L. 1985, c403 and N.J.A.C. 7:31 et seq.	This act requires that certain facilities handling extraordinarily hazardous substances have approved risk management programs.
Superfund Amendments and Reauthorization Act (SARA) Title III (42 U.S.C. 11001 et seq.)	Emergency Planning Notification - State Emergency Response Commission and the local emergency planning committee.
NJ Spill Compensation and Control Act N.J.S.A 58:10-23.11	Emergency Release Notification
NJ Worker and Community Right-to-Know Act - N.J.S.A. 34:5-1 et seq. and NJ Pollution Prevention Act - N.J.S.A. 13:1D-35 et seq.	Toxic Chemical Release Inventory, Release and Pollution Prevention Report
Underground Storage of Hazardous Substances Act – N.J.S.A. 58:10A-21 et seq. and N.J.A.C. 7:14B	Registration of underground storage tanks (USTs), installation or substantial modification of USTs, UST Closure Plan Approval
Solid Waste Management Act – N.J.S.A. 13:1E-1 et seq. and N.J.A.C. 7:26G-1 et seq.	Regulates the registration, operation, maintenance and closure of sanitary landfills and other solid and hazardous waste facilities, as well as the registration, operation and maintenance of solid waste transporting operations and facilities in New Jersey.
Biotic Resource Protection	
NJ Natural Heritage Rare, Threatened, and Endangered Species Consultation	Consultation is requested from the New Jersey Natural Heritage Office regarding plant and animal species (and their habitat) that may be adversely affected by the project. Consultation with this agency identifies primarily state-listed species as well as federal species.
Freshwater Wetlands Protection Act – N.J.S.A. 13:9B and N.J.A.C. 7:7A, Wetlands Act of 1970 – N.J.S.A. 13:9A, N.J.S.A. 12:5-3, 13:1D-29 et seq., 13:9A-1 et seq., and 13:19-1 et seq.	Permit would be required for impacts to wetlands or any surrounding buffer area. Primary jurisdiction is NJDEP for freshwater wetlands.

Law/Regulation	Requirements
Coastal Permit Program Rules - N.J.A.C. 7:7, Coastal Zone Management Rules – N.J.A.C. 7:7E	Provides standards for coastal permit applications for coastal activities and developments under CAFRA, the Waterfront Development Law and Wetlands Act of 1970.
Division of Fish and Wildlife Rules – N.J.A.C. 7-25	Governs the management and harvest of fish and wildlife within the State.
Other	
National Historic Preservation Act of 1966, Section 106 – Stat. 915, 16 U.S.C. 470 et seq., 36 CFR Part 800	Designed to ensure that historic properties are given consideration during federal project planning and execution. These activities can include, but are not limited to: construction, rehabilitation and repair projects, demolition, licenses, and permits.
New Jersey Register of Historic Places Rules N.J.A.C. 7:4	Concerns the preservation of the State's historic, architectural, archaeological, engineering and cultural heritage.
NJDOT - Transport permit for radioactive waste N.J.A.C. 16:49	Governs the transportation of hazardous materials in the State of New Jersey; regulates the shipping, packaging, marking, labeling, placarding, handling, and transportation of hazardous materials; and, to the maximum extent practicable, conforms to the requirements of the regulations issued by the United States Department of Transportation
Radiation Protection Program – N.J.S.A. Title 26:2D and N.J.A.C. 7:28	Reduce exposure to unnecessary radiation through licensing users of radioactive materials, addressing radioactively contaminated sites, assessing exposure to non-ionizing radiation and conducting a statewide radon program.
Noise Control - N.J.A.C. 7:29	Sets forth regulations relating to the control and abatement of noise.

Note: The above list represents a composite of potential permits and approvals needed for an expansion/modification these facilities. The nature of the project, areas of disturbance, specific quantities of air emissions, water use and discharge, chemical usage, fuel stored, chemical usage and other information will allow for this list to be refined. Note that the NJDEP recommends that developers of new or significantly modified projects perform a "one stop" review such that NJDEP input as to permits and approvals can be obtained early in the project. In addition, permitting timeframes are from the submittal for a permit/approval to the issuance of the final notice to construct. Public participation, political intervention and legal challenges may alter the timeframe for individual permits/approvals.

C.2 Operating Permits and Other Requirements

Several operating permit applications may be prepared and submitted, and regulator approval and permits would be received prior to license renewal approval by the NRC. Table C-2 lists representative Federal, State, and local permits.

Table C-2. Federal, State, and Local Permits and Other Requirements. *Salem and HCGS are subject to other requirements regarding various aspects of their environmental program. Those requirements are briefly described below.*

License, Permit, or Other Required Approval	Responsible Agency	Authority	Relevance and Status
Federal			
Combined License / COL Application (Construction Permit and Operating License)	NRC	Standard Design Certifications and Combined Licenses for Nuclear Power Plants (10 CFR 52, specifically Subpart C, 52.71 – 52.103) and requirements contained in 10 CFR 50.30, with the environmental report prepared in accordance with Subpart A of 10 CFR 51. Administrative review per 10 CFR part 2 (see Note 1)	Construction and Operation
National Environmental Policy Act (NEPA) (Title 42 United States Code [USC] 4321-4347)	NRC	As referenced in 10 CFR 52 and within the context of the combined operating license application (COLA), Complete environmental report to assess impacts of both construction and operation, including alternative sites, as required by 10 CFR 51. Consultations triggered as a result of the NEPA action include National Historic Preservation Act Section 106, Section 7 of the Endangered Species Act, and Magnuson-Stevens Fishery Conservation Management Act	Construction
General Conformity Approval	NRC	Conformity to New Jersey Strategic Implementation Plan's purpose of eliminating or reducing severity and number of National Ambient Air Quality Standards (NAAQS) violations (NO_x and volatile organic compound (VOC) emissions); 40 CFR 93, Subpart B. Applies to construction activities and air emissions not regulated and/or New Source Review.	Construction

License, Permit, or Other Required Approval	Responsible Agency	Authority	Relevance and Status
Section 10 of the Rivers and Harbors Act of 1899 (33 USC 403) Water Obstruction and Encroachment Permit	US Army Corps of Engineers (Philadelphia District) / Jointly with the NJ DEP	Permit is required for structures or work in or affecting navigable waters of the US (including wetlands); 33 CFR 322	Construction. This permit activity is required for intake/discharge modifications and/or work at any waterfront piers.
Section 404 of Clean Water Act (33 USC 1344)	US Army Corps of Engineers (Philadelphia District) / Jointly with the NJDEP	Regulates the discharge of dredged or fill material into waters of the US. Projects affecting under 0.5 acres of wetlands or less than 152 meters (500 linear feet) of stream may be eligible for a general (nationwide, regional or state) permit; otherwise, an individual permit is required. Triggers Fish and Wildlife Service and National Marine Fisheries review.	Construction Requires a permit before dredged or fill material may be discharged into waters of the US, including wetlands. May apply to any underwater activity such as installation of an electric cable.
Section 401 of Clean Water Act – Certification and Wetlands (33 USC 1341)	US Army Corps of Engineers (Philadelphia District) / Jointly with the NJDEP	Required for all federal permits related to water quality. Any applicant for a Federal license or permit to conduct any activity including, but not limited to, the construction or operation of facilities, which may result in any discharge into the navigable waters, shall provide the licensing or permitting agency a certification from the State in which the discharge originates or will originate, or, if appropriate, from the interstate water pollution control agency having jurisdiction over the navigable waters at the point where the discharge originates or will originate, that any such discharge will comply with the applicable provisions of	Construction-related disturbance within a wetland area.
Spill Prevention and Countermeasure Control (SPCC) Plan	United States Environmental Protection Agency (EPA)	Needed for storage of oil products; Subparts A through C of Oil Pollution Prevention Regulation (40 CFR 112) are referred to as the SPCC rule. SPCC goal is to prevent oil spills from reaching the nation's waters; spill contingency plan is required as a part of the SPCC plan	Oil fuel may be needed for emergency power equipment.

License, Permit, or Other Required Approval	Responsible Agency	Authority	Relevance and Status
Superfund Amendments and Reauthorization Act of 1986 (SARA) Title 3 / Emergency Planning and Community Right to Know (EPRCRA) Sections 311-312 / Toxic Chemical Release Inventory (Section 313)	EPA	Chemicals may be subject to reporting requirements	Operation
Title III Air Toxics	EPA	Greater than 10 tons per year (tpy) of any single hazardous air pollutant or 25 tpy of any combination or a maximum available control technology (MACT) determination; 40 CFR 63	Construction/Operation
Risk Management Program	EPA	Section 112(r) of Clean Air Act – Chemicals subject to accident prevention regulations hazardous chemical storage; 40 CFR 68	Operation
316(a) and 316(b) of Clean Water Act	EPA	Intake and discharge structures. Section 316(a) of the Clean Water Act regulates heated discharges into waters of the United States; Section 316(b) requires that the location, design, construction and capacity of cooling water intake structures reflect the best technology available for minimizing adverse environmental impact.	Modification or expansion of plant cooling system.
RCRA, Section 3010	EPA	Acknowledgement of Notification of Hazardous Waste Activity – Hazardous Waste Generation	Hazardous waste generation
Facility Response Plan, and Hazardous Waste Contingency Plan	EPA	Facility Response Plan Approval – Spill/Discharge Response Program. 40 CFR 9 and 112 and 40 CFR 265 Subparts C and D	Spill/Discharge Response Program
Spill Prevention Control, and Countermeasure (SPCC) rule	EPA	(40 CFR 112) Appendix F, Sections 1.2.1 and 1.2.2	Spill/Discharge Prevention Plan
Determination of No Hazard to Air Navigation	Federal Aviation Administration	Aeronautical study under provisions of 49 U.S.C., Section 44718. For new structures and possibly for construction equipment capable of affecting navigable airspace (e.g., cranes)	Generally, for construction of structures >61meters (>200 ft) above grade or shorter structures within glide path of an airport.

License, Permit, or Other Required Approval	Responsible Agency	Authority	Relevance and Status
Magnuson-Stevens Fishery Conservation Management Act (Public Law 94-265)	US Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service	Section 7 of the Endangered Species Act (16 USC 1531-1544) – Incidental Take Statement - Covers possession and disposition of impinged or stranded threatened or endangered species such as sea turtles and shortnose sturgeon. Consultation with these agencies is required for new construction/projects that may adversely affect federally listed species.	Construction, Operation
Consultation and Conference Activities Under Section 7 of the Endangered Species Act (ESA of 1973, as amended, 16 USC 1531 *et seq.*)	US Fish and Wildlife Service and National Marine Fisheries Service	The Endangered Species Act (ESA) requires consultation to insure that an action is not likely to jeopardize the continued existence of a listed species or result in the destruction or adverse modification of designated critical habitat. (*part of NEPA Process; NRC is lead*)	Construction
Floodplain Development Permit	Federal Emergency Management Agency (FEMA)	Verification from FEMA or FEMA-approved local authority for construction within a 100-year floodplain	Construction
Registration	US Department of Transportation	Required for hazardous material shipments; 40 CFR 5108	Operation
Alternate Fuels Capability Certification	US Department of Energy (DOE)	Baseload facilities fueled by natural gas or oil	Construction
Fuel Use Act of 1978	US Department of Energy (DOE)	Waiver	Construction
State of New Jersey			
Air Quality – Title V Operating Permit (significant modification) or State only Permit	NJDEP – Air Quality Permitting Program	This permit authorizes a facility to operate its emission units in accordance with all applicable federal and state regulations. The permit specifies the monitoring, record keeping, and reporting requirements to demonstrate compliance with these regulations and permit conditions. NJDEP has a joint preconstruction and Title V program.	Construction/Operation
Air Quality - Clean Air Interstate Rule (CAIR) Permit	NJDEP – Air Quality Permitting Program	Chapter 106, P.L. 1967 (N.J.S.A. 26:2C-9.2), 42 U.S.C. 7401, 7403, 7410, 7426, 7601, and 7651, *et seq.*, and Title V of the Clean Air Act and N.J.A.C. 7:27-30	Construction/Operation

License, Permit, or Other Required Approval	Responsible Agency	Authority	Relevance and Status
Air Quality - Nonattainment New Source Review	NJDEP – Air Quality Permitting Program	Imposes LAER control technology, emission offsets, and requirements on any proposed new project, if thresholds triggered	Salem County is non-attainment for ozone. NOx and VOC emissions are regulated as ozone precursors.
Air Quality - Prevention of Significant Deterioration (PSD) permit	NJDEP – Air Quality Permitting Program	Required if PSD thresholds are exceeded from any new unit or plant modification.	Construction
Water Quality – New Jersey Pollutant Discharge Elimination System (NJPDES) permit - Wastewater– Part 1 (Clean Water Act, 33 USC 1251 et seq. and N.J.A.C. 7:9A)	NJDEP – Division of Water Quality	Needed if treating and discharging wastewater or cooling water to surface waters (316 (b) Compliance) ; N.J.A.C 7:9A. Category B – Industrial Wastewater	Construction/Operation
Water Quality - NJPDES – Industrial Stormwater Permit	NJDEP – Division of Water Quality	General or individual permit for point source discharges disturbance areas. Requires erosion and sediment control plan. Category RF – Industrial Stormwater	Construction/Operation – Offsite stormwater discharge/conveyance.
Water Quality - NJPDES – Discharge to Groundwater Permit	NJDEP – Division of Water Quality	N.J.A.C. 7:14A and N.J.A.C. 7:9-6 et seq.	Construction/Operation
Water Quality - Water Quality Management Plan Consistency Determination	NJDEP – Division of Water Quality	NJDEP to determine if water quality measures are consistent with state and local Water Quality Management Plans	Construction/Operation
Water Supply - Water Allocation Permit (N.J.S.A. 58:1A-1 et seq.)	NJDEP – Division of Water Supply	Needed if diverting more than 378,500 liters (100,000 gallons) of water per day. (N.J.S.A. 58:1A-1 et seq.)	Current permit allows groundwater withdrawal of up to 163.5 million liters (43.2 million gallons)/month (30 days) and 1,136 million liters (300 million gallons)/year
Site Remediation – S1 Wastewater Treatment License/SRP-PI	NJDEP – Division of Water Quality and Division of Water Supply	N.J.A.C. 7:10A-1.14 System classification - Wastewater treatment	Operation
Water Supply – Safe Drinking Water	NJDEP – Division of Water Supply, Bureau of Safe Drinking Water	Ensure public water systems satisfy Federal and State drinking water requirements. N.J.A.C. 7:10	Operation
Toxic Catastrophic Prevention Act – T1 Water Treatment License/TCPA facilities	NJDEP – Bureau of Release Prevention	N.J.S.A. 13:1K-19 et seq. and the regulations arising from the Act as codified in N.J.A.C. 7:31.	

License, Permit, or Other Required Approval	Responsible Agency	Authority	Relevance and Status
NJDEP - Treatment Works Approval	NJDEP – Division of Water Quality	Process involves assessing the design of new sewer lines and other wastewater conveyance facilities, as well as evaluating wastewater treatment plant design and ability to meet the effluent standards specified in the NJPDES permit for the facility.	Construction
Federal Coastal Zone Management Act (16 USC 1452 et seq.)	NJDEP – Division of Land Use Regulation	Verification of determination that renewal of operating license would be consistent with the NJ Coastal Zone Program.	Construction, Operation
NJDEP - Coastal Area Facility Review Act (CAFRA) Permit	NJDEP – Division of Land Use Regulation	CAFRA regulates all development on beaches and dunes, and development within 46 meters (150 feet) of tidal waters. N.J.S.A. 13:19-1 et seq. Permit	Construction, Operation
NJDEP - Waterfront Development Permit	NJDEP – Division of Land Use Regulation	Encompasses all development at or below the mean high water line in tidal waters of the state. It also stipulates that most developments up to 152 meters (500 feet) from the mean high water line in the Coastal Zone but outside of the CAFRA area, be subject to a permit. (N.J.S.A. 12:5-3)	Facility has both CAFRA and Waterfront Development permits.
NJDEP - Flood Hazard Area Permit	NJDEP – Division of Land Use Regulation	Sets forth requirements governing human disturbance to land and vegetation in the flood hazard area of a regulated water, and the riparian zone of a regulated water. Individual and General Permits, and Permits-by-Rule. (N.J.A.C. 7:13)	Construction, Operation, Maintenance
Wetlands – Freshwater Wetlands Permit	NJDEP – Division of Land Use Regulation	N.J.S.A. 13:19-1, 13:9B-1 and 13:1D-1	
Wetlands – Type “B” Wetlands Permit	NJDEP – Division of Land Use Regulation	N.J.A.C. 13:9A-4	
Storage Tank Registration and Permitting	NJDEP – Site Remediation Program	N.J.A.C. 7:14B	Operation
National Historic Preservation Act Section 106 Authorization to construct with historical / archeological resources	New Jersey State Historic Preservation (SHPO) Office	Requires federal agency issuing license to consider cultural impacts and consult with SHPO. SHPO must concur that license renewal will not affect any sites listed or eligible for listing. (*part of NEPA Process; NRC is lead*)	Construction

License, Permit, or Other Required Approval	Responsible Agency	Authority	Relevance and Status
Well Construction and Maintenance; Sealing of Abandoned Wells - Permits	NJDEP – Division of Water Supply	Requirements for the construction and decommissioning of wells. N.J.A.C. 7:9D et seq.	Operation of well
NJ Natural Heritage Program (Threatened and Endangered Species)	NJDEP – Natural Heritage Program (NHP)	NJ NHP conducts inventories and collects data regarding the State's native biological diversity. This information is stored in the State's Landscape Project.	Possible onsite survey for threatened and endangered species and habitat.
Riparian Grant/Riparian License	NJDEP – Bureau of Tidelands	The grant by the State Tidelands Resource Council of its right to area within the flow of the mean high tide or which was historically flowed by the mean high tide and was artificially filled in without the appropriate consent or permission of the State, as reflected upon the tidal claims map maintained by the N. J. Department of Environmental Protection, Division of Coastal Resources, Bureau of Tidelands.	Needed if additional transmission corridor is proposed.
Grant of Permanent Right-of-Way (N.J.S.A. 23:8A-1 and N.J.S.A. 13:8A-1 et seq.)		Grants permanent right-of-way for transmission line corridors associated with station	
NJDEP - Radiation – X-ray Facility Industrial	NJDEP – Division of Radiation Protection and Release Prevention	Required under the Radiation Protection Act N.J.A.C. 7:28 et seq., N.J.S.A. 26:2D	
NJDEP - Right-to-Know – Pollution Prevention Planning	NJDEP – Pollution Prevention and Community Right to Know	New Jersey Worker and Community Right to Know Act - N.J.S.A.34:5A	This information is used by the public, emergency planners, and first responders to determine the chemical hazards in the community.
NJDEP - Lab Certification – Non-Commercial Environmental Lab	NJDEP – Office of Quality Assurance	Ensures that regulatory decisions made by federal, state, and municipal government agencies are based upon accurate and dependable analytical data N.J.A.C. 7:18	Operation
NJDEP - Hazardous Waste Generator and Treatment, Storage, and Disposal	NJDEP – Compliance and Enforcement	N.J.A.C. 7.26G-6 et seq. – Regulates how hazardous waste is handled, stored and transported.	Construction and Operation

License, Permit, or Other Required Approval	Responsible Agency	Authority	Relevance and Status
Medical Waste Generator Certificate (N.J.A.C. 7:26-38.8)	NJDEP – Division of Solid and Hazardous Waste	Generation of regulated medical waste. Permit expires annually. N.J.A.C. 7:26-3A	Operation
Transport permit for radioactive waste	Department of Transportation	N.J.A.C. 16:49 - Governs the transportation of hazardous materials in the State of New Jersey, regulates the shipping, packaging, marking, labeling, placarding, handling, and transportation of hazardous materials, and, to the maximum extent practicable, conforms to the requirements of the regulations issued by the United States Department of Transportation	Operation
Local			
Delaware River Basin Commission Docket Approval	Delaware River Basin Commission	All public and private project proposed within the Basin that will substantially affect water resources must obtain commission approval. The commission has also established minimum restriction for flood plain development along non-tidal streams in the basin. State and local governments may impose more stringent requirements.	An Environmental Impact Statement (EIS) may be required for plant modification affecting water resources.
Delaware River Basin Commission – Surface Water Permit		Issued for the construction and operation of facilities.	Construction/Operation
Delaware River Basin Commission – Water Use Contract		Water use contract for Delaware River water withdrawal in compliance with D-73-193 CP.	Construction/Operation
Delaware River Basin Commission – Oxygen Demand Wasteload Allocation		Allocation for first stage oxygen demand discharge to Delaware Estuary.	Construction/Operation
Delaware River Basin Commission – Sewage Treatment Plant		Installation of new sewage treatment plant.	Construction
Erosion and Sediment Control Plan	Cumberland - Salem Conservation District	Per the requirements of P.L. 1975, Chapter 251, N.J.S.A. 4:29-39 (Erosion and Sediment Control), must be properly designed, implemented, and available on site for all earth disturbance activities that disturb 464 square meters (5,000 square feet) or more.	Onsite construction land clearing
Conditional Use Approval/Preliminary Site Plan Approval	Lower Alloways Creek Township	Lower Alloways Creek Township Code, Land Development Chapter, Section 5.07B2 -	Needed for any new development

License, Permit, or Other Required Approval	Responsible Agency	Authority	Relevance and Status
Preliminary and Final Site Plan Approval	Lower Alloways Creek Township	Lower Alloways Creek Township Code – Preliminary and Final Site Plan Approval	Needed for any new development
South Carolina Radioactive Waste Transport Permit	South Carolina Department of Health and Environmental Control – Division of Waste Management	South Carolina Radioactive Waste Transportation and Disposal Act (Act No. 429)	Transportation of radioactive waste into the State of South Carolina
Tennessee Radioactive Waste License-for-Delivery	State of Tennessee Department of Environment and Conservation Division of Radiological Health	Tennessee Department of Environment and Conservation Rule 1200-2-10.32	Transportation of radioactive waste into the State of Tennessee

Note: The above list represents a composite of potential permits and approvals needed for an expansion/modification of these facilities. The nature of the project, areas of disturbance, specific quantities of air emissions, water use and discharge, chemical usage, fuel stored, chemical usage and other information will allow for this list to be refined. Note that the NJDEP recommends that developers of new or significantly modified projects perform a "one stop" review such that NJDEP input as to permits and approvals can be obtained early in the project. In addition, permitting timeframes are from the submittal for a permit/approval to the issuance of the final notice to construct. Public participation, political intervention and legal challenges may alter the timeframe for individual permit/approvals.

Appendix D

Consultation Correspondences

D. CONSULTATION CORRESPONDENCES

The Endangered Species Act of 1973, as amended, the Magnuson-Stevens Fisheries Management Act of 1996, as amended; and the National Historic Preservation Act of 1966 as amended require that Federal agencies consult with applicable State and Federal agencies and groups prior to taking action that may affect threatened and endangered species, essential fish habitat, or historic and archaeological resources, respectively. This appendix contains consultation documentation.

Table D-1. Consultation Correspondences. *This is a list of the consultation documents sent between the NRC and other agencies in accordance with the National Environmental Policy Act (NEPA) requirements.*

Author	Recipient	Date of Letter
Delaware Dept. of Natural Resources & Environmental Control (S. Cooksey)	PSEG Nuclear LLC	July 14, 2009 ML101970074
New jersey Dept. of Environmental Protection, Hope Creek station (C. Dolphin)	PSEG Nuclear LLC	October 8, 2009 ML101970076
New Jersey Dept. of Environmental Protection, Salem Units 1 & 2 (C. Dolphin)	PSEG Nuclear LLC	October 8, 2009 ML101970075
U.S. Nuclear Regulatory Commission (B. Pham)	Pocomoke Indian Nation (J. Douglas) [(a)]	November 12, 2009 ML0930901248
U.S. Nuclear Regulatory Commission (B. Pham)	Delaware Division of Historical and Cultural Affairs (T. Slavin)	November 24, 2009 ML0931604446
U.S. Nuclear Regulatory Commission (B. Pham)	Maryland Historical Trust (J. R. Little)	November 24, 2009 ML0931604446
U.S. Nuclear Regulatory Commission (B. Pham)	New Jersey Historic Preservation Office (D. Saunders)	November 24, 2009 ML0931604446
U.S. Nuclear Regulatory Commission (B. Pham)	Pennsylvania Bureau for Historic Preservation (J. Cutler)	November 24, 2009 ML0931604446
U.S. Nuclear Regulatory Commission (B. Pham)	U.S. Fish and Wildlife Service (A. Scherer)	December 23, 2009 ML0933500195
U.S. Nuclear Regulatory Commission (B. Pham)	National Marine Fisheries (P. Kurkul)	December 23, 2009 ML093500057
State of Delaware Historical and Cultural Affairs (J. Larrivee)	U.S. Nuclear Regulator Comission (B.Pham)	January 4, 2010 ML101970071

National Marine Fisheries Service (M. Colligan)	U.S. Nuclear Regulatory Commission (B. Pham)	February 11, 2010 ML101970073
National Marine Fisheries Service (S. Gorski)	U.S. Nuclear Regulatory Commission (B. Pham)	February 23, 2010 ML101970072

[a]Similar letters went to sixteen other Native American Tribes listed in Section 1.8.

D.1 Consultation Correspondence

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

November 12, 2009

Pocomoke Indian Nation
P.O. Box 687
Mount Airy, MD 21771

SUBJECT: SALEM NUCLEAR GENERATING STATIONS, UNITS 1 AND 2, AND HOPE CREEK GENERATING STATION, UNIT 1, LICENSE RENEWAL APPLICATIONS

To Whom It May Concern:

The United States Nuclear Regulatory Commission (NRC) is seeking input for its environmental review of applications from PSEG Nuclear, LLC (PSEG Nuclear) for the renewal of the operating licenses for the Salem Nuclear Generating Station, Units 1 and 2 (SALEM), and Hope Creek Generating Station, Unit 1 (HCGS), located 18 miles south of Wilmington, Delaware. SALEM and HCGS are within a region that may be of interest to your tribe. As described below, the NRC process includes an opportunity for public and inter-governmental participation in the environmental review. We want to ensure that you are aware of our efforts and, pursuant to Title 10 of the *Code of Federal Regulations* Part 51.28(b) (10 CFR 51.28(b)), the NRC invites your tribe to provide input relating to the NRC's environmental review of these applications. In addition, as outlined in 36 CFR 800.8, the NRC plans to coordinate compliance with Section 106 of the National Historic Preservation Act of 1966 through the requirements of the National Environmental Policy Act of 1969.

Under NRC regulations, the original operating license for a nuclear power plant is issued for up to 40 years. The license may be renewed for up to an additional 20 years if NRC requirements are met. The current operating licenses for SALEM, Units 1 and 2, will expire on August 13, 2016 and April 18, 2020, respectively. The current operating license for HCGS, Unit 1, will expire on April 11, 2026. The license renewal applications for SALEM and HCGS, submitted by PSEG Nuclear, were dated August 18, 2009. Notices of acceptance for docketing of the applications for renewal of the facilities' operating licenses were published in the *Federal Register* on October 23, 2009 (SALEM: 74 FR 54854 and HCGS: 74 FR 54856).

The NRC is gathering information for SALEM and HCGS site-specific supplements to its Generic Environmental Impact Statement (GEIS) for License Renewal of Nuclear Plants, NUREG-1437. The supplement will contain the results of the review of the environmental impacts on the area surrounding the SALEM and HCGS sites that are related to terrestrial ecology, aquatic ecology, hydrology, cultural resources, and socioeconomic issues (among others) and will contain a recommendation regarding the environmental acceptability of the license renewal action. Enclosed for your information, are the SALEM and HCGS site description, site boundary map, and transmission line map.

Pocomoke Indian Nation - 2 -

You are invited to submit comments on the supplemental environmental impact statements (SEIS). Comments are due by December 22, 2009. The draft SEIS is anticipated to be issued for public comment by the NRC on September 10, 2010. Your office will also receive a copy of the draft SEIS along with a request for comments.

The license renewal application is publicly available at the NRC Public Document Room (PDR), located at One White Flint North, 11555 Rockville Pike, Rockville, Maryland 20852, or from the NRC's Agencywide Documents Access and Management System (ADAMS). The ADAMS Public Electronic Reading Room is accessible at http://adamswebsearch.nrc.gov/dologin.htm. The accession numbers for the Environmental Reports (ERs) are ML092400532 for SALEM and ML092430484 for HCGS. Persons who do not have access to ADAMS, or who encounter problems in accessing the documents located in ADAMS, should contact the NRC's PDR reference staff by telephone at 1-800-397-4209, or 301-415-4737, or by e-mail at pdr.resource@nrc.gov.

The SALEM and HCGS ERs are also available on the Internet at:
http://www.nrc.gov/reactors/operating/licensing/renewal/applications/salem.html
http://www.nrc.gov/reactors/operating/licensing/renewal/applications/hope-creek.html. In addition, the Salem Free Library, located at 112 West Broadway Avenue, Salem, New Jersey 08079, has agreed to make the applications available for public inspection.

The GEIS assesses the scope and impact of environmental effects that are associated with license renewal at any nuclear power plant site, and can also be found on the NRC's website or at the NRC's PDR.

Please submit any comments that you may have to the Chief, Rulemaking and Directives Branch, Division of Administrative Services, Office of Administration, Mailstop TWB-5B01M, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001. Comments may be submitted to the NRC by e-mail at SalemEIS@nrc.gov and HopeCreekEIS@nrc.gov by December 22, 2009. At the conclusion of the scoping process, the NRC staff will prepare a summary of the significant issues identified and the conclusions reached, and mail a copy to you.

- 3 -

If you have any questions or require additional information, please contact Charles Eccleston, Project Manager, by phone at 301-415-8537 or by e-mail at Charles.Eccleston@nrc.gov, or Donnie Ashley at 301-415-3191 or by e-mail at Donnie.Ashley@nrc.gov.

Sincerely,

/RA/

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

Docket Nos. 50-272, 50-311, and 50-354

Enclosures:
As stated

cc w/encls: See next page

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PUBLIC
RidsNrrDlr Resource
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RdsNrrDlrRer1 Resource
RidsNrrDlrRer2 Resource
RidsOgcMailCenter Resource

DPelton
DAshley
JRobinson
REnnis
MModes, RI
DKern, RI
JBrand, RI
RConte, RI
RBellamy, RI
PBamford, RI
MMcLaughlin, RI

*Identical letters have been sent to: Ramapough Mountain Lenape, Nanticoke Lenni-Lenape Indians of New Jersey, Powhatan Renape Nation, Echota Chickamauga Cherokee Tribe of New Jersey, Osprey Band of Free Cherokees, Unalachtigo Band of the Nanticoke-Lenni Lenape Nation, Nanticoke Indians Association, Inc., Lenape Tribe of Delaware, Piscataway-Conoy Confederacy and Sub-Tribes, Inc., Piscataway Indian Nation, Youghiogheny Shawnee Band, Accohannock Indian Tribe, Nause-Waiwash Tribe, Delaware Nation, Pocomoke Indian Nation, Eastern Lenape Nation of Pennsylvania

ADAMS Accession No.: **ML093090124**

OFFICE	PM:RPB1:DLR	LA:RPOB:DLR	BC:RPB1:DLR
NAME	C. Eccleston	S. Figueroa	B. Pham
DATE	11/09/09	11/06/09	11/12/09

OFFICIAL RECORD COPY

Hope Creek Generating Station and
Salem Nuclear Generating Station,
Unit Nos. 1 and 2

cc:

Mr. Thomas Joyce
President and Chief Nuclear Officer
PSEG Nuclear LLC
One Alloway Creek Neck Road
Hancocks Bridge, NJ 08038

Mr. Dennis Winchester
Vice President - Nuclear Assessment
PSEG Nuclear
P.O. Box 236
Hancocks Bridge, NJ 08038

Mr. Robert Braun
Site Vice President - Salem
PSEG Nuclear LLC
One Alloway Creek Neck Road
Hancocks Bridge, NJ 08038

Mr. George Barnes
Site Vice President - Hope Creek
PSEG Nuclear
P.O. Box 236
Hancocks Bridge, NJ 08038

Mr. Carl Fricker
Vice President - Operations Support
PSEG Nuclear LLC
One Alloway Creek Neck Road
Hancocks Bridge, NJ 08038

Mr. George Gellrich
Plant Manager - Salem
PSEG Nuclear
P.O. Box 236
Hancocks Bridge, NJ 08038

Mr. Larry Wagner
Site Vice President - Hope Creek
PSEG Nuclear LLC
One Alloway Creek Neck Road
Hancocks Bridge, NJ 08038

Mr. James Mallon
Manager - Licensing
PSEG Nuclear
P.O. Box 236
Hancocks Bridge, NJ 08038

Mr. Jeffrie J. Keenan, Esquire
Manager - Licensing
PSEG Nuclear LLC
One Alloway Creek Neck Road
Hancocks Bridge, NJ 08038

Mr. Michael Gaffney
Manager - Hope Creek Regulatory
Assurance
PSEG Nuclear LLC
One Alloway Creek Neck Road
Hancocks Bridge, NJ 08038

Mr. Steven Mannon
Manager - Salem Regulatory Assurance
P.O. Box 236
Hancocks Bridge, NJ 08038

Township Clerk
Lower Alloways Creek Township
Municipal Building, P.O. Box 157
Hancocks Bridge, NJ 08038

Mr. Paul Bauldauf, P.E., Asst. Director
Radiation Protection Programs
NJ Department of Environmental
Protection and Energy, CN 415
Trenton, NJ 08625-0415

Mr. Brian Beam
Board of Public Utilities
2 Gateway Center, Tenth Floor
Newark, NJ 07102

Regional Administrator, Region I
U.S. Nuclear Regulatory Commission
475 Allendale Road
King of Prussia, PA 19406

Hope Creek Generating Station and Salem Nuclear Generating Station, Unit Nos. 1 and 2 - 2 -

cc:

Senior Resident Inspector
Salem Nuclear Generating Station
U.S. Nuclear Regulatory Commission
Drawer 0509
Hancocks Bridge, NJ 08038

Mr. Michael Gallagher
Vice President – License Renewal Projects
Exelon Nuclear LLC
200 Exelon Way
Kennett Square, PA 19348

Mr. Ed Eilola
Plant Manager – Salem
PSEG Nuclear LLC
One Alloway Creek Neck Road
Hancocks Bridge, NJ 08038

Mr. Larry Wagner
Plant Manager – Hope Creek
PSEG Nuclear LLC
One Alloway Creek Neck Road
Hancocks Bridge, NJ 08038

Mr. Paul Davison
Director – Nuclear Oversight
PSEG Nuclear LLC
One Alloway Creek Neck Road
Hancocks Bridge, NJ 08038

Ms. Christine Neely
Director – Regulator Affairs
PSEG Nuclear LLC
One Alloway Creek Neck Road
Hancocks Bridge, NJ 08038

Mr. Ali Fakhar
Manager, License Renewal
PSEG Nuclear LLC
One Alloway Creek Neck Road
Hancocks Bridge, NJ 08038

Mr. William Mattingly
Manager – Salem Regulatory Assurance
PSEG Nuclear LLC
One Alloway Creek Neck Road
Hancocks Bridge, NJ 08038

Mr. Earl R. Gage
Salem County Administrator
Administration Building
94 Market Street
Salem, NJ 08079

Senior Resident Inspector
Hope Creek Generating Station
U.S. Nuclear Regulatory Commission
Drawer 0509
Hancocks Bridge, NJ 08038

SALEM NUCLEAR GENERATING STATION, UNITS 1 AND 2, AND HOPE CREEK GENERATING STATION, UNIT 1, SITE DESCRIPTION

SITE DESCRIPTION

The Salem Nuclear Generating Station, Units 1 and 2 (SALEM), and Hope Creek Generating Station, Unit 1 (HCGS), sites are located on the southern part of Artificial Island on the east bank of the Delaware River in Lower Alloways Creek Township, Salem County, New Jersey. The sites are 15 miles south of the Delaware Memorial Bridge, 18 miles south of Wilmington, Delaware, and 7.5 miles southwest of Salem, New Jersey. The SALEM and HCGS sites each occupy approximately 220 acres and 153 acres within this area, respectively. The distances from the SALEM and HCGS reactor buildings to the site boundary are 4,200 feet and 2,960 feet, respectively. There are no major highways or railroads within approximately seven miles of the sites; the only land access is a road that PSEG Nuclear, LLC constructed to connect with an existing secondary road approximately three miles to the east. Barge traffic has access to the sites by way of the Intracoastal Waterway channel maintained in the Delaware River.

TOPOGRAPHY

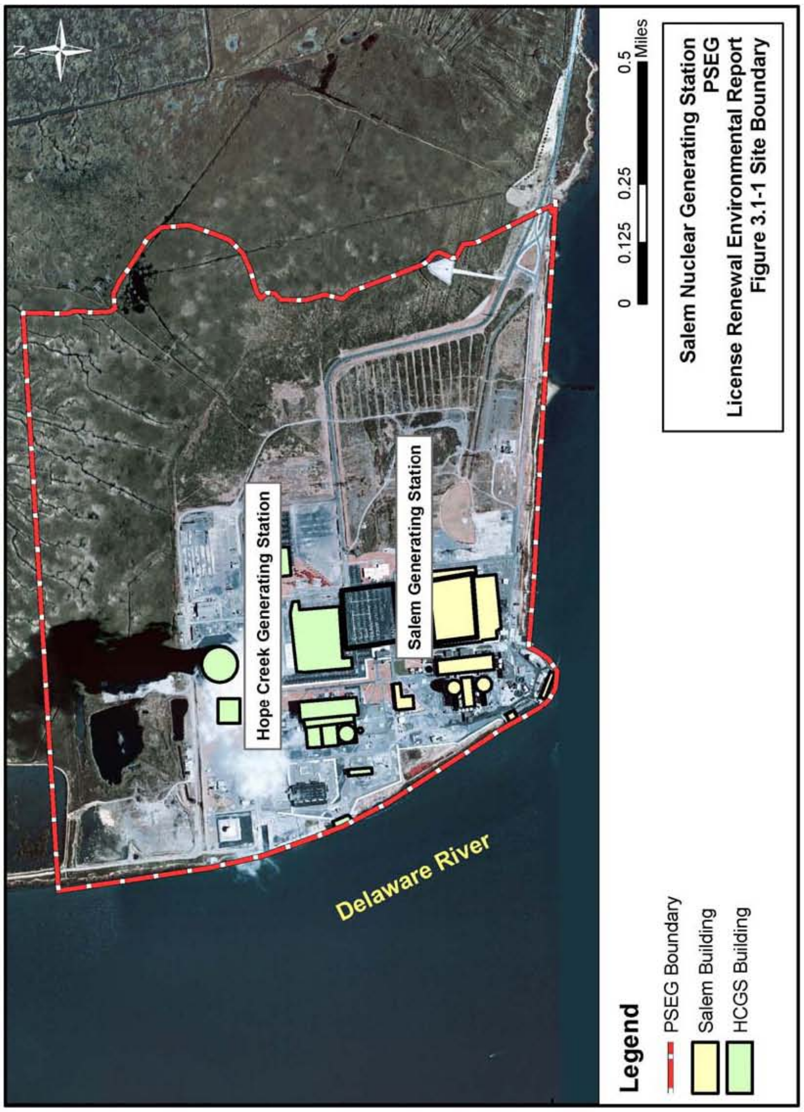
Artificial Island is a 1,500-acre island that was created, beginning early in the twentieth century, when the United States Army Corps of Engineers began disposing of hydraulic dredge spoils within a progressively enlarged diked area established around a natural bar that projected into the river. Habitats on the low and flat island, which has an average elevation of approximately nine feet above mean sea level (msl) and a maximum elevation of about 18 feet above msl, can best be characterized as tidal marsh and grassland.

TRANSMISSION LINE CORRIDORS

Four 500-kV transmission lines extend beyond the site boundary to deliver electricity generated by SALEM and HCGS to the transmission system. One line extends north for 13 miles and then crosses over the New Jersey-Delaware state line. It then continues west over the Delaware River approximately four miles to the Red Lion substation. Two-thirds of the 17-mile corridor is 200 feet wide, and the remainder is 350 feet wide. Another segment of this line extends from the Red Lion substation eight miles northwest to the Keeney switch station. Two-thirds of the corridor is 200 feet wide and the remainder is 350 feet wide. Two lines share a 350 feet-wide corridor that extends approximately 40 miles north to the New Freedom switching station north of Williamstown, New Jersey. One of these lines is divided into two segments by the Orchard substation. The final 500-kV line extends northeast for 42 miles in a 350 feet-wide corridor to the New Freedom substation.

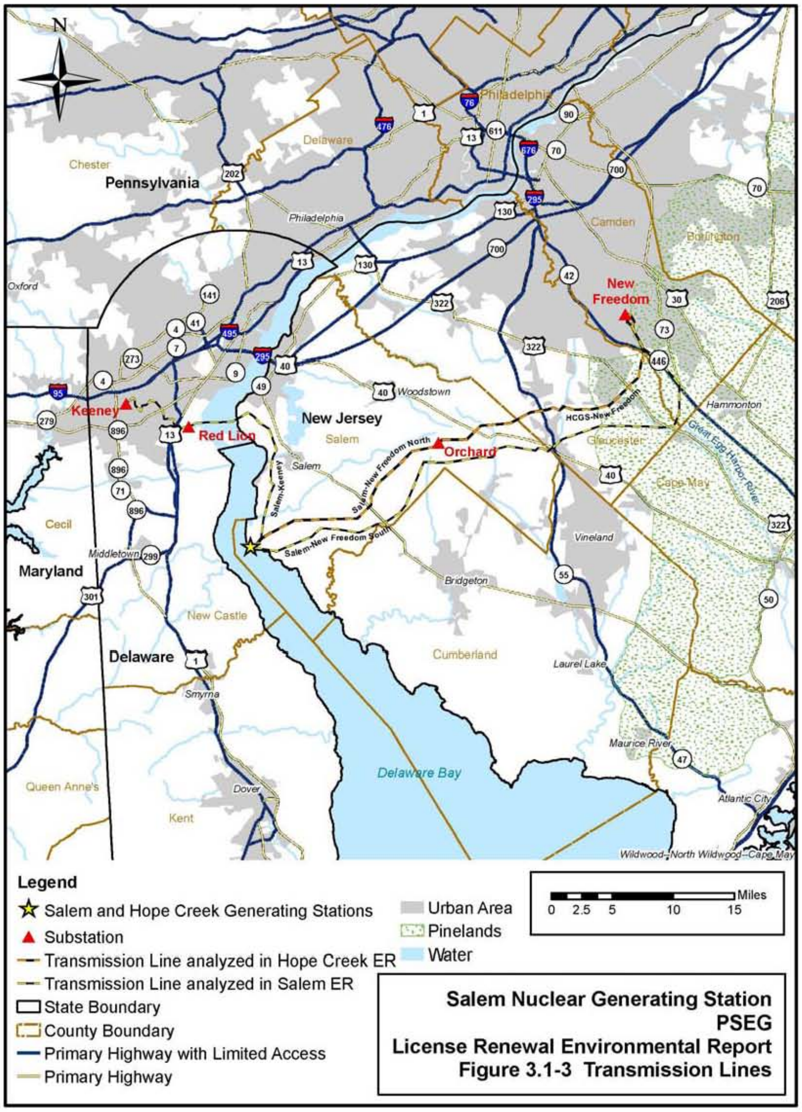
ENCLOSURE 1

SALEM NUCLEAR GENERATING STATION, UNITS 1 AND 2, AND HOPE CREEK GENERATING STATION, UNIT 1, SITE BOUNDARY MAP



ENCLOSURE 2

SALEM NUCLEAR GENERATING STATION, UNITS 1 AND 2, AND HOPE CREEK GENERATING STATION, UNIT 1, TRANSMISSION LINE MAP



ENCLOSURE 3

November 24, 2009

Mr. Timothy A. Slavin, State Historic
Preservation Officer
Delaware Division of Historical and
Cultural Affairs
21 The Green
Dover, DE 19901

SUBJECT: SALEM AND HOPE CREEK LICENSE RENEWAL APPLICATIONS REVIEW

Dear Mr. Slavin:

The United States Nuclear Regulatory Commission (NRC) is seeking input for its environmental review of applications from PSEG Nuclear, LLC (PSEG Nuclear) for the renewal of the operating licenses for the Salem Nuclear Generating Station, Units 1 and 2 (SALEM), and Hope Creek Generating Station, Unit 1 (HCGS), located 18 miles south of Wilmington, Delaware. As described below, the NRC process includes an opportunity for public and inter-governmental participation in the environmental review. We want to ensure that you are aware of our efforts and, pursuant to Title 10 of the *Code of Federal Regulations* Part 51.28(a) (10 CFR 51.28(a)), the NRC invites you to provide input relating to the NRC's environmental review of these applications. In addition, as outlined in 36 CFR 800.8, the NRC plans to coordinate compliance with Section 106 of the National Historic Preservation Act of 1966 through the requirements of the National Environmental Policy Act of 1969.

Under NRC regulations, the original operating license for a nuclear power plant is issued for up to 40 years. The license may be renewed for up to an additional 20 years if NRC requirements are met. The current operating licenses for SALEM, Units 1 and 2, will expire on August 13, 2016 and April 18, 2020, respectively. The current operating license for HCGS, Unit 1, will expire on April 11, 2026. The license renewal applications for SALEM and HCGS, submitted by PSEG Nuclear, were dated August 18, 2009. Notices of acceptance for docketing of the applications for renewal of the facilities' operating licenses were published in the *Federal Register* on October 23, 2009 (SALEM: 74 FR 54854 and HCGS: 74 FR 54856).

The NRC is gathering information for SALEM and HCGS site-specific supplements to its Generic Environmental Impact Statement (GEIS) for License Renewal of Nuclear Plants, NUREG-1437. The supplement will contain the results of the review of the environmental impacts on the area surrounding the SALEM and HCGS sites that are related to terrestrial

T. Slavin - 2 -

ecology, aquatic ecology, hydrology, cultural resources, and socioeconomic issues (among others) and will contain a recommendation regarding the environmental acceptability of the license renewal action. Enclosed for your information, are the SALEM and HCGS site description, site boundary map, 6-mile vicinity, and transmission line map.

You are invited to submit comments on the supplemental environmental impact statements (SEIS). Comments are due by December 22, 2009. The draft SEIS is anticipated to be issued for public comment by the NRC on September 10, 2010. Your office will also receive a copy of the draft SEIS along with a request for comments.

The license renewal application is publicly available at the NRC Public Document Room (PDR), located at One White Flint North, 11555 Rockville Pike, Rockville, Maryland 20852, or from the NRC's Agencywide Documents Access and Management System (ADAMS). The ADAMS Public Electronic Reading Room is accessible at http://adamswebsearch.nrc.gov/dologin.htm. The accession numbers for the Environmental Reports (ERs) are ML092400532 for SALEM and ML092430484 for HCGS. Persons who do not have access to ADAMS, or who encounter problems in accessing the documents located in ADAMS, should contact the NRC's PDR reference staff by telephone at 1-800-397-4209, or 301-415-4737, or by e-mail at pdr.resource@nrc.gov.

The SALEM and HCGS ERs are also available on the Internet at:
http://www.nrc.gov/reactors/operating/licensing/renewal/applications/salem.html
http://www.nrc.gov/reactors/operating/licensing/renewal/applications/hope-creek.html. In addition, the Salem Free Library, located at 112 West Broadway Avenue, Salem, New Jersey 08079, has agreed to make the applications available for public inspection.

The GEIS assesses the scope and impact of environmental effects that are associated with license renewal at any nuclear power plant site, and can also be found on the NRC's website or at the NRC's PDR.

Please submit any comments that you may have to the Chief, Rulemaking and Directives Branch, Division of Administrative Services, Office of Administration, Mailstop TWB 5B01M, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001. Comments may be submitted to the NRC by e-mail at SalemEIS@nrc.gov and HopeCreekEIS@nrc.gov by December 22, 2009. At the conclusion of the scoping process, the NRC staff will prepare a summary of the significant issues identified and the conclusions reached, and mail a copy to you.

If you have any questions or require additional information, please contact Charles Eccleston, Project Manager at 301-415-8537 or by e-mail at Charles.Eccleston@nrc.gov, or Donnie Ashley, Project Manager at 301-415-3191 or by e-mail at Donnie.Ashley@nrc.gov.

Sincerely,

/RA Donnie Ashley for/

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

Docket Nos. 50-272, 50-311, and 50-354

Enclosures:
As stated

cc w/encls: See next page

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DAshley
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REnnis
MModes, RI
JBrand, RI
RConte, RI
RBellamy, RI
PBamford, RI
MMcLaughlin, RI

*Identical letters have been sent to the following State Historic Preservation Offices: Delaware Historic Preservation Office; Maryland Historical Trust; New Jersey Historic Preservation Office; and Pennsylvania Bureau of Historic Preservation

ADAMS Accession No. **ML093160444**

OFFICE	PM:RPB1:DLR	LA:RPOB:DLR	BC:RPB1:DLR
NAME	C. Eccleston	S. Figueroa	B. Pham (D. Ashley for)
DATE	11/23/09	11/23/09	11/24/09

OFFICIAL RECORD COPY

Hope Creek Generating Station and
Salem Nuclear Generating Station,
Units1 and 2

cc:

Mr. Thomas Joyce
President and Chief Nuclear Officer
PSEG Nuclear LLC
One Alloway Creek Neck Road
Hancocks Bridge, NJ 08038

Mr. Dennis Winchester
Vice President - Nuclear Assessment
PSEG Nuclear
P.O. Box 236
Hancocks Bridge, NJ 08038

Mr. Robert Braun
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PSEG Nuclear LLC
One Alloway Creek Neck Road
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PSEG Nuclear LLC
One Alloway Creek Neck Road
Hancocks Bridge, NJ 08038

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PSEG Nuclear
P.O. Box 236
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Board of Public Utilities
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Newark, NJ 07102

Regional Administrator, Region I
U.S. Nuclear Regulatory Commission
475 Allendale Road
King of Prussia, PA 19406

Hope Creek Generating Station and Salem Nuclear Generating Station, Units 1 and 2 - 2 -

cc:

Senior Resident Inspector
Salem Nuclear Generating Station
U.S. Nuclear Regulatory Commission
Drawer 0509
Hancocks Bridge, NJ 08038

Mr. Michael Gallagher
Vice President – License Renewal Projects
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Kennett Square, PA 19348

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One Alloway Creek Neck Road
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One Alloway Creek Neck Road
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One Alloway Creek Neck Road
Hancocks Bridge, NJ 08038

Mr. Earl R. Gage
Salem County Administrator
Administration Building
94 Market Street
Salem, NJ 08079

Senior Resident Inspector
Hope Creek Generating Station
U.S. Nuclear Regulatory Commission
Drawer 0509
Hancocks Bridge, NJ 08038

SITE DESCRIPTION
SALEM NUCLEAR GENERATING STATION, UNITS 1 AND 2, AND HOPE CREEK GENERATING STATION, UNIT 1

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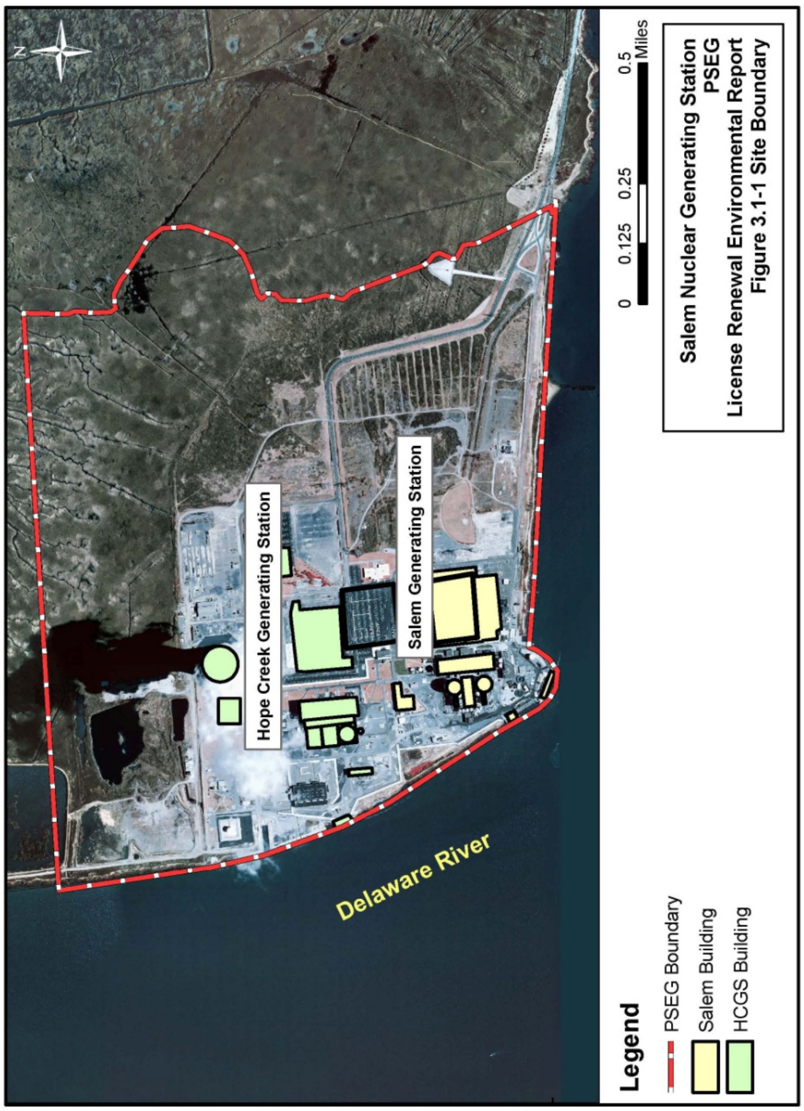
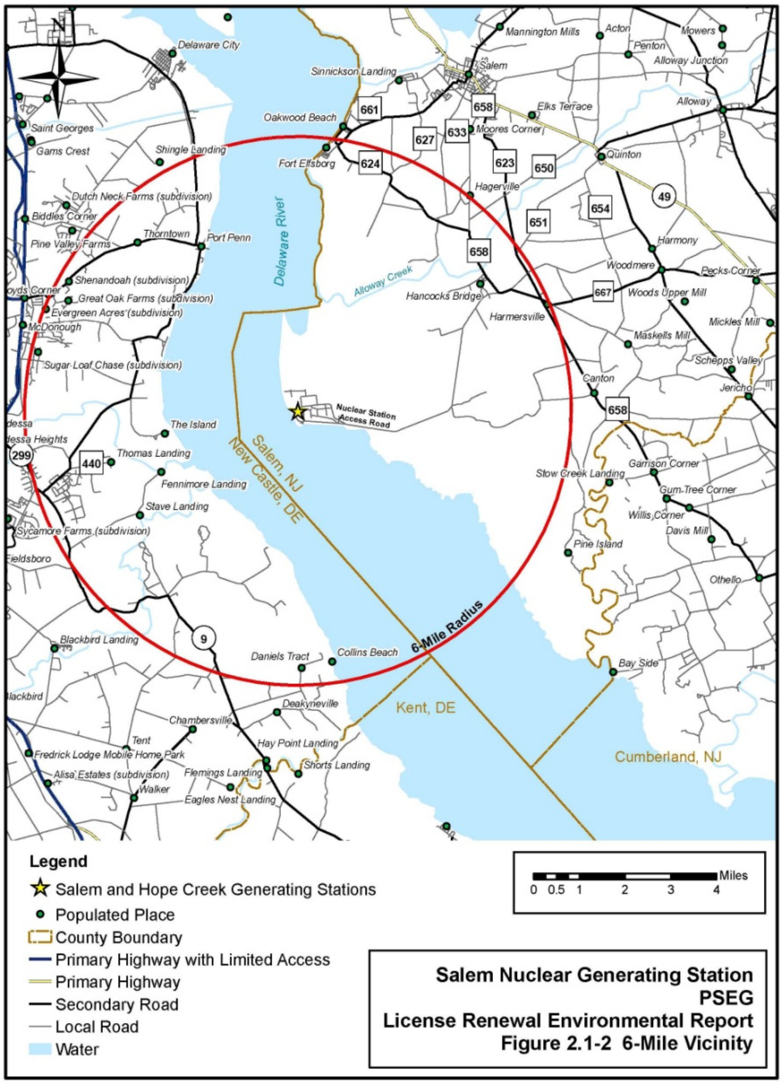
ENCLOSURE 1

SITE BOUNDARY MAP
SALEM NUCLEAR GENERATING STATION, UNITS 1 AND 2, AND
HOPE CREEK GENERATING STATION, UNIT 1



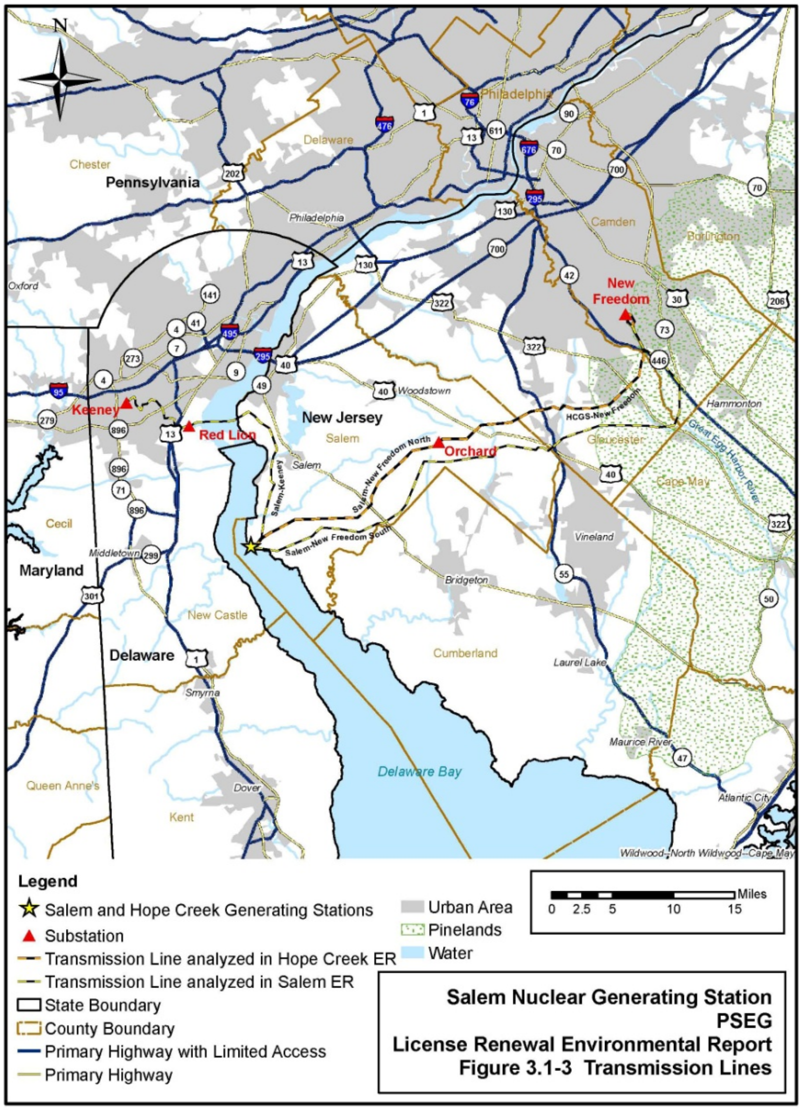
ENCLOSURE 2

6-MILE VICINITY MAP
SALEM NUCLEAR GENERATING STATION, UNITS 1 AND 2, AND
HOPE CREEK GENERATING STATION, UNIT 1



ENCLOSURE 3

TRANSMISSION LINE MAP
SALEM NUCLEAR GENERATING STATION, UNITS 1 AND 2, AND
HOPE CREEK GENERATING STATION, UNIT 1



ENCLOSURE 4

November 24, 2009

Mr. J. Rodney Little, Director and State
Historic Preservation Officer
Maryland Historical Trust
100 Community Place, 3rd Floor
Crownsville, MD 21032-2023

SUBJECT: SALEM AND HOPE CREEK LICENSE RENEWAL APPLICATIONS REVIEW

Dear Mr. Little:

The United States Nuclear Regulatory Commission (NRC) is seeking input for its environmental review of applications from PSEG Nuclear, LLC (PSEG Nuclear) for the renewal of the operating licenses for the Salem Nuclear Generating Station, Units 1 and 2 (SALEM), and Hope Creek Generating Station, Unit 1 (HCGS), located 18 miles south of Wilmington, Delaware. As described below, the NRC process includes an opportunity for public and inter-governmental participation in the environmental review. We want to ensure that you are aware of our efforts and, pursuant to Title 10 of the *Code of Federal Regulations* Part 51.28(a) (10 CFR 51.28(a)), the NRC invites you to provide input relating to the NRC's environmental review of these applications. In addition, as outlined in 36 CFR 800.8, the NRC plans to coordinate compliance with Section 106 of the National Historic Preservation Act of 1966 through the requirements of the National Environmental Policy Act of 1969.

Under NRC regulations, the original operating license for a nuclear power plant is issued for up to 40 years. The license may be renewed for up to an additional 20 years if NRC requirements are met. The current operating licenses for SALEM, Units 1 and 2, will expire on August 13, 2016 and April 18, 2020, respectively. The current operating license for HCGS, Unit 1, will expire on April 11, 2026. The license renewal applications for SALEM and HCGS, submitted by PSEG Nuclear, were dated August 18, 2009. Notices of acceptance for docketing of the applications for renewal of the facilities' operating licenses were published in the *Federal Register* on October 23, 2009 (SALEM: 74 FR 54854 and HCGS: 74 FR 54856).

The NRC is gathering information for SALEM and HCGS site-specific supplements to its Generic Environmental Impact Statement (GEIS) for License Renewal of Nuclear Plants, NUREG-1437. The supplement will contain the results of the review of the environmental impacts on the area surrounding the SALEM and HCGS sites that are related to terrestrial

ecology, aquatic ecology, hydrology, cultural resources, and socioeconomic issues (among others) and will contain a recommendation regarding the environmental acceptability of the license renewal action. Enclosed for your information, are the SALEM and HCGS site description, site boundary map, 6-mile vicinity, and transmission line map.

You are invited to submit comments on the supplemental environmental impact statements (SEIS). Comments are due by December 22, 2009. The draft SEIS is anticipated to be issued for public comment by the NRC on September 10, 2010. Your office will also receive a copy of the draft SEIS along with a request for comments.

The license renewal application is publicly available at the NRC Public Document Room (PDR), located at One White Flint North, 11555 Rockville Pike, Rockville, Maryland 20852, or from the NRC's Agencywide Documents Access and Management System (ADAMS). The ADAMS Public Electronic Reading Room is accessible at http://adamswebsearch.nrc.gov/dologin.htm. The accession numbers for the Environmental Reports (ERs) are ML092400532 for SALEM and ML092430484 for HCGS. Persons who do not have access to ADAMS, or who encounter problems in accessing the documents located in ADAMS, should contact the NRC's PDR reference staff by telephone at 1-800-397-4209, or 301-415-4737, or by e-mail at pdr.resource@nrc.gov.

The SALEM and HCGS ERs are also available on the Internet at:
http://www.nrc.gov/reactors/operating/licensing/renewal/applications/salem.html
http://www.nrc.gov/reactors/operating/licensing/renewal/applications/hope-creek.html. In addition, the Salem Free Library, located at 112 West Broadway Avenue, Salem, New Jersey 08079, has agreed to make the applications available for public inspection.

The GEIS assesses the scope and impact of environmental effects that are associated with license renewal at any nuclear power plant site, and can also be found on the NRC's website or at the NRC's PDR.

Please submit any comments that you may have to the Chief, Rulemaking and Directives Branch, Division of Administrative Services, Office of Administration, Mailstop TWB 5B01M, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001. Comments may be submitted to the NRC by e-mail at SalemEIS@nrc.gov and HopeCreekEIS@nrc.gov by December 22, 2009. At the conclusion of the scoping process, the NRC staff will prepare a summary of the significant issues identified and the conclusions reached, and mail a copy to you.

If you have any questions or require additional information, please contact Charles Eccleston, Project Manager at 301-415-8537 or by e-mail at Charles.Eccleston@nrc.gov, or Donnie Ashley, Project Manager at 301-415-3191 or by e-mail at Donnie.Ashley@nrc.gov.

Sincerely,

/RA Donnie Ashley for/

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

Docket Nos. 50-272, 50-311, and 50-354

Enclosures:
As stated

cc w/encls: See next page

November 24, 2009

Mr. Daniel Saunders, Deputy State
  Historic Preservation Officer
New Jersey Historic Preservation
  Office
401 East State Street
P.O. Box 304
Trenton, NJ 08625-0404

SUBJECT: SALEM AND HOPE CREEK LICENSE RENEWAL APPLICATIONS REVIEW

Dear Mr. Saunders:

The United States Nuclear Regulatory Commission (NRC) is seeking input for its environmental review of applications from PSEG Nuclear, LLC (PSEG Nuclear) for the renewal of the operating licenses for the Salem Nuclear Generating Station, Units 1 and 2 (SALEM), and Hope Creek Generating Station, Unit 1 (HCGS), located 18 miles south of Wilmington, Delaware. As described below, the NRC process includes an opportunity for public and inter-governmental participation in the environmental review. We want to ensure that you are aware of our efforts and, pursuant to Title 10 of the *Code of Federal Regulations* Part 51.28(a) (10 CFR 51.28(a)), the NRC invites you to provide input relating to the NRC's environmental review of these applications. In addition, as outlined in 36 CFR 800.8, the NRC plans to coordinate compliance with Section 106 of the National Historic Preservation Act of 1966 through the requirements of the National Environmental Policy Act of 1969.

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D. Saunders - 2 -

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Please submit any comments that you may have to the Chief, Rulemaking and Directives Branch, Division of Administrative Services, Office of Administration, Mailstop TWB 5B01M, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001. Comments may be submitted to the NRC by e-mail at SalemEIS@nrc.gov and HopeCreekEIS@nrc.gov by December 22, 2009. At the conclusion of the scoping process, the NRC staff will prepare a summary of the significant issues identified and the conclusions reached, and mail a copy to you.

D. Saunders - 3 -

If you have any questions or require additional information, please contact Charles Eccleston, Project Manager at 301-415-8537 or by e-mail at Charles.Eccleston@nrc.gov, or Donnie Ashley, Project Manager at 301-415-3191 or by e-mail at Donnie.Ashley@nrc.gov.

Sincerely,

/RA Donnie Ashley for/

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

Docket Nos. 50-272, 50-311, and 50-354

Enclosures:
As stated

cc w/encls: See next page

November 24, 2009

Ms. Jean Cutler, Deputy State
Historic Preservation Officer
Pennsylvania Bureau for Historic
Preservation
Commonwealth Keystone Building
2nd Floor
400 North Street
Harrisburg, PA 17120-0093

SUBJECT: SALEM AND HOPE CREEK LICENSE RENEWAL APPLICATIONS REVIEW

Dear Mr. Cutler:

The United States Nuclear Regulatory Commission (NRC) is seeking input for its environmental review of applications from PSEG Nuclear, LLC (PSEG Nuclear) for the renewal of the operating licenses for the Salem Nuclear Generating Station, Units 1 and 2 (SALEM), and Hope Creek Generating Station, Unit 1 (HCGS), located 18 miles south of Wilmington, Delaware. As described below, the NRC process includes an opportunity for public and inter-governmental participation in the environmental review. We want to ensure that you are aware of our efforts and, pursuant to Title 10 of the *Code of Federal Regulations* Part 51.28(a) (10 CFR 51.28(a)), the NRC invites you to provide input relating to the NRC's environmental review of these applications. In addition, as outlined in 36 CFR 800.8, the NRC plans to coordinate compliance with Section 106 of the National Historic Preservation Act of 1966 through the requirements of the National Environmental Policy Act of 1969.

Under NRC regulations, the original operating license for a nuclear power plant is issued for up to 40 years. The license may be renewed for up to an additional 20 years if NRC requirements are met. The current operating licenses for SALEM, Units 1 and 2, will expire on August 13, 2016 and April 18, 2020, respectively. The current operating license for HCGS, Unit 1, will expire on April 11, 2026. The license renewal applications for SALEM and HCGS, submitted by PSEG Nuclear, were dated August 18, 2009. Notices of acceptance for docketing of the applications for renewal of the facilities' operating licenses were published in the *Federal Register* on October 23, 2009 (SALEM: 74 FR 54854 and HCGS: 74 FR 54856).

The NRC is gathering information for SALEM and HCGS site-specific supplements to its Generic Environmental Impact Statement (GEIS) for License Renewal of Nuclear Plants, NUREG-1437. The supplement will contain the results of the review of the environmental impacts on the area surrounding the SALEM and HCGS sites that are related to terrestrial

J. Cutler - 2 -

ecology, aquatic ecology, hydrology, cultural resources, and socioeconomic issues (among others) and will contain a recommendation regarding the environmental acceptability of the license renewal action. Enclosed for your information, are the SALEM and HCGS site description, site boundary map, 6-mile vicinity, and transmission line map.

You are invited to submit comments on the supplemental environmental impact statements (SEIS). Comments are due by December 22, 2009. The draft SEIS is anticipated to be issued for public comment by the NRC on September 10, 2010. Your office will also receive a copy of the draft SEIS along with a request for comments.

The license renewal application is publicly available at the NRC Public Document Room (PDR), located at One White Flint North, 11555 Rockville Pike, Rockville, Maryland 20852, or from the NRC's Agencywide Documents Access and Management System (ADAMS). The ADAMS Public Electronic Reading Room is accessible at http://adamswebsearch.nrc.gov/dologin.htm. The accession numbers for the Environmental Reports (ERs) are ML092400532 for SALEM and ML092430484 for HCGS. Persons who do not have access to ADAMS, or who encounter problems in accessing the documents located in ADAMS, should contact the NRC's PDR reference staff by telephone at 1-800-397-4209, or 301-415-4737, or by e-mail at pdr.resource@nrc.gov.

The SALEM and HCGS ERs are also available on the Internet at:
http://www.nrc.gov/reactors/operating/licensing/renewal/applications/salem.html
http://www.nrc.gov/reactors/operating/licensing/renewal/applications/hope-creek.html. In addition, the Salem Free Library, located at 112 West Broadway Avenue, Salem, New Jersey 08079, has agreed to make the applications available for public inspection.

The GEIS assesses the scope and impact of environmental effects that are associated with license renewal at any nuclear power plant site, and can also be found on the NRC's website or at the NRC's PDR.

Please submit any comments that you may have to the Chief, Rulemaking and Directives Branch, Division of Administrative Services, Office of Administration, Mailstop TWB 5B01M, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001. Comments may be submitted to the NRC by e-mail at SalemEIS@nrc.gov and HopeCreekEIS@nrc.gov by December 22, 2009. At the conclusion of the scoping process, the NRC staff will prepare a summary of the significant issues identified and the conclusions reached, and mail a copy to you.

J. Cutler - 3 -

If you have any questions or require additional information, please contact Charles Eccleston, Project Manager at 301-415-8537 or by e-mail at Charles.Eccleston@nrc.gov, or Donnie Ashley, Project Manager at 301-415-3191 or by e-mail at Donnie.Ashley@nrc.gov.

Sincerely,

/RA Donnie Ashley for/

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

Docket Nos. 50-272, 50-311, and 50-354

Enclosures:
As stated

cc w/encls: See next page

December 23, 2009

Ms. Annette Scherer, Senior Fish &
Wildlife Biologist
U.S. Fish and Wildlife Service
New Jersey Field Office
927 North Main Street
Heritage Square, Building D
Pleasantville, NJ 08232

SUBJECT: REQUEST FOR LIST OF PROTECTED SPECIES WITHIN THE AREA UNDER EVALUATION FOR THE SALEM AND HOPE CREEK NUCLEAR GENERATING STATIONS LICENSE RENEWAL APPLICATION REVIEW

Dear Ms. Scherer:

The U.S. Nuclear Regulatory Commission (NRC) is reviewing an application submitted by PSEG Nuclear, LLC for the renewal of the operating licenses for Salem Nuclear Generating Station, Units 1 and 2 (Salem), and Hope Creek Nuclear Generating Station, Unit 1 (HCGS). Salem and HCGS are located in Salem County, New Jersey on the eastern bank of the Delaware River, approximately 7.5 miles (12 km) southwest of Salem, New Jersey. As part of the review of the license renewal application, the NRC is preparing a supplemental environmental impact statement (SEIS) under the provisions of the National Environmental Policy Act of 1969, as amended. The SEIS includes an analysis of pertinent environmental issues, including endangered or threatened species, and fish and wildlife impacts. This letter is being submitted under the provisions of the Endangered Species Act of 1973, as amended, and the Fish and Wildlife Coordination Act of 1934, as amended.

PSEG Nuclear, LLC has stated that it has no plans to alter current operations over the license renewal period. If granted renewed licenses, Salem and HCGS would use existing plant facilities and transmission lines and would not require additional construction or disturbance of new areas. Any maintenance activities would be limited to previously disturbed areas.

The Salem and HCGS sites each encompass approximately 220 and 153 acres, (89 and 62 ha) respectively, on the southern part of Artificial Island. Habitats on the island can best be described as tidal marsh and grassland. Aquatic communities of the Delaware River near Salem and HCGS are directly influenced by the quantity and quality of water in the river, which is the source of makeup water for HCGS's cooling tower and Salem's once-through cooling system. The enclosed map shows the layout of the sites in relation to the surrounding area.

HCGS employs a closed-cycle circulating water system for condenser cooling that consists of a natural draft cooling tower and associated withdrawal, circulation, and discharge facilities. HCGS withdraws brackish water with the service water system from the Delaware Estuary through an intake structure which was designed to control the amount of debris entering the

A. Scherer - 2 -

system. Service water provides cooling to various cooling systems and heat exchangers and is discharged to the cooling tower basin to serve as condenser cooling water makeup to replace the water lost through evaporation and cooling tower blowdown. The system effluent is then discharged into the Delaware Estuary through an underwater conduit.

The Salem units have once-through circulating water systems for condenser cooling that withdraw brackish water from the Delaware Estuary though one intake structure at the south end of the site. Through a separate intake structure, Salem also withdraws brackish water from the Delaware Estuary for use in its service water system. Both the cooling water system and service water system discharge to the river through a common return system.

Four 500-kV transmission lines extend beyond the site boundary to deliver electricity generated by Salem and HCGS to the transmission system. The following is a short description of each transmission line:

- Salem-New Freedom North – This 500 kV line, which is operated by PSE&G, runs northeast from HCGS for 63 km (39 mi) in a 107-m (350-ft) wide corridor to the New Freedom Switching Station north of Williamstown, New Jersey. This line shares the corridor with the 500 kV HCGS-New Freedom line.

- Salem-Red Lion segment of Salem-Keeney – This 500 kV line extends north from HCGS for 21 km (13 mi) and then crosses over the New Jersey-Delaware state line. It then continues west over the Delaware River about 6 km (4 mi) to the Red Lion substation. In New Jersey the line is operated by PSE&G and in Delaware it is operated by Pepco Holdings, Inc (PHI). Two thirds of the 27 km (17 mi) corridor is 61 m (200 ft) wide, and the remainder is 107 m (350 ft) wide.

- Red Lion-Keeney segment of Salem-Keeney – This 500 kV line, which is operated by PHI, extends from the Red Lion substation 13 km (eight mi) northwest to the Keeney switch station. Two thirds of the corridor is 70 m (200 ft) wide, and the remainder is 107 m (350 ft) wide.

- Salem-New Freedom South – This 500 kV line, operated by PSE&G, extends northeast from Salem for 68 km (42 mi) in a 107-m (350-ft) wide corridor from Salem to the New Freedom substation north of Williamstown, New Jersey.

- HCGS-New Freedom – This 500 kV line, operated by PSE&G, extends northeast from Salem for 69 km (43 mi) in a 107-m (350-ft) wide corridor to the New Freedom switching station north of Williamstown, New Jersey. This line shares the corridor with the 500 kV Salem-New Freedom North line. During 2008, a new substation (Orchard) was installed along this line, dividing it into two segments.

A. Scherer - 3 -

To support the SEIS preparation process and to ensure compliance with Section 7 of the Endangered Species Act, the NRC requests a list of species and information on protected, proposed, and candidate species and critical habitat that may be within the vicinity of Salem and Hope Creek and its associated transmission line right-of-way. In addition, please provide any additional information you consider appropriate under the provisions of the Fish and Wildlife Coordination Act. To support the project schedule, we request that this information be transmitted by February 15, 2010.

Your office will receive a copy of the draft SEIS along with a request for comments. The anticipated publication date for the draft SEIS is September 2010. If you would like to submit any comments regarding the scope of this SEIS, or have any questions, please contact Mr. Charles Eccleston, Project Manager at 301-415-8537 or by e-mail at Charles.Eccleston@nrc.gov or Mr. Donnie Ashley, Project Manager at 301-415-3191 or by e-mail at Donnie.Ashley@nrc.gov.

Sincerely,

/RA/

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

Docket Nos. 50-272, 50-311, and 50-354

Enclosures:
1. Salem and Hope Creek Site Description
2. Salem and Hope Creek Site Boundary Map
3. Salem and Hope Creek 6 Mile Vicinity Map
4. Salem and Hope Creek Transmission System

cc w/encls: See next page

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ADAMS Accession No. ML093350019

OFFICE	PM:DLR:RPB1	LA: DLR	PM:DLR:RPB1	BC:RPB1:DLR
NAME	C. Eccleston	S. Figueroa	D. Doyle	B. Pham
DATE	12/22/09	12/22/09	12/23/09	12/23/09

OFFICIAL RECORD COPY

Letter to Andrea Scherer from Bo Pham dated December 23, 2009

UBJECT: REQUEST FOR LIST OF PROTECTED SPECIES WITHIN THE AREA UNDER EVALUATION FOR THE SALEM AND HOPE CREEK NUCLEAR GENERATING STATIONS LICENSE RENEWAL APPLICATION REVIEW

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MModes, RI
JBrand, RI
RConte, RI
RBellamy, RI
PBamford, RI
MMcLaughlin, RI

Hope Creek and Salem Nuclear
Generating Station,
Units. 1 and 2

cc:

Mr. Thomas Joyce
President and Chief Nuclear Officer
PSEG Nuclear LLC
One Alloway Creek Neck Road
Hancocks Bridge, NJ 08038

Mr. Dennis Winchester
Vice President - Nuclear Assessment
PSEG Nuclear
P.O. Box 236
Hancocks Bridge, NJ 08038

Mr. Robert Braun
Site Vice President - Salem
PSEG Nuclear LLC
One Alloway Creek Neck Road
Hancocks Bridge, NJ 08038

Mr. George Barnes
Site Vice President - Hope Creek
PSEG Nuclear
P.O. Box 236
Hancocks Bridge, NJ 08038

Mr. Carl Fricker
Vice President - Operations Support
PSEG Nuclear LLC
One Alloway Creek Neck Road
Hancocks Bridge, NJ 08038

Mr. George Gellrich
Plant Manager - Salem
PSEG Nuclear
P.O. Box 236
Hancocks Bridge, NJ 08038

Mr. Larry Wagner
Site Vice President - Hope Creek
PSEG Nuclear LLC
One Alloway Creek Neck Road
Hancocks Bridge, NJ 08038

Mr. James Mallon
Manager - Licensing
PSEG Nuclear
P.O. Box 236
Hancocks Bridge, NJ 08038

Mr. Jeffrie J. Keenan, Esquire
Manager - Licensing
PSEG Nuclear LLC
One Alloway Creek Neck Road
Hancocks Bridge, NJ 08038

Mr. Michael Gaffney
Manager - Hope Creek Regulatory
Assurance
PSEG Nuclear LLC
One Alloway Creek Neck Road
Hancocks Bridge, NJ 08038

Mr. Steven Mannon
Manager - Salem Regulatory Assurance
P.O. Box 236
Hancocks Bridge, NJ 08038

Township Clerk
Lower Alloways Creek Township
Municipal Building, P.O. Box 157
Hancocks Bridge, NJ 08038

Mr. Paul Bauldauf, P.E., Asst. Director
Radiation Protection Programs
NJ Department of Environmental
Protection and Energy, CN 415
Trenton, NJ 08625-0415

Mr. Brian Beam
Board of Public Utilities
2 Gateway Center, Tenth Floor
Newark, NJ 07102

Regional Administrator, Region I
U.S. Nuclear Regulatory Commission
475 Allendale Road
King of Prussia, PA 19406

Senior Resident Inspector
Salem Nuclear Generating Station
U.S. Nuclear Regulatory Commission
Drawer 0509
Hancocks Bridge, NJ 08038

Hope Creek and Salem Nuclear - 2 -
Generating Station,
Units. 1 and 2

cc:

Mr. Michael Gallagher
Vice President – License Renewal Projects
Exelon Nuclear LLC
200 Exelon Way
Kennett Square, PA 19348

Mr. Ed Eilola
Plant Manager – Salem
PSEG Nuclear LLC
One Alloway Creek Neck Road
Hancocks Bridge, NJ 08038

Mr. Paul Davison
Director – Nuclear Oversight
PSEG Nuclear LLC
One Alloway Creek Neck Road
Hancocks Bridge, NJ 08038

Ms. Christine Neely
Director – Regulator Affairs
PSEG Nuclear LLC
One Alloway Creek Neck Road
Hancocks Bridge, NJ 08038

Mr. Ali Fakhar
Manager, License Renewal
PSEG Nuclear LLC
One Alloway Creek Neck Road
Hancocks Bridge, NJ 08038

Mr. William Mattingly
Manager – Salem Regulatory Assurance
PSEG Nuclear LLC
One Alloway Creek Neck Road
Hancocks Bridge, NJ 08038

Mr. Earl R. Gage
Salem County Administrator
Administration Building
94 Market Street
Salem, NJ 08079

Senior Resident Inspector
Hope Creek Generating Station
U.S. Nuclear Regulatory Commission
Drawer 0509
Hancocks Bridge, NJ 08038

Salem and Hope Creek Site Description

SITE DESCRIPTION

The Salem and Hope Creek sites are located on the southern part of Artificial Island on the east bank of the Delaware River in Lower Alloways Creek Township, Salem County, New Jersey. The sites are 15 miles (mi) south of the Delaware Memorial Bridge, 18 mi south of Wilmington, Delaware, and 7.5 mi southwest of Salem, New Jersey. The Salem and Hope Creek sites each occupy about 220 acres and 153 acres within this area, respectively. The distances from the Salem and Hope Creek reactor buildings to the site boundary are 4,200 feet (ft) and 2,960 ft, respectively. There are no major highways or railroads within about 7 mi of the site; the only land access is a road that PSEG constructed to connect with an existing secondary road about 3 mi to the east. Barge traffic has access to the site by way of the Intracoastal Waterway channel maintained in the Delaware River.

TOPOGRAPHY

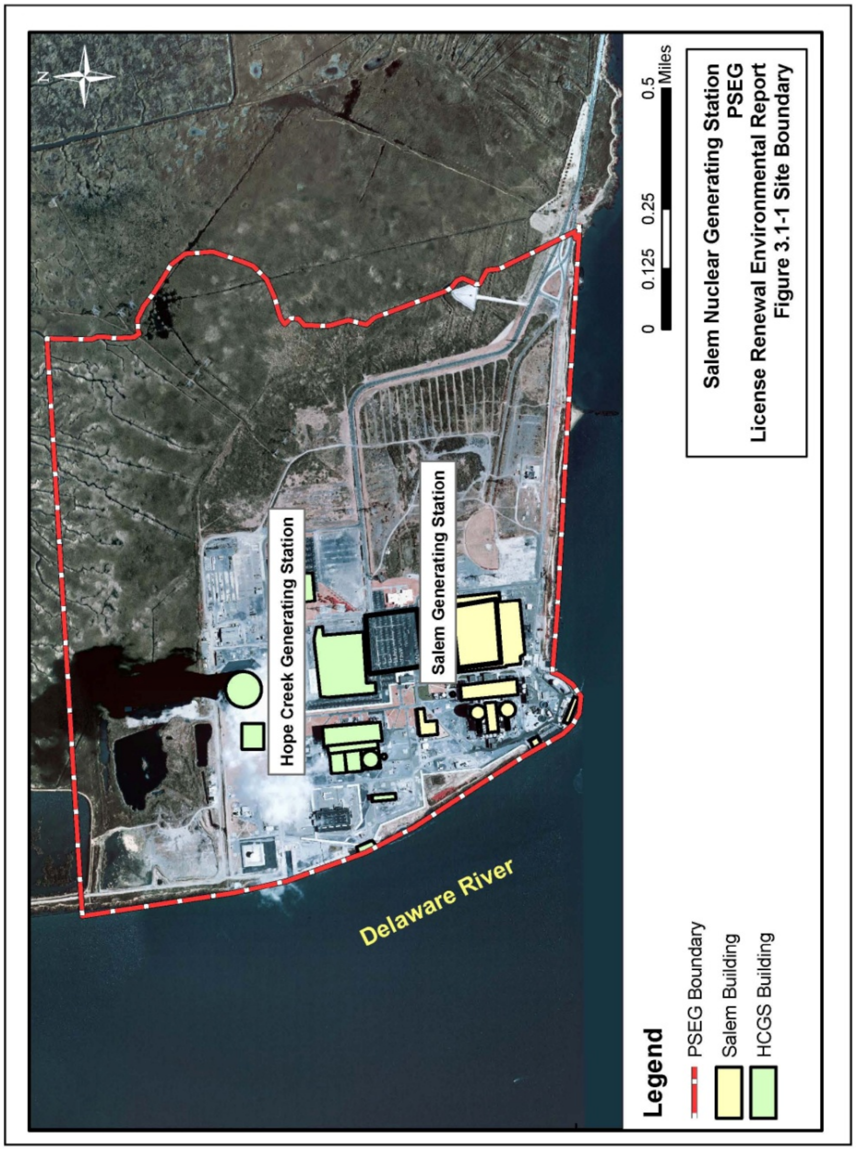
Artificial Island is a 1,500 acre island that was created, beginning early in the twentieth century, when the U.S. Army Corps of Engineers began disposing of hydraulic dredge spoils within a progressively enlarged diked area established around a natural bar that projected into the river. Habitats on the low and flat island, which has an average elevation of about 9 ft above mean sea level (msl) and a maximum elevation of about 18 ft above msl, can best be characterized as tidal marsh and grassland.

TRANSMISSION LINE CORRIDORS

Four 500-kV transmission lines extend beyond the site boundary to deliver electricity generated by Salem and Hope Creek to the transmission system. One line extends north for 13 mi and then crosses over the New Jersey-Delaware state line. It then continues west over the Delaware River about 4 mi to the Red Lion substation. Two thirds of the 17-mi corridor is 200 ft wide, and the remainder is 350 ft wide. Another segment of this line extends from the Red Lion substation 8 mi northwest to the Keeney switch station. Two thirds of the corridor is 200 ft wide, and the remainder is 350 ft wide. Two lines share a 350 ft wide corridor that extends about 40 mi north to the New Freedom switching station north of Williamstown, New Jersey. One of these lines is divided into two segments by the Orchard substation. The final 500-kV line extends northeast for 42 mi in a 350 ft wide corridor to the New Freedom substation.

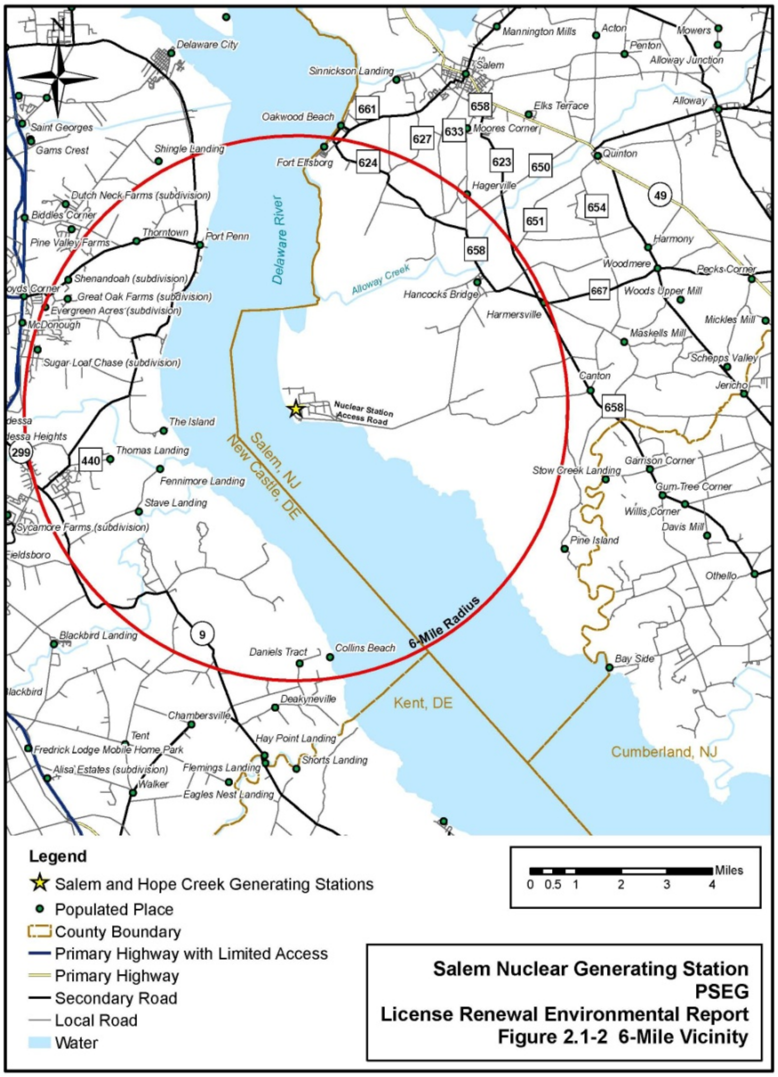
ENCLOSURE 1

Salem and Hope Creek Site Boundary Map



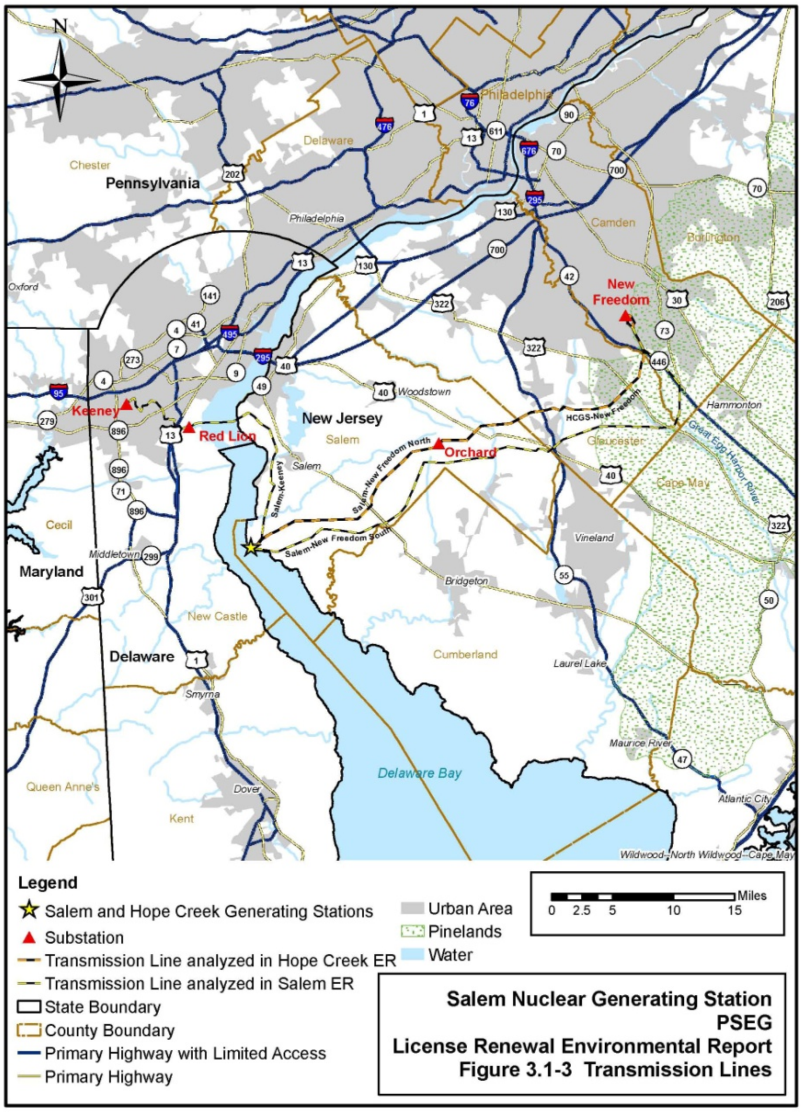
ENCLOSURE 2

Salem and Hope Creek 6 Mile Vicinity Map



ENCLOSURE 3

Salem and Hope Creek Transmission System



ENCLOSURE 4

December 23, 2009

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

SUBJECT: REQUEST FOR LIST OF PROTECTED SPECIES WITHIN THE AREA UNDER EVALUATION FOR THE SALEM AND HOPE CREEK NUCLEAR GENERATING STATIONS LICENSE RENEWAL APPLICATION REVIEW

Dear Ms. Kurkul:

The U.S. Nuclear Regulatory Commission (NRC) is reviewing an application submitted by PSEG Nuclear, LLC for the renewal of the operating licenses for Salem Nuclear Generating Station, Units 1 and 2 (Salem), and Hope Creek Nuclear Generating Station, Unit 1 (HCGS). Salem and HCGS are located in Salem County, New Jersey on the eastern bank of the Delaware River, approximately 7.5 miles (12 km) southwest of Salem, New Jersey. As part of the review of the license renewal application, the NRC is preparing a supplemental environmental impact statement (SEIS) under the provisions of the National Environmental Policy Act of 1969, as amended. The SEIS includes an analysis of pertinent environmental issues, including endangered or threatened species, and fish and wildlife impacts. This letter is being submitted under the provisions of the Endangered Species Act of 1973, as amended, and the Fish and Wildlife Coordination Act of 1934, as amended.

PSEG Nuclear, LLC has stated that it has no plans to alter current operations over the license renewal period. If granted renewed licenses, Salem and HCGS would use existing plant facilities and transmission lines and would not require additional construction or disturbance of new areas. Any maintenance activities would be limited to previously disturbed areas.

The Salem and HCGS sites each encompass approximately 220 and 153 acres, (89 and 62 ha) respectively, on the southern part of Artificial Island. Habitats on the island can best be described as tidal marsh and grassland. Aquatic communities of the Delaware River near Salem and HCGS are directly influenced by the quantity and quality of water in the river, which is the source of makeup water for HCGS's cooling tower and Salem's once-through cooling system. The enclosed map shows the layout of the sites in relation to the surrounding area.

HCGS employs a closed-cycle circulating water system for condenser cooling that consists of a natural draft cooling tower and associated withdrawal, circulation, and discharge facilities. HCGS withdraws brackish water with the service water system from the Delaware Estuary through an intake structure which was designed to control the amount of debris entering the system. Service water provides cooling to various cooling systems and heat exchangers and is discharged to the cooling tower basin to serve as condenser cooling water makeup to replace the water lost through evaporation and cooling tower blowdown. The system effluent is then discharged into the Delaware Estuary through an underwater conduit.

The Salem units have once-through circulating water systems for condenser cooling that withdraw brackish water from the Delaware Estuary though one intake structure at the south end of the site. Through a separate intake structure, Salem also withdraws brackish water from the Delaware Estuary for use in its service water system. Both the cooling water system and service water system discharge to the river through a common return system.

Four 500-kV transmission lines extend beyond the site boundary to deliver electricity generated by Salem and HCGS to the transmission system. The following is a short description of each transmission line:

- Salem-New Freedom North – This 500 kV line, which is operated by PSE&G, runs northeast from HCGS for 63 km (39 mi) in a 107-m (350-ft) wide corridor to the New Freedom Switching Station north of Williamstown, New Jersey. This line shares the corridor with the 500 kV HCGS-New Freedom line.

- Salem-Red Lion segment of Salem-Keeney – This 500 kV line extends north from HCGS for 21 km (13 mi) and then crosses over the New Jersey-Delaware state line. It then continues west over the Delaware River about 6 km (4 mi) to the Red Lion substation. In New Jersey the line is operated by PSE&G and in Delaware it is operated by Pepco Holdings, Inc (PHI). Two thirds of the 27 km (17 mi) corridor is 61 m (200 ft) wide, and the remainder is 107 m (350 ft) wide.

- Red Lion-Keeney segment of Salem-Keeney – This 500 kV line, which is operated by PHI, extends from the Red Lion substation 13 km (eight mi) northwest to the Keeney switch station. Two thirds of the corridor is 70 m (200 ft) wide, and the remainder is 107 m (350 ft) wide.

- Salem-New Freedom South – This 500 kV line, operated by PSE&G, extends northeast from Salem for 68 km (42 mi) in a 107-m (350-ft) wide corridor from Salem to the New Freedom substation north of Williamstown, New Jersey.

- HCGS-New Freedom – This 500 kV line, operated by PSE&G, extends northeast from Salem for 69 km (43 mi) in a 107-m (350-ft) wide corridor to the New Freedom switching station north of Williamstown, New Jersey. This line shares the corridor with the 500 kV Salem-New Freedom North line. During 2008, a new substation (Orchard) was installed along this line, dividing it into two segments.

To support the SEIS preparation process and to ensure compliance with Section 7 of the Endangered Species Act, the NRC requests a list of endangered, threatened, candidate, and proposed species, and designated and proposed critical habitat under the jurisdiction of the National Marine Fisheries Service that may be in the vicinity of the Salem and HCGS sites and their transmission line corridors.

In addition, please provide any information you consider appropriate under the provisions of the Fish and Wildlife Coordination Act. Also, in support of the SEIS preparation and to ensure compliance with Section 305 of the Magnuson-Stevens Fishery Conservation and Management Act, the NRC requests a list of essential fish habitat that has been designated in the vicinity of the Salem and HCGS sites and their associated transmission line corridors. To support the project schedule, we request that this information be transmitted by February 15, 2010.

Your office will receive a copy of the draft SEIS along with a request for comments. The anticipated publication date for the draft SEIS is September 2010. If you would like to submit any comments regarding the scope of this SEIS, or have any questions, please contact Mr. Charles Eccleston, Project Manager at 301-415-8537 or by e-mail at Charles.Eccleston@nrc.gov or Mr. Donnie Ashley, Project Manager at 301-415-3191 or by e-mail at Donnie.Ashley@nrc.gov.

Sincerely,

/RA/

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

Docket Nos. 50-272, 50-311, and 50-354

Enclosures:
1. Salem and Hope Creek Site Description
2. Salem and Hope Creek Site Boundary Map
3. Salem and Hope Creek 6 Mile Vicinity Map
4. Salem and Hope Creek Transmission System

cc w/encls: See next page

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OFFICE	PM:DLR:RPB1	LA:DLR	PM:DLR:RPB1	BC:RPB1:DLR
NAME	C. Eccleston	S. Figueroa	D. Doyle	B. Pham
DATE	12/22/09	12/22/09	12/23/09	12/23/09

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Letter to Patricia Kurkul from Bo Pham dated December 23, 2009

UBJECT: REQUEST FOR LIST OF PROTECTED SPECIES WITHIN THE AREA UNDER EVALUATION FOR THE SALEM AND HOPE CREEK NUCLEAR GENERATING STATIONS LICENSE RENEWAL APPLICATION REVIEW

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

FEB 11 2010

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

Re: Salem and Hope Creek Nuclear Generating Stations License Renewal Review

Dear Mr. Pham,

This is in response to your letter dated December 23, 2009 regarding the Nuclear Regulatory Commission's ongoing review of an application submitted by PSEG Nuclear, LLC for the renewal of the operating licenses for Salem Nuclear Generaing Station, Units 1 and 2 and Hope Creek Nuclear Generaring Station, Unit 1. Salem and Hope Crek are located in Salem County, New Jserey on the eastern bacnk of the Delaware River. The NRC is currently preparing a supplemental environmental impact statement (SEIS) under the provisions of the National Environmental Policy Act of 1969, as amended. In your letter you requested information on the presence of species listed as threatened or endangered by NOAA's National Marine Fisheries Service (NMFS) that may occur in the vicinity of the Salem and Hope Creek generating stations.

NMFS Listed Species in the Action Area
Four species of sea turtles occur seasonally (May – November) in the Delaware River estuary, including the threatened loggerhead (*Caretta caretta*), and endangered Kemp's ridley (*Lepidochelys kempi*), green *(Chelonia mydas*), and leatherback (*Dermochelys coriacea*) sea turtles. Additionally, a population of endangered shortnose sturgeon (*Acipenser brevirostrum*) occurs in the Delaware River. Shortnose sturgeon, loggerhead, Kemp's ridley and green sea turtles have all been documented in the Delaware River near or at the project site. Leatherback sea turtles are less likely to occur near the facility. At this time there is no critical habitat as designated by NMFS in the vicinity of either facility.

Any discretionary federal action that may affect a listed species must undergo consultation pursuant to Section 7 of the Endangered Species Act (ESA) of 1973, as amended. Consultation pursuant to Section 7 of the ESA between NRC and NMFS on the effects of the operation of the existing Salem and Hope Creek facilities has been ongoing since 1979. Most recently, a Biological Opinions (Opinion) was issued by NMFS on May 14, 1993 in which NMFS concluded that the ongoing operation was not likely to jeopardize shortnose sturgeon, Kemp's ridley, green or loggerhead sea turtles. This Opinion was amended by a letter dated January 21, 1999 which made certain modifications to the Incidental Take Statement.

The relicensing of the Salem and Hope Creek Generating Stations by the NRC would be a federal action that will require section 7 consultation. If it is determined through consultation between the NRC and NMFS that the action is likely to adversely affect any listed species (i.e., if any adverse effect to listed species may occur as a direct or indirect result of the proposed action or its interrelated or interdependent actions, and the effects are not: discountable, insignificant, or beneficial) then a formal consultation, resulting in the issuance of a Biological Opinion and accompanying Incidental Take Statement would be required.

Any NEPA documentation prepared by NRC relating to the relicensing of these facilities should contain an assessment of the facility's impact on listed shortnose sturgeon and sea turtles. As shortnose sturgeon and sea turtles have been impinged at the intakes of the existing Salem facility, in the draft SEIS the NRC should consider the potential for future impingement of these species. Additional effects that should be considered by NRC include impingement or entrainment of prey resources, discharge of pollutants, including heated effluent, and effects of the maintenance of shoreline facilities, including dredging.

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

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

My staff looks forward to working with PSEG and NRC as you move forward with the relicensing process. Should you have any questions regarding this correspondence or would like to arrange a meeting to discuss the effects of the proposed action on listed and candidate species, please contact Julie Crocker of my staff at (978)282-8480 or by e-mail (Julie.Crocker@noaa.gov). Questions specific to the status of Atlantic sturgeon should be directed to Lynn Lankshear of my staff at (978)282-8473 or by e-mail (Lynn.Lankshear@noaa.gov). It is my understanding that correspondence from NMFS' Habitat Conservation Division regarding Essential Fish Habitat as designated under the Magnuson-Steven Fisheries Management and Conservation Act as well information related to the Fish and Wildlife Conservation Act will be provided to NRC under separate cover.

Sincerely,

Mary A. Colligan
Assistant Regional Administrator for
Protected Resources

CC: Greene, F/NER4 SH

EC: Crocker, F/NER3

File Code: Sec 7 NRC Salem and Hope Creek Nuclear (Relicensing)
PCTS: T/NER/2010/00335

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE

Habitat Conservation Division
James J. Howard Marine
Sciences Laboratory
74 Magruder Road
Highlands, NJ 07732

February 23, 2010

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

RE: Salem and Hope Creek Nuclear Generating Station License Renewal Review
Salem County, New Jersey

Dear Mr. Pham:

The National Marine Fisheries Service (NMFS) Northeast Region Habitat Conservation Division is in receipt of your letter dated December 23, 2009 regarding the Nuclear Regulatory Commission's (NRC) ongoing review of an application submitted by PSE&G Nuclear, LLC for the renewal of the operating licenses for Salem Nuclear Generating Station, Units 1 and 2 (Salem) and Hope Creek Nuclear Generating Station, Unit 1 (HCNGS). Salem and HCNGS are both located along the Delaware River in an area of Salem County, New Jersey known as Artificial Island. According to your letter, the NRC is currently preparing a supplemental environmental impact statement (SEIS) under the provisions of the National Environmental Policy Act of 1969, as amended. In your letter, you have requested a list of essential fish habitat designated in accordance with Section 305 of the Magnuson Stevens Act (MSA) in the vicinity of the Salem and HCNGS sites as well as any appropriate information under the provisions of the Fish and Wildlife Coordination Act of 1934, as amended.

Magnuson Stevens Fishery Conservation and Management Act (MSA)
Section 305 (b)(2) of the 1996 amendments to the Magnuson-Stevens Fishery Conservation and Management Act (MSA) requires all federal agencies to consult with NOAA Fisheries on any action authorized, funded, or undertaken by that agency that may adversely affect EFH. Included in this consultation process is the preparation of a complete and appropriate EFH assessment to provide necessary information on which to consult. Our EFH regulation at 50 CFR 600.905 mandates the preparation of EFH assessments and generally outlines each agency's obligations in this consultation procedure.

The estuarine portions of the Delaware River and its tributaries including the estuarine areas crossed by the transmission lines have been designated as essential fish habitat (EFH) for a wide variety of species including red hake (*Urophycis chuss*), winter flounder (*Pseudopleuronectes americanus*), windowpane flounder (*Scophthalmus aquosus*), bluefish (*Pomatomus saltatrix*), Atlantic butterfish (*Peprilus triacanthus*), scup (*Stenotomus chrysops*), summer flounder (*Paralichthys dentatus*), scup (*Stenotomus chrysops*), black sea bass (*Centropristis striata*), king mackerel (*Scomberomorus cavalla*), Spanish mackerel (*Scomberomorus maculatus*), cobia

(*Rachycentron canadum*), little skate (*Leucoraja erinacea*), winter skate (*Leucoraja ocellata*) and clearnose skate (*Raja eglanteria*). A more detailed listing of EFH and federally managed species and EFH consultation requirements can be found on our website at: www.nero.nmfs.gov/hcd.

The EFH final rule published in the Federal Register on January 17, 2002 defines an adverse effect as: "any impact which reduces the quality and/or quantity of EFH." The rule further states that:

> An adverse effect may include direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to, benthic organisms, prey species and their habitat and other ecosystems components, if such modifications reduce the quality and/or quantity of EFH. Adverse effects to EFH may result from action occurring within EFH or outside EFH and may include site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions.

In order to complete the required EFH consultation, NRC must submit a full and compete EFH assessment that considers the individual and cumulative and the direct and indirect impacts of the proposed relicensing on EFH, federal managed species and their prey recognizing the definition of adverse impact discussed above. The required contents of an EFH assessment includes: 1) a description of the action; 2) an analysis of the potential adverse effects of the action on EFH and the managed species; 3) the ACOE's conclusions regarding the effects of the action on EFH; 4) proposed mitigation, if applicable. Other information that should be contained in the EFH assessment includes: 1) the results of on-site inspections to evaluate the habitat and site-specific effects; 2) the views of recognized experts on the habitat or the species that may be affected; 3) a review of pertinent literature and related information; and 5) an analysis of alternatives to the action that could avoid or minimize the adverse effects on EFH. Please note that any impacts to prey species of federally managed fish species such as juvenile *Alosids*, bay anchovy (*Anchoa mitchilli*), Atlantic silverside (*Menidia menidia*), striped killifish (*Fundulus majalis*), mummichog (*Fundulus heteroclitus*) and weakfish (*Cynoscion regalis*) would be considered an impact to EFH.

Fish and Wildlife Coordination Act

The Delaware Estuary including its tributaries provides habitat for a wide variety of NOAA trust resources including alewife (*Alosa pseudoharengus*), American eel (*Anguilla rostrata*) American shad (*Alosa sapidissima*), Atlantic croaker (*Micropogonias undulatus*), Atlantic menhaden (*Brevoortia tyrannus*), Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*), blueback herring (*Alosa aestivalis*), bluefish, hickory shad (*Alosa mediocris*), spot (*Leiostomus xanthurus*) tautog (*Tautoga onitis*), weakfish, white perch (*Morone americana*), yellow perch (*Perca flavescens*), striped bass (*Morone saxatilis*), hogchoker (*Trinectes maculatus*), killifish, bay anchovy, silversides, mummichog and may others.

The Delaware River and its tributaries including some of those crossed by the transmission lines, are migratory pathways as well as spawning, nursery and forage habitats for anadromous fishes such as American shad, alewife, blueback herring, white perch and striped bass. Because landing statistics and the number of fish observed on annual spawning runs indicate a drastic decline in alewife and blueback herring populations throughout much of their range since the mid-1960's, they have been designated as species of concern by NMFS in a Federal Register Notice dated October 17, 2006 (71 FRN 61022). "Species of concern" are those species about which NMFS has some concerns regarding status and threats, but for which insufficient information is available to indicate a need to list the species under the Endangered Species Act. NMFS would not support any actions that would disrupt or prevent the upstream migration of anadromous fish, or would reduce or degrade their spawning, nursery or forage habitat.

Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) are also present in the Delaware River. Atlantic sturgeon were listed as a candidate species for listing under the Endangered Species Act (ESA) by NMFS in the Federal Register on published on October 16, 2006 (71 FRN 61002). The term "candidate species" refers to species that are the subject of a petition to list as threatened or endangered and for which NMFS has determined that listing pursuant to section 4 (b) (3) (A) of the ESA may be warranted, and those species are not the subject of a petition but for which NMFS has announced the initiation of a status review in the Federal Register.

The Atlantic Sturgeon Status Review Team (ASSRT) has determined that the Hudson River and Delaware River Atlantic sturgeon stock constitute a distinct population segment (DPS) called the New York Bight DPS. The ASSRT has also concluded that the New York Bight DPS was likely (>50 % chance) to become endangered within the next twenty years. NMFS is currently considering the information in the status report to determine if action under the ESA is warranted. As stated in the February 11, 2010 letter from our Protected Resources Division in Gloucester, MA, Atlantic sturgeon receive no substantive or procedural protection under the Endangered Species Act. However, until a listing decision is made, they remain a NOAA Trust resource under our Fish and Wildlife Coordination Act authorities.

Submerged aquatic vegetation (SAV) including wild celery (*Vallisneria americana*) can be found in some areas of the Delaware River and its tributaries. SAV provides valuable nursery, forage and refuge habitat for a variety of fish including striped bass, American shad, alewife, and blueback herring. It is also an important food source for waterfowl. As water quality in the Delaware River continues to improve, more areas of SAV may be found within the River. To date, there has been no comprehensive mapping of SAV in the Delaware Estuary.

In recent years, efforts have been made to restore oyster beds in Delaware Bay. Since 2004, the Army Corps of Engineers has worked with the States of New Jersey and Delaware to plant shell in portions of natural oyster beds in Delaware Bay. Native oysters are ecologically important species. According to the New Jersey Department of Environmental Protection, an expansive area of habitat has been identified near the Salem and HCNGS.

Blue crab (*Callinectes sapidus*) can also be found in the vicinity of the Salem and HCNGS. The crabs can generally be found in the lower salinity areas of the estuary in the summer and higher salinities in the winter. Following mating in the summer, which typically occurs in lower salinity waters, the females move to high salinity waters to spawn. After spawning, the larvae move toward the lower salinity areas to mature.

Lastly, horseshoe crabs remain a species of concern in the Delaware Estuary. In recent years NMFS has banned fishing for horseshoe crabs in federal waters off the mouth of Delaware Bay. The States of New Jersey and Delaware have also taken steps to restrict the harvest of horseshoe crabs in State waters. The ban provides additional protection for local horseshoe crab stocks and ensures that declining populations of migratory shorebirds have an abundant source of horseshoe crab eggs to feed upon when they stop to rest in Delaware Bay before moving north to their Canadian nesting areas. The shores of the Delaware Bay are an important spawning area for this species.

We look forward to continued coordination with the NRC as it moves forward with the development of the SEIS and the relicensing process. Should you have any questions, need additional information or would life to arrange a meeting to discuss the EFH consultation process or impacts to resources of concern to NMFS, please contact Karen Greene at 732 872-3023.

Sincerely,

Stanley W. Gorski
Field Offices Supervisor

cf: J. Crocker

Appendix E

Chronology of Environmental Review Correspondence

E. Chronology of Environmental Review Correspondence

This appendix contains a chronological listing of correspondence between the U.S. Nuclear Regulatory Commission (NRC) and external parties as part of its environmental review for Salem Nuclear Generating Station and Hope Creek Generating Station. All documents, with the exception of those containing proprietary information, are available electronically from the NRC's Public Electronic Reading Room found on the Internet at the following Web address: http://www.nrc.gov/reading-rm.html. From this site, the public can gain access to the NRC's Agencywide Document Access and Management System (ADAMS), which provides text and image files of NRC's public documents in ADAMS. The ADAMS accession number for each document is included below.

E.1 Environmental Review Correspondence

September 8, 2009	*Federal Register* notice: "Notice of Receipt and Availability of Application for Renewal of Hope Creek Generating Station for an Additional 20-year period". Federal Register, Vol.74. No. 172 (74 FR 46238) (ADAMS Accession No. ML092290801).
September 8, 2009	*Federal Register* notice: "Notice of Receipt and Availability of Application for Renewal of Salem, Units 1 and 2 Facility Operating License Nos. DPR-70 and DPR-75 for an Additional 20-year Period". Federal Register, Vol.74. No. 172, September 8, 2009 (74 FR 46238) (ADAMS Accession No. ML092150718).
September 18, 2009	PSEG Nuclear, Salem Nuclear Generating Station, Units 1 and 2, License Renewal Application (ADAMS Accession No. ML092430232).
September 18, 2009	PSEG Nuclear, Hope Creek Generating Generating Station, Units 1 and 2, License Renewal Application (ADAMS Accession No. ML092430376).
October 15, 2009	Notice of Acceptability for Docketing of the Application and Notice of Opportunity for Hearing Regarding Renewal of Facility Operating License No. NPF-57 for an Additional 20-Year Period, PSEG Nuclear, LLC, Hope Creek Nuclear Generating Station (ADAMS Accession No. ML092780147).
October 15, 2009	Notice of Intent to Prepare an Environmental Impact Statement and Conduct the Scoping Process for Salem Nuclear Generating Station, Units 1 and 2, and Hope Creek Nuclear Generating Station (ADAMS Accession No. ML092740421).
October 23, 2009	Notice of Meeting to Discuss License Renewal Process and Environmental Scoping for Salem Nuclear Generating Station, Units 1 and 2, and Hope Creek Generating Station, License Renewal Application Review (ADAMS Accession No. ML092870635).
October 25, 2009	Notice (email) sent the week of October 25, 2009, notifying the Delaware Tribal Headquarters of the Salem-Hope Creek public Scoping Meeting to be held on November 5, 2010 (ADAMS

	Accession No. ML093090124).
October 25, 2009	Notice (email) sent the week of October 25, 2009, notifying the Ramapough Mountain Lenape (NJ) of the Salem-Hope Creek public Scoping Meeting to be held on November 5, 2010 (ADAMS Accession No. ML093090124).
October 25, 2009	Notice (email) sent the week of October 25, 2009,notifying the Nanticoke Lenni-Lenape Indians of New Jersey of the Salem-Hope Creek public Scoping Meeting to be held on November 5, 2010 (ADAMS Accession No. ML093090124).
October 25, 2009	Notice (email) sent the week of October 25, 2009, notifying the Powhatan Renape Nation (NJ) of the Salem-Hope Creek public Scoping Meeting to be held on November 5, 2010 (ADAMS Accession No. ML093090124).
October 25, 2009	Notice (email) sent the week of October 25, 2009, notifying the Pocomoke Indian Nation (MD) of the Salem-Hope Creek public Scoping Meeting to be held on November 5, 2010 (ADAMS Accession No. ML093090124).
October 25, 2009	Notice (email) sent the week of October 25, 2009, notifying The Nause-Waiwash Band of Indians, Inc. (MD) of the Salem-Hope Creek public Scoping Meeting to be held on November 5, 2010. (ADAMS Accession No. ML093090124).
November 5, 2009	Transcript of Salem & Hope Creek License Renewal Public Meeting, November 05, 2009, Pages 1-79 (ADAMS Accession No. ML093240195).
November 5, 2009	Transcript of Salem and Hope Creek License Renewal Process, Public Meeting: Evening Session November 05, 2009, Pages 1-63 (ADAMS Accession No. ML100471177).
November 5, 2009	Salem/Hope Creek Public Meeting Slides from November 5, 2009 (ADAMS Accession No. ML093380118).
November 12, 2009	Consultation letter to Jerry Douglas, Delaware Tribe of Indians, Delaware Tribal Headquarters, Bartlesville, OK, “Salem Nuclear Generating Stations, Units 1 and 2, and Hope Creek Generation Station, Unit 1, License Renewal Applications” (ADAMS Accession No. ML093090124).
November 24, 2009	Consultation letter to Mr. Timothy A. Slavin, SHPO, Delaware Division of Historical and Cultural Affairs, “Salem and Hope Creek License Renewal Applications Review” (ADAMS Accession No. ML093160444).
November 24, 2009	Consultation letter to Mr. J. Rodney Little, Maryland Historical Trust, “Salem and Hope Creek License Renewal Applications Review” (ADAMS Accession No. ML093160444).

November 24, 2009	Consultation letter to Mr. Daniel Saunders, New Jersey Historic Preservation Office, “Salem and Hope Creek License Renewal Applications Review” (ADAMS Accession No. ML093160444).
November 24, 2009	Consultation letter to Ms. Jean Cutler, Pennsylvania Bureau for Historic Preservation, “Salem and Hope Creek License Renewal Applications Review” (ADAMS Accession No. ML093160444).
December 23, 2009	Consultation letter to Ms. Patricia Kurkul, Regional Administrator, National Marine Fisheries Service Northeast Regional Office, “Request for List of Protected Species within the Area under Evaluation for the Salem and Hope Creek Nuclear Generating Stations License Renewal Application Review” (ADAMS Accession No. ML093500057).
December 23, 2009	Consultation letter to Ms. Annette Scherer, Senior Fish & Wildlife Biologist (Endangered Species), U.S. Fish and Wildlife Service, New Jersey Field Office, “Request for List of Protected Species within the Area under Evaluation for the Salem and Hope Creek Nuclear Generating Stations License renewal Application Review”, (ADAMS Accession No. ML093350019).
April 6, 2010	Salem, Units 1 & 2 - Corrections to the License Renewal Application Environmental Report (ADAMS Accession No. ML100980030).
April 6, 2010	Hope Creek Generating Station - Corrections to the License Renewal Application Environmental Report (ADAMS Accession No. ML100980029).
April 12, 2010	Request for Additional Information Regarding Severe Accident Mitigation Alternatives for Salem Nuclear Generating Station Units 1 and 2 (ADAMS Accession No. ML100910252).
April 16, 2010	Request for Additional Information Regarding The Review of the License Renewal Application for Salem Nuclear Generating Station, Units 1 and 2, and Hope Creek Generating Station (ADAMS Accession No. 100910367).
April 20, 2010	Hope Creek, SAMA Request for Additional Information (RAI) (ADAMS Accession No. ML100840225).

Appendix F

U.S. Nuclear Regulatory Commission Staff Evaluation of Severe Accident Mitigation Alternatives for Salem Nuclear Generating Station Units 1 and 2 In Support of License Renewal Application Review

F. U.S. Nuclear Regulatory Commission Staff Evaluation of Severe Accident Mitigation Alternatives for Salem Nuclear Generating Station Units 1and 2 in Support of License Renewal Application Review

F.1 Introduction

PSEG Nuclear, LLC, (PSEG) submitted an assessment of severe accident mitigation alternatives (SAMAs) for the Salem Nuclear Generating Station (SGS) as part of the environmental report (ER) (PSEG 2009). This assessment was based on the most recent Salem probabilistic risk assessment (PRA) available at that time, a plant-specific offsite consequence analysis performed using the MELCOR Accident Consequence Code System 2 Version 2 (MACCS2) computer code, and insights from the Salem individual plant examination (IPE) (PSEG 1993) and individual plant examination of external events (IPEEE) (PSEG 1996). In identifying and evaluating potential SAMAs, PSEG considered SAMAs that addressed the major contributors to core damage frequency (CDF) and release frequency at SGS, as well as SAMA candidates for other operating plants that have submitted license renewal applications. PSEG initially identified 27 potential SAMAs. This list was reduced to 25 unique SAMA candidates by eliminating SAMAs that are not applicable to Salem due to design differences, have already been implemented at SGS, would achieve the same risk reduction results that had already been achieved at SGS by other means, or have excessive implementation cost. PSEG assessed the costs and benefits associated with each of the potential SAMAs and concluded in the ER that several of the candidate SAMAs evaluated are potentially cost-beneficial.

Based on a review of the SAMA assessment, the U.S. Nuclear Regulatory Commission (NRC) staff issued a request for additional information (RAI) to PSEG by letter dated April 12, 2010 (NRC 2010a) and, based on a review of the RAI responses, a request for RAI response clarification by teleconference dated July 29, 2010 (NRC 2010b). The staff's requests concerned the following:

- discussing internal and external review comments on the PRA model, including the impact of the Pressurized Water Reactor (PWR) Owner's Group PRA peer review comments on the SAMA analysis results;
- clarifying the development bases and assumptions for the Level 2 PRA model;
- additional details on the quality and implementation status of the SGS fire risk model;
- the SAMA screening process and additional potential SAMAs not previously considered; and

- further information on the costs and benefits of several specific candidate SAMAs.

PSEG submitted additional information in response to the NRC request by letters dated May 24, 2010 (PSEG 2010a) and August 18, 2010 (PSEG 2010b). In these response letters, PSEG provided the following:

- a listing of open gaps and "key findings" from the 2008 PRA peer review and an assessment of their impact on the SAMA analysis;
- clarification of Level 2 PRA modeling details and assumptions;
- further details on the SGS fire PRA model;
- analyses of additional SAMAs; and
- additional information regarding several specific SAMAs.

The licensee's responses addressed the NRC staff's concerns.

An assessment of SAMAs for SGS is presented below.

F.2 Estimate of Risk for Salem

PSEG's estimates of offsite risk at SGS are summarized in Section F.2.1. The summary is followed by the NRC staff's review of PSEG's risk estimates in Section F.2.2.

F.2.1 PSEG's Risk Estimates

Two distinct analyses are combined to form the basis for the risk estimates used in the SAMA analysis: (1) the SGS Level 1 and 2 PRA model, which is an updated version of the IPE (PSEG 1993), and (2) a supplemental analysis of offsite consequences and economic impacts (essentially a Level 3 PRA model) developed specifically for the SAMA analysis. The SAMA analysis is based on the most recent SGS Level 1 and Level 2 PRA model available at the time of the ER, referred to as the Salem PRA (Revision 4.1, September 2008 model of record (MOR)). The scope of this Salem PRA does not include external events.

The SGS CDF is approximately 4.8×10^{-5} per year for internal events as determined from quantification of the Level 1 PRA model at a truncation of 1×10^{-11} per year. When determined from the sum of the containment event tree (CET) sequences, or Level 2 PSA model, the release frequency (from all release categories, which consist of intact containment, late release, and early release) is approximately 5.0×10^{-5} per year, also at a truncation of 1×10^{-11} per year. The latter value was used as the baseline CDF in the SAMA evaluations (PSEG 2009). The

CDF is based on the risk assessment for internally initiated events, which includes internal flooding. PSEG did not explicitly include the contribution from external events within the SGS risk estimates; however, it did account for the potential risk reduction benefits associated with external events by multiplying the estimated benefits for internal events by a factor of 2. This is discussed further in Sections F.2.2 and F.6.2.

The breakdown of CDF by initiating event is provided in Table F-1. As shown in this table, events initiated by loss of control area ventilation, loss of offsite power, and loss of service water are the dominant contributors to the CDF. PSEG identified that Station Blackout (SBO) contributes 8×10^{-6} per year, or 17 percent, to the total internal events CDF (PSEG 2010a).

Table F-1. SGS Core Damage Frequency for Internal Events (PSEG 2010a)

Initiating Event	**CDF[1] (per year)**	**% Contribution to CDF[2]**
Loss of Control Area Ventilation	1.8×10^{-5}	37
Loss of Off-site Power (LOOP)	8.1×10^{-6}	17
Loss of Service Water	6.6×10^{-6}	14
Internal Floods	4.5×10^{-6}	9
Transients	4.0×10^{-6}	8
Steam Generator Tube Rupture (SGTR)	2.7×10^{-6}	6
Loss of Component Cooling Water (CCW)	1.0×10^{-6}	2
Anticipated Transient Without Scram (ATWS)	7.4×10^{-7}	2
Loss of 125V DC Bus A	6.9×10^{-7}	1
Others (less than 1 percent each)[3]	1.8×10^{-6}	4
Total CDF (internal events)	$\mathbf{4.8 \times 10^{-5}}$	**100**

[1]Calculated from Fussel-Vesely risk reduction worth (RRW) provided in response to NRC staff RAI 1.e (PSEG 2010a).

[2]Based on Internal Events CDF contribution and total Internal Events CDF.

[3]CDF value derived as the difference between the total Internal Events CDF and the sum of the individual internal events CDFs calculated from RRW.

The Level 2 Salem PRA model that forms the basis for the SAMA evaluation is essentially a complete revision of the original IPE Level 2 model and conforms to current industry guidance. The Level 2 model utilizes a single CET containing both phenomenological and systemic events. The Level 1 core damage sequences are binned into accident classes which provide the interface between the Level 1 and Level 2 CET analysis. The CET is linked directly to the Level 1 event trees and CET nodes are evaluated using supporting fault trees and logic rules.

The result of the Level 2 PRA is a set of 11 release or source term categories, with their respective frequency and release characteristics. The results of this analysis for SGS are provided in Table E.3-6 of ER Appendix E (PSEG 2009). The categories were defined based on the timing of the release, the initiating event, whether feedwater is available, and the containment failure mode. The frequency of each release category was obtained by summing the frequency of the individual accident progression CET endpoints binned into the release category. Source terms were developed for each of the 11 release categories using the results of Modular Accident Analysis Program (MAAP Version 4.0.6) computer code calculations (PSEG 2010a).

The offsite consequences and economic impact analyses use the MACCS2 code to determine the offsite risk impacts on the surrounding environment and public. Inputs for these analyses include plant-specific and site-specific input values for core radionuclide inventory, source term and release characteristics, site meteorological data, projected population distribution (within a 50-mile radius) for the year 2040, emergency response evacuation modeling, and economic data. The core radionuclide inventory corresponds to the end-of-cycle values for SGS operating at 3632 MWt, which is five percent above the current licensed power level of 3,459 MWt. The magnitude of the onsite impacts (in terms of clean-up and decontamination costs and occupational dose) is based on information provided in NUREG/BR-0184 (NRC 1997a).

In the ER, PSEG estimated the dose to the population within 80-kilometers (50-miles) of the SGS site to be approximately 0.78 person-Sievert (Sv) (78 person-roentgen equivalent man (rem)) per year. The breakdown of the total population dose by containment release mode is summarized in Table F-2. Containment bypass events (such as SGTR-initiated large early release frequency (LERF) accidents) and late containment failures without feedwater dominate the population dose risk at SGS.

Table F-2. Breakdown of Population Dose by Containment Release Mode

Containment Release Mode	Population Dose (Person-Rem[1] Per Year)	Percent Contribution[2]
Containment over-pressure (late)	42.9	55
Steam generator rupture	31.9	41
Containment isolation failure	2.3	3
Containment intact	0.2	<1
Interfacing system LOCA	0.6	<1
Catastrophic isolation failure	0.4	<1
Basemat melt-through (late)	negligible	negligible
Total[3]	**78.2**	**100**

[1]One person-rem = 0.01 person-Sv
[2]Derived from Table E.3-7 of the ER (PSEG 2009)
[3]Column totals may be different due to round off.

F.2.2 Review of PSEG's Risk Estimates

PSEG's determination of offsite risk at the SGS is based on the following three major elements of analysis:

- the Level 1 and 2 risk models that form the bases for the 1993 IPE submittal (PSEG 1993), and the external event analyses of the 1996 IPEEE submittal (PSEG 1996),
- the major modifications to the IPE model that have been incorporated in the SGS PRA, including a complete revision of the Level 2 risk model, and
- the MACCS2 analyses performed to translate fission product source terms and release frequencies from the Level 2 PRA model into offsite consequence measures (essentially this equates to a Level 3 PRA).

Each of these analyses was reviewed to determine the acceptability of the SGS's risk estimates for the SAMA analysis, as summarized below.

The NRC staff's review of the SGS IPE is described in an NRC report dated March 21, 1996 (NRC 1996). Based on a review of the original IPE submittal, responses to RAIs, and a revised IPE submittal, the NRC staff concluded that the IPE submittal met the intent of GL 88-20

(NRC 1988); that is, the licensee's IPE process is capable of identifying the most likely severe accidents and severe accident vulnerabilities. Although no vulnerabilities were identified in the IPE, three improvements to plant and procedures were identified. Two of the improvements were revising SGS procedures related to interfacing systems loss of coolant accidents (ISLOCA) and the third was to install an isolation valve in the demineralized water line to be used to prevent flooding in the relay and switchgear rooms. All of these improvements are stated to have been implemented (PSEG 2009).

There have been eight revisions to the IPE model since the 1993 IPE submittal. A listing of the major changes made to the SGS PRA since the original IPE submittal was provided in the ER (PSEG 2009) and in response to an RAI (PSEG 2010a) and is summarized in Table F-3. A comparison of the internal events CDF between the 1993 IPE and the current PRA model indicates an increase of about 25 percent in the total CDF (from 6.4×10^{-5} per year to 4.8×10^{-5} per year).

Table F-3. SGS PRA Historical Summary (PSEG 2009)

PRA Version	Summary of Changes from Prior Model[2]	CDF[1] (per year)
1993	IPE Submittal	6.4×10^{-5}
Model 1.0 8/1996	- Updated plant and common cause data	5.1×10^{-5}
Model 2.0 8/1998	- Enhanced the service water system and reactor coolant pump (RCP) seal models - Added anticipated transients without trip (ATWT) mitigation system actuation circuitry (AMSAC) and valves for containment isolation system - Eliminated switchgear ventilation as a support system - Added ISLOCA logic	5.2×10^{-5}
Model 3.0 6/2002	- Incorporated resolution of 2001 Westinghouse Owner's Group (WOG) PRA certification comments - Added switchgear ventilation as a support system - Addressed HRA dependency issues, updated common-cause calculations, and adjusted initiating event fault tree logic - Modified how recovery actions were credited	5.2×10^{-5}
Model 3.1 7/2003	- Revised system models for charging pumps, emergency diesel generator (EDG), and AMSAC - Revised models for feedwater line break and steam-line break initiators - Added human actions to close the service water turbine header isolation valve(s)	4.1×10^{-5}
Model 3.2 3/2005	- Enhanced the internal flooding and offsite power recovery models - Revised models for the switchyard and service water crosstie between units	2.5×10^{-5}

PRA Version	Summary of Changes from Prior Model[2]	CDF[1] (per year)
	- Revised common cause failure data - Adjusted the auxiliary feedwater (AFW) pump failure rate	
Model 3.2a[3] 3/2006	- Removed recovery from loss of switchgear ventilation and for loss of primary coolant system (PCS) when the initiator causes loss of PCS - Removed credit for 1) cross-tying the Unit 2 positive displacement pump (PDP) with Unit 1, 2) cross-tying DC power supplies to power-operated relief valves (PORVs), 3) cross-tying power to diesel fuel oil transfer pumps, and 4) repair of failed EDGs - Updated the split fraction for a seal LOCA after loss of cooling - Reduced credit for 1) use of the gas turbine generator in several sequences, 2) use of a condensate pump for steam generator makeup, 3) an action to preserve service water availability, and 3) switching from the volume control tank (VCT) to the refueling water storage tank (RWST) - Removed unavailability of both trains of residual heat removal (RHR) - Revised operator actions for maintaining AFW suction source - Changed the loss of DC power initiator - Revised numerous human error probabilities - Added new failure mode for component cooling system (CCS) - Revised modeling of stuck open PORV for SBO and very small LOCA (VSLOCA) sequences - Revised model to require recovery following loss of CCW and failure to swap charging suction to the RWST - Changed split fractions in service water logic	6.2×10^{-5}
Model 4.0[3] 3/2008	- Completely revised and updated the human reliability analysis (HRA) - Updated failure and common-cause data - Updated model to better reflect post small LOCA operator actions - Updated model for loss of control area ventilation (CAV) initiator - Corrected model to have EDG C fail when EDGs A and B or their associated fuel oil transfer pumps fail - Updated the service water system and reactor coolant pump (RCP) seal system models - Reduced credit for use of GTG during grid-related LOOPs - Updated modeling of DC dependencies	4.5×10^{-5}
Model 4.1 9/2008	- Completely revised the SGS internal flooding analysis - Updated model for charging pump upon failure to operate minimum flow valves - Refined the HRA analyses for SGTR events	4.8×10^{-5}

[1]The IPE, Model 1.0, and Model 2.0 SGS PRAs were performed for both Units 1 and 2; the CDF values shown for these PRA versions are for the SGS unit having the highest internal events and internal flooding CDFs. Starting with Model 3.0, the SGS PRA was performed for Unit 1 only.

[2]Summarized from information provided in the ER and a response a NRC staff RAI (PSEG 2010).

[3]The internal flooding contribution is not included in the reported CDF.

The CDF values from the 1993 IPE (6.4×10^{-5} per year for Unit 1 and 6.0×10^{-5} per year for Unit 2) are in the middle range of the CDF values reported in the IPEs for Westinghouse four-loop plants. Figure 11.6 of NUREG-1560 shows that the IPE-based total internal events CDF for Westinghouse four-loop plants ranges from 2×10^{-6} per year to 2×10^{-4} per year, with an average CDF for the group of 6×10^{-5} per year (NRC 1997b). It is recognized that other plants have updated the values for CDF subsequent to the IPE submittals to reflect modeling and hardware changes. The current internal events CDF results for SGS (4.8×10^{-5} per year) are comparable to that for other plants of similar vintage that have updated their models to reflect completed hardware changes.

PSEG explained in the ER that the Salem PRA model is representative of Unit 1, that differences in system configuration and success criteria between Units 1 and 2 are minimal, and that plant-specific data are averaged between the two units. In response to an NRC staff RAI (PSEG 2010a), PSEG further clarified that there are currently no differences between Units 1 and 2 that are believed to be important from a risk perspective. The specific design differences are 1) the recirculation switchover on unit 1 is strictly manual whereas on Unit 2 it is semi-automatic and 2) one component cooling heat exchanger on Unit 1 is of a different design than its counterpart on Unit 2. PSEG also stated that future plant modifications that make the risk profile significantly different between the two units will be addressed by the PRA maintenance and update process. The NRC staff concurs that these design differences between Units 1 and 2 are not likely to impact the results of the SAMA evaluation and that use of Revision 4.1 of the Salem PRA model to represent Unit 2 is reasonable.

The NRC staff considered the peer reviews performed for the SGS PRA, and the potential impact of the review findings on the SAMA evaluation. In the ER (PSEG 2009) and in response to an NRC staff RAI (PSEG 2010a), PSEG described two industry peer reviews of the SGS PRA. The first, conducted by the Westinghouse Owners Group in February 2002, reviewed PRA Model Revision 3.2a. The second, conducted by the PWR Owners Group in November 2008, reviewed PRA Model Revision 4.1.

PSEG stated in the ER that all Level A and B (extremely important and important, respectively) facts and observations (F&Os) from the Westinghouse Owners Group peer review have been addressed (PSEG 2009).

The 2008 peer review of Model Revision 4.1 was performed using the Nuclear Energy Institute peer review process (NEI 2007) and the ASME PRA Standard (ASME 2005) as endorsed by the NRC in Regulatory Guide 1.200, Rev. 1 (NRC 2007). The final report for this peer review had not been completed when the SAMA analysis was performed. In response to an NRC staff RAI, PSEG provided a listing and discussion of eight “key” findings from the 2008 PWR Owners Group peer review (PSEG 2010a). A finding is an observation that is necessary to address to ensure 1) the technical adequacy of the PRA, 2) the capability/robustness of the PRA update process, and 3) the process for evaluating the necessary capability of the PRA technical elements (NEI 2007). Four of the findings were determined to have no impact on the SAMA analysis because it was either a documentation issue (one finding), the current treatment in the PRA model was determined to be conservative (one finding), the finding was determined to be in conflict with other requirements in the PRA standard which were met by the PRA (one finding), or no change to the model was determined to be necessary based on additional analysis (one finding). The other four findings were determined to have a non-significant impact on the SAMA analysis for the following reasons:

- Component availability did not include a contribution from surveillance testing. PSEG explained that component availability is based on Mitigating Systems Performance Index (MSPI) and Maintenance Rule data, which is believed to be accurate, and that any changes in failure rates resulting from a comparison of this data with expected unavailability due to test procedures and maintenance is expected to be non-significant.

- Events that occurred at conditions other than at-power operation or which resulted in controlled shutdown were not considered. PSEG explained that identification of initiating events did include a review of events other than at-power operations and that events occurring during shutdowns and non-power conditions which could have occurred at power were not excluded from the review.

- The SBO success paths following offsite power recovery do not address recovery and operation of required safety systems. PSEG explained that the likelihood of loss of offsite power (LOOP), followed by station blackout (SBO), followed by successful recovery of offsite power, and then followed by multiple equipment failures preventing long-term safe shutdown is very small and that, therefore, the current treatment of SBO is sufficient for the SAMA analysis.

- Omission of failure modes for the EDGs due to the use of only MSPI data and not all plant-specific data. PSEG explained that component availability is based on MSPI and Maintenance Rule data, which is believed to be reliable, and that any changes in failure rates resulting from a validation with other plant-specific data is expected to be non-significant.

In response to another NRC staff RAI to describe the results of the 2008 Peer Review, including the key findings, PSEG provided a listing and discussion of the resolution of the 72 supporting requirements (SRs) that did not meet Capability Category II or higher and that remain open in SGS PRA MOR Revision 4.3 (PSEG 2010b). The 2005 ASME PRA standard describes Capability Category II is described as follows: 1) the scope and level of detail has resolution and specificity sufficient to identify the relative importance of significant contributors at the component level including human actions, as necessary, 2) plant-specific data/models used for significant contributors, and 3) departures from realism will have small impact on the conclusions and risk insights as supported by good practices (ASME 2005). PSEG evaluated each of the 72 SRs for impact on the SAMA evaluation and concluded the following:

- Sixty-three SRs were documentation issues and have no impact on the SAMA analysis.
- Three issues related to plant specific and similar plants' initiating events, and consistency of nomenclature for failure data were determined to have no impact on the SAMA analysis because: 1) the finding is principally a documentation issue and the one event cited by the peer reviewer as being mis-classified was determined by PSEG to be appropriately classified (SR IE-A3), 2) PSEG determined that they made appropriate approximations for certain component/failure models where data were lacking (SR SY-A21), and 3) the finding has to do with a conservative modeling issue that does not impact the SAMA analysis (SR IE-C3).
- Six issues related to loss of an AC bus, grouping of initiating events, one particular human action, and miscalibration of standby equipment were determined to have minimal impact on the SAMA analysis because: 1) the referenced event is bounded by the current PRA model (SR IE-A1), 2) the issue relates to how initiating events are grouped (SRs IE-B3 and AS-A5), 3) the issue impacts only one specific human failure event (HFE) (SR SY-A16), or 4) the un-modeled pre-initiator human errors are viewed as having a low risk contribution (SRs HR-C3 and SY-B16).

PSEG further states that, overall, resolution of the SRs will have a minimal impact on the SAMA evaluation and is well within the uncertainty analysis discussed in Section F.6.2, and that all of the identified SRs that did not meet Capability Category II or higher will be reviewed for consideration during the next periodic update of the PRA model.

Based on the staff's review with respect to the requirements of the ASME PRA standard, the NRC staff considers PSEG's disposition of the peer review findings to be reasonable and that final resolution of the findings is not likely to impact the results of the SAMA analysis.

PSEG also stated that there have not been any further reviews of the SGS internal events PRA since the 2008 peer review of PRA Model Revision 4.1.

The NRC staff asked PSEG to identify any changes to the plant, including physical and procedural modifications, since Revision 4.1 of the Salem PRA model that could have a significant impact on the results of the SAMA analysis (NRC 2010). In response to the RAI (PSEG 2010a), PSEG explained that one design change and one procedural change have been made since PRA Model Revision 4.1 that have the potential to significantly change the PRA results. The design change allows the use of two small non-engineered safety feature (ESF) diesel generators to provide power for control and operation of switchyard breakers and to provide a backup source of power to station battery chargers. The procedure change included new procedural steps to provide forced flow of large quantities of outside air to areas supplied by the control area ventilation system. These plant changes resulted in a reduction in the SGS CDF. While the CDF for the updated SGS PRA model, designated as model of record Revision 4.3, was not provided in the RAI response, PSEG did provide the updated SGS release frequency of 2.2×10^{-5} per year, which is more than a 50 percent reduction from the 5.0×10^{-5} per year used in the SAMA analysis. The impact of this change on the SAMA analysis is discussed in Sections F.3.2 and F.6.2.

In the ER, PSEG explains that, in addition to peer reviews, other measures to ensure, validate, and maintain the quality of the SGS PRA include a formal qualification program for PRA staff, use of procedural guidance to perform PRA tasks, and a program to control PRA models and software. PSEG concludes that based on this quality control process, use of PRA Model Revision 4.1 for the SAMA evaluation was deemed appropriate.

Given that the PSEG internal events PRA model has been peer-reviewed and the peer review findings were judged to have minimal impact on the results of the SAMA analysis, and that PSEG has satisfactorily addressed NRC staff questions regarding the PRA, the NRC staff concludes that the internal events Level 1 PRA model is of sufficient quality to support the SAMA evaluation.

As indicated above, the current SGS PRA does not include external events. In the absence of such an analysis, PSEG used the SGS IPEEE to identify the highest risk accident sequences and the potential means of reducing the risk posed by those sequences, as discussed below and in Section F.3.2.

The SGS IPEEE was submitted in November 1995 (PSEG 1996), in response to Supplement 4 of Generic Letter 88-20 (NRC 1991a). The submittal included a seismic PRA, a fire PRA, and a screening analysis for other external events. While no fundamental weaknesses or vulnerabilities to severe accident risk in regard to the external events were identified, several potential enhancements were identified as discussed below. In a letter dated May 21, 1999, (NRC 1999) NRC staff concluded that the submittal met the intent of Supplement 4 to Generic Letter 88-20, and that the licensee's IPEEE process is capable of identifying the most likely severe accidents and severe accident vulnerabilities.

The SGS IPEEE seismic analysis utilized a seismic PRA following NRC guidance (NRC 1991a). The seismic PRA included: a seismic hazard analysis, a seismic fragility assessment, a seismic systems analysis, and quantification of seismic CDF.

The seismic hazard analysis estimated the annual frequency of exceeding different levels of ground motion. Seismic CDFs were determined for both the EPRI (EPRI 1989) and the Laurence Livermore National Laboratory (LLNL) (NRC 1994) hazard assessments. The seismic fragility assessment utilized the walkdown and screening procedures in EPRI's seismic margin assessment methodology (EPRI 1991). Fragility calculations were made for about 100 components and, using a screening criteria of median peak ground acceleration (pga) of 1.5 g which corresponds to a 0.5 pga high confidence low probability of failure (HCLPF) capacity, a total of 27 components remained after screening. The seismic systems analysis defined the potential seismic induced structure and equipment failure scenarios that could occur after a seismic event and lead to core damage. The SGS IPE event tree and fault tree models were used as the starting point for the seismic analysis but an explicit seismic event tree (SET) was used to delineate the potential successes and failures that could occur due to a seismic event. Quantification of the seismic models consisted of considering the seismic hazard curve with the appropriate structural and equipment seismic fragility curves to obtain the frequency of the seismic damage state. The conditional probability of core damage given each seismic damage state was then obtained from the IPE models with appropriate changes to reflect the seismic damage state. The CDF was then given by the product of the seismic damage state probability and the conditional core damage probability.

The seismic CDF resulting from the SGS IPEEE was calculated to be 9.5×10^{-6} per year using the LLNL seismic hazard curve and 4.7×10^{-6} per year using the EPRI seismic hazard curve. Both utilized the IPE internal events PRA, with a CDF of 6.4×10^{-5} per year for quantification of non-seismic failures. While the IPEEE indicated that the EPRI results were believed to be more realistic PSEG assumed a seismic CDF of 9.5×10^{-6} per year based on the LLNL seismic hazard curve in the development of the external events multiplier for purposes of the SAMA evaluation (PSEG 2009). In the ER, PSEG provided a listing and description of the top seven seismic core damage contributors. The dominant seismic core damage contributors for the LLNL seismic hazard curve, representing about 95 percent of the seismic CDF, are listed in Table F-4. The largest contributors to seismic CDF are seismic-induced LOOP caused by failure of the switchyard ceramic insulators combined with random failure of the EDGs and seismic-induced LOOP and failure of battery trains A and B caused by failure of the masonry block walls around the batteries. Since the use of the larger value provides more conservatism in the estimation of whether SAMAs may be cost-beneficial, the NRC staff agrees that the seismic CDF of 9.5×10^{-6} per year is reasonable for the SAMA analysis.

Table F-4. Dominant Contributors to the Seismic CDF (PSEG 2009)

Sequence ID	Seismic Sequence Description	CDF (per year)	% Contribution to Seismic CDF
17	OP: Seismically-Induced LOOP caused by failure of the switchyard ceramic insulators	2.9×10^{-6}	31

Sequence ID	Seismic Sequence Description	CDF (per year)	% Contribution to Seismic CDF
33	OP-DAB: Seismically-Induced LOOP and failure of battery trains A and B	2.0×10^{-6}	21
31	OP-SW: Seismically-Induced LOOP and failure of the service water system	1.3×10^{-6}	14
35	OP-IC: Seismically-Induced LOOP and failure of instrumentation and control capability and equipment in the main control room	1.2×10^{-6}	13
34	OP-DAB-DG: Same as 33 OP-DAB and failure of battery train C	7.7×10^{-7}	8
17F	OP-FW: Same as 17 OP and failure of containment fan coolers	5.4×10^{-7}	6
21F	OP-FW-FC: Same as 17F OP-FW and failure of auxiliary feed water (AFW)	2.9×10^{-7}	3

The SGS IPEEE did not identify any vulnerabilities due to seismic events but did identify three improvements to reduce seismic risk. These improvements are 1) procedural change to ensure long term alternate ventilation for the Auxiliary Building, 2) replacement of identified low ruggedness relays with higher seismic capacity relays, and 3) reinforcement of an 8-foot masonry wall in the 4kV switchgear room. PSEG clarified in response to an NRC staff RAI that the first two improvements have been implemented (PSEG 2010a). The third improvement is discussed further in Section F.3.2.

The SGS IPEEE fire analysis employed EPRI's fire-induced vulnerability evaluation (FIVE) methodology (EPRI 1993) followed by a PRA quantification of the unscreened compartments. The fire evaluation was performed on the basis of fire areas which are plant locations completely enclosed by 2-hour rated fire barriers and meeting the FIVE fire barrier criterion related to preventing propagation. Stage 1 consisted of qualitative screening of all plant fire areas to determine whether a fire could cause a plant shutdown or trip, or lead to loss of safe shutdown equipment. Stage 1 also consisted of quantitative screening performed by estimating whether an area's associated fire frequency in combination with the conditional core damage probability given by the loss of functions potentially impacted by the fire was less than the 1×10^{-6} per year. Based on qualitative and quantitative screening all but 38 fire areas were screened out. Stage 2 was to evaluate the remaining fire areas by modeling fire growth and propagation to determine the fire damage state for each fire area. Stage 3 was an evaluation of Sandia Fire Risk Scoping Study issues (NRC 1989) using the tailored walkdown approach provided in the FIVE methodology. Containment performance was also examined to evaluate the performance of containment systems and equipment following core damage resulting from a fire. The final stage was assessment of the functional effects on the plant for each fire damage state by developing explicit fire event trees to probabilistically assess unscreened areas. Probabilistic credit was given for automatic and manual fire suppression systems. Final quantification utilized FIVE fire data and refined conditional core damage probabilities (CCDPs) from the IPE internal events PRA. The resulting fire induced CDF was calculated to be 2.3×10^{-5} per year.

In the ER, PSEG provided a listing and description of the top ten fire core damage contributors. The dominant fire core damage contributors, representing about 99 percent of the fire CDF, are listed in Table F-5. The largest contributors to fire CDF are fires in the 460V Switchgear Rooms, Relay Room, and Control Rooms.

Subsequent to the IPEEE, SGS replaced the CO_2 suppression systems with water sprinkler systems in the 460V Switchgear Rooms, 4160V Switchgears Rooms, and Lower Electrical Penetration Area. In addition, the results of cable wrap tests suggested that the cable wrap would not perform as expected in some areas of the plant and, subsequent to the IPEEE, was removed and replaced. Because of the suppression system changes made to the three areas identified, PSEG did not consider the IPEEE results for these areas valid. PSEG reassessed the fire CDF for these areas using PRA insights from an interim SGS fire model. If the interim SGS fire model showed a higher CDF for any of these three areas, the higher CDF was used for the SAMA analysis. This was the case for the 460V Switchgear Rooms and the Lower Electrical Penetration Area. The fire CDF from the interim SGS fire model for these two fire areas are provided in Table F-5. These insights increased the total fire CDF to 3.8×10^{-5} per year, which was used in the SAMA analysis.

The NRC staff asked PSEG to provide additional information about the interim SGS fire model and, specifically, why it was not used for the SAMA analysis beyond the three areas discussed (NRC 2010a). In response to the RAI, PSEG explained that after the completion of the IPEEE, there was an effort made to develop a fire PRA. This resulted in a partially complete "interim SGS fire model." However, the interim SGS fire model was never integrated into the internal events PRA model of record (which at the time was Revision 3) and was essentially abandoned because of the forthcoming NUREG/CR-6850 fire PRA development guidance that would render the SGS fire modeling methodology obsolete.

Table F-5. Important Fire Areas and Their Contribution to Fire CDF (PSEG 2009)

Fire Area Description	CDF[1] (per year)	% Contribution to Fire CDF
460V Switchgear Rooms	1.3×10^{-5}	34

Fire Area Description	CDF[1] (per year)	% Contribution to Fire CDF
Relay Room	7.2×10^{-6}	19
Control Rooms, Peripheral Room, and Ventilation Rooms	7.0×10^{-6}	18
4160V Switchgear Room	3.4×10^{-6}	9
Lower Electrical Penetration Area	3.2×10^{-6}	8
Upper Electrical and Piping Penetration Areas	1.3×10^{-6}	3
Reactor Plant Auxiliary Equipment Area (84B)	1.1×10^{-6}	3
Turbine and Service Buildings	6.4×10^{-7}	2
Service Water Intake	4.2×10^{-7}	1
Reactor Plant Auxiliary Equipment Area (100C)	2.9×10^{-7}	1

[1]CDF reported for the 460V Switchgear Rooms and 4160V Switchgear Rooms is from the interim SGS fire model. All other CDFs are from the IPEEE.

The SGS IPEEE did not identify any vulnerabilities due to fire events but did identify two improvements to reduce fire risk. These improvements are 1) procedural change to enhance cooling in the switchgear and control areas in the event of a fire and 2) procedural change for the control of transient combustibles in the turbine building. PSEG clarified in response to an NRC staff RAI that the two suggested improvements have been implemented (PSEG 2010a).

As discussed previously, PSEG identified in the ER that SGS has replaced CO_2 fire suppression systems with water sprinkler systems in three areas of the plant since the IPEEE and that cable wrap has been removed and replaced in several areas of the plant since the IPEEE. The NRC staff asked PSEG if any other fire-related improvements have been made since the IPEEE (NRC 2010a). In response to the RAI, PSEG indicated that the following improvements had been made since the IPEEE: 1) the ventilation system and strategy for maintaining viable working conditions was revised for the 4160V Switchgear Room and the Upper Electrical and Piping Penetration Areas and 2) the maintenance shop was eliminated in the Turbine and Service Buildings in order to reduce the initiating event frequency of fires that would damage the cables for the emergency 4kV buses (PSEG 2010a).

In the ER, PSEG states that an effective comparison between the internal events PRA results and the fire analysis results is not possible because neither the plant response model or the fire modeling methodology used in the IPEEE is up-to-date. PSEG also identified areas where fire CDF quantification may introduce different levels of uncertainty than expected in the internal events PRA and identified a number of conservatisms in the IPEEE fire analysis, including:

- A revised NRC fire events database indicates a trend toward lower frequency and less severe fires than assumed in the SGS IPEEE.

- Bounding fire modeling assumptions are used for many fire scenarios. For example, all equipment in a cabinet is damaged for any fire within a cabinet, regardless of whether it is suppressed. Other examples are provided in the ER.

- Because of a lack of industry experience with regard to crew performance during the types of fires modeled in the fire PRA, the characterization of crew actions in the fire PRA is generally conservative.

PSEG's conclusion is that while there are both conservative and potentially non-conservative factors included in the IPEEE fire model, the IPEEE is judged to have more conservative bias than the internal events model.

Although the arguments regarding the conservatisms in the fire analysis are presented in the ER, PSEG used the modified IPEEE fire CDF of 3.8×10^{-5} per year in the SAMA analysis rather than some reduced value. Considering the above discussion, the conservatisms in the IPEEE fire analysis as currently understood, and the response to the NRC staff RAIs, the NRC staff concludes that the fire CDF of 3.8×10^{-5} per year is reasonable for the SAMA analysis.

The SGS IPEEE analysis of high winds, floods, and other external (HFO) events followed the progressive screening method defined in NUREG-1407 (NRC 1991b). While SGS is not considered a 1975 Standard Review Plan (SRP) plant, aspects of its licensing basis do conform to the 1975 SRP criteria because SGS is co-located with Hope Creek Generating Station (HCGS), which does meet the 1975 SRP criteria (PSEG 1996). For those events that are based on the location of the site, and not plant-specific features, the 1975 SRP criteria was used for the HFO screening analysis. Progressively more quantitatively based methods were employed for those events that could not be shown to conform to the 1975 SRP criteria. The IPEEE concluded that all HFO events either complied with the 1975 SRP criteria or that their predicted CDF was below the IPEEE screening criteria (i.e. $< 1 \times 10^{-6}$ per year). For the SAMA analysis, PSEG assumed a CDF contribution of 1×10^{-6} per year for each of high winds, external floods, transportation and nearby facilities, detritus, and chemical releases for a total HFO CDF contribution of 5×10^{-6} per year (PSEG 2009).

Although the SGS IPEEE did not identify any vulnerabilities due to HFO events, three improvements to reduce risk were identified. These improvements are 1) modify the circulating water intake structure to protect against detritus (blockage), 2) make improvements to protect against water ingress pathways for external flooding events, and 3) improve the hold downs for hydrogen tanks to protect against tornados. PSEG clarified in response to an NRC staff RAI that the first two suggested improvements have been implemented (PSEG 2010a). The third improvement is discussed further in Section F.3.2.

A review of transportation and nearby facility accidents confirmed that there were no severe accident vulnerabilities from these accidents. Accidents from river traffic, including detonation of explosives and impacts with the Service Water intake structure, were examined in the IPEEE. The IPEEE concluded that the detonation of explosives related to river shipping would not threaten the integrity of the safety structures even under the conditions present during the performance of the IPEEE. In addition, the potential for an impact on the Service Water intake structure was estimated to be on the order of 1E-07 per yr and it was excluded from further review in the IPEEE. Subsequent changes to the shipping procedures and exclusion zones since the IPEEE have reduced the potential for these types of events to occur. ,Given that the potential averted cost-risk associated with an event with a frequency of 1E-07 per yr is only about $16,000 (assuming core damage occurs at that frequency), no SAMAs are suggested to address river shipping hazards.

The NRC staff asked about the status and potential impact on the SAMA analysis of a liquefied natural gas (LNG) terminal planned for Logan Township, New Jersey, upstream on the Delaware River from the SGS site (NRC 2010a). In response to the RAI, PSEG discussed the current status of the LNG terminal as well as the regulatory controls for LNG marine traffic and LNG ship design and the safety record of LNG shipping (PSEG 2010a). The LNG terminal remains in the planning stage and no construction has begun. Further, the state of Delaware has denied applications for several required environmental permits and approvals. PSEG concluded that based on the regulatory process and controls for assuring the safety and security of LNG ships, the safety record of LNG ships, and the uncertainty of the planned terminal, consideration of potential SAMAs associated with the possible future terminal is not warranted. The NRC staff agrees with this conclusion.

Based on the aforementioned results, the external events CDF is approximately equal to the internal events CDF (based on a seismic CDF of 9.5×10^{-6} per year, a fire CDF of 3.8×10^{-5} per year, an HFO CDF of 5.0×10^{-6} per year, and an internal events CDF of 5.0×10^{-5} per year used in the SAMA analysis). Accordingly, the NRC staff concurred with SGS's conclusion that the total CDF (from internal and external events) would be approximately 2 times the internal events CDF. In the SAMA analysis submitted in the ER, PSEG doubled the benefit that was derived from the internal events model to account for the combined contribution from internal and external events. The NRC staff agrees with the licensee's overall conclusion concerning the multiplier used to represent the impact of external events and concludes that the licensee's use of a multiplier of 2 to account for external events is reasonable for the purposes of the SAMA evaluation. This is discussed further in Section F.6.2.

The NRC staff reviewed the general process used by PSEG to translate the results of the Level 1 PRA into containment releases, as well as the results of the Level 2 analysis, as described in the ER and in response to NRC staff RAIs (PSEG 2010a). The current Level 2 model is essentially a complete revision of the IPE Level 2 model. In response to an NRC staff RAI, related to the history of the Level 2 model, PSEG stated that the IPE Level 2 model was abandoned, with the exception of LERF, with Revision 3 of the SGS PRA model and that the Level 2 model was recreated incorporating current industry guidance as part of the transition from Revision 3 to Revision 4 of the PRA model (PSEG 2010a).

The current SGS Level 2 model utilizes a single CET containing both phenomenological and systemic events. The Level 1 core damage sequences are grouped into core damage accident classes, or plant damage states (PDSs), with similar characteristics. The PDSs are defined based on the following attributes: (1) reactor coolant system (RCS) pressure (high or low), (2) containment isolation status, (3) containment bypass status, (4) containment bypass via an unisolated steam generator tube rupture (SGTR), (5) containment bypass via an unisolated, large ISLOCA, (6) containment spray operation mode, (7) containment fan cooler operation, and (8) refueling water storage tank (RWST) injection. All of the sequences in an accident class are then input to the CET by linking the level 1 event tree sequences with the level 2 CET. The CET is analyzed by the linking of fault trees that represent each CET node. Whenever possible the fault trees utilized in the Level 1 analysis are utilized in the CET to propagate dependencies. In response to an NRC staff RAI, PSEG states that the Level 1 and Level 2 models are integrated in that the Level 1 sequences are directly passed to the Level 2 model in the software through the Level 1 sequence fault trees (PSEG 2010a). Twenty-three distinct CET end states or sequences result.

Section E.2.2.3 of the ER describes each of the top events of the CET and states that branch point probabilities for each top event are based on previous SGS Level 2 analyses, recent accident progression research, and similar analyses for other nuclear plants. The NRC staff requested that PSEG describe how the branch point probabilities were developed specifically for top events RCS Depressurization and Containment Heat Removal (NRC 2010a). In response to the RAI, PSEG clarified that top event RCS Depressurization consists of the combination of an existing human action from the human reliability analysis (HRA) and the fault tree for power-operated relief valve (PORV) operation (PSEG 2010a). The Containment Heat Removal top event is determined by specific Level 2 system models for containment fan cooler units (CFCUs) and containment spray (CS), either of which can be used for containment heat removal at SGS.

Each CET end state represents a radionuclide release to the environment and is assigned to a release category based on timing of release, the initiating event, whether feedwater is available, and the containment failure mode. Three general release categories are defined: intact containment, late release, and early release. These are further divided into eleven detailed release categories based on the above attributes, as defined in Section E.2.2.6 of the ER.

The frequency of each release category was obtained by summing the frequency of the contributing CET end states. The release characteristics for each release category were developed by using the results of Modular Accident Analysis Program (MAAP Version 4.0.6) computer code calculations (PSEG 2010a). Representative MAAP cases for each release category were chosen to either represent the most likely initiators in the release category (intact containment and late release categories) or to conservatively bound the consequences of the release (early release categories). The NRC questioned why PSEG did not also use representative cases that bound the consequences for the late release categories (NRC 2010a). In response to the RAI, PSEG stated that, because the late release categories take more time to evolve than the early release categories, the late release categories are less affected by the initial accident conditions and so result in more uniform consequences than the early release categories (PSEG 2010a). Since the accident sequences assigned to the late release categories yielded similar consequences, PSEG selected representative MAAP cases that represented the most likely initiators within those release categories. The release categories, their frequencies, and release characteristics are presented in Tables E.3-5 and E.3-6 of Appendix E to the ER (PSEG 2009).

The total Level 2 release frequency is of 5.0×10^{-5} per year, which is about 4 percent higher than the internal events CDF of 4.8×10^{-5} per year. The ER states that this difference is due to truncation of low probability sequences and inclusion of non-minimal Level 1 sequences. The NRC staff considers that use of the release frequency rather than the Level 1 CDF will have a negligible impact on the results of the SAMA evaluation because the external event multiplier and uncertainty multiplier used in the SAMA analysis (discussed in Section F.6.2) have a much greater impact on the SAMA evaluation results than the small error arising from the model quantification approach.

The revised SGS Level 2 PRA model was included in the 2008 PWR Owner's Group peer review discussed above. While none of the eight key findings had to do with the Level 2 analysis, eight LERF analysis SRs did not meet Capability Category II or higher and remain open in SGS PRA MOR Revision 4.3 (PSEG 2010b). PSEG determined that all eight of these findings were documentation issues that did not impact the SAMA analysis. As any associated technical aspects had been resolved, the NRC staff agrees with PSEG's characterization as documentation issues.

Based on the NRC staff's review of the Level 2 methodology, that PSEG has adequately addressed NRC staff RAIs, and that the Level 2 model was reviewed in more detail as part of the 2008 PWR Owners Group peer review and there were no findings that impacted the SAMA analysis, the NRC staff concludes that the Level 2 PRA provides an acceptable basis for evaluating the benefits associated with various SAMAs.

The NRC staff reviewed the process used by PSEG to extend the containment performance (Level 2) portion of the PRA to an assessment of offsite consequences (essentially a Level 3

PRA). This included consideration of the source terms used to characterize fission product releases for the applicable containment release categories and the major input assumptions used in the offsite consequence analyses. The MACCS2 code was utilized to estimate offsite consequences. Plant-specific input to the code includes the source terms for each source term category and the reactor core radionuclide inventory (both discussed above), site-specific meteorological data, projected population distribution within an 80-kilometer (50-mile) radius for the year 2040, emergency evacuation modeling, and economic data. This information is provided in Section E.3 of Appendix E to the ER (PSEG 2009).

PSEG used the MACCS2 code and a core inventory from a plant specific calculation at end of cycle to determine the offsite consequences of activity release. In response to an NRC staff RAI, PSEG stated that the MACCS2 analysis was based on the core inventory used in the February 2006 NRC-approved Alternate Source Term for SGS (PSEG 2010a). As indicated in the ER, the reactor core radionuclide inventory used in the consequence analysis was based on a thermal power of 3632 MWt, which is 5 percent higher than the current licensed thermal power of 3459 MWt for SGS. In response to an NRC staff RAI, PSEG stated that the higher thermal power was used to provide margin for a future power uprate (PSEG 2010a).

All releases were modeled as being from the top of the reactor containment building and at low thermal content (ambient). Sensitivity studies were performed on these assumptions and indicated little or no change in population dose or offsite economic cost. Assuming a ground level release decreased dose risk and cost risk by 8 percent and 7 percent, respectively. Assuming a buoyant plume decreased dose risk and cost risk by 1 percent or less. Based on the information provided, the staff concludes that the release parameters utilized are acceptable for the purposes of the SAMA evaluation.

PSEG used site-specific meteorological data for the 2004 calendar year as input to the MACCS2 code. The development of the meteorological data is discussed in Section E.3.7 of Appendix E to the ER. The data were collected from onsite and local meteorological monitoring systems. Sensitivity analyses using MACCS2 and the meteorological data for the years 2005 through 2007 show that use of data for the year 2004 results in the largest dose and economic cost risk. Missing meteorological data was filled by (in order of preference): using data from the backup met pole instruments (10-meter), using corresponding data from another level of the main met tower, interpolation (if the data gap was less than 6 hours), or using data from the same hour and a nearby day (substitution technique). The 10-meter wind speed and direction were combined with precipitation and atmospheric stability (derived from the vertical temperature gradient) to create the hourly data file for use by MACCS2. The NRC staff notes that previous SAMA analyses results have shown little sensitivity to year-to-year differences in meteorological data and concludes that the use of the 2004 meteorological data in the SAMA analysis is reasonable.

The population distribution the licensee used as input to the MACCS2 analysis was estimated for the year 2040 using year 1990 and year 2000 census data as accessed by SECPOP2000 (NRC 2003) as a starting point. In response to an NRC staff RAI, PSEG stated that the transient population was included in the 10-mile EPZ, and in the population projection (PSEG 2010a). A ten year population growth rate was estimated using the year 1990 to year 2000 SECPOP2000 data and applied to obtain the distribution in 2040. The baseline population was determined for each of 160 sectors, consisting of sixteen directions for each of ten concentric distance rings to a radius of 50 miles surrounding the site. The SECPOP2000 census data from 1990 and 2000 were used to determine a ten year population growth factor for each of the concentric rings. The population growth was averaged over each ring and applied uniformly to all sectors within each ring. The NRC staff requested PSEG provide an assessment of the impact on the SAMA analysis if a wind-direction weighted population estimate for each sector were used (NRC 2010a). In response to the RAI, PSEG stated that the impacts associated with angular population growth rates on population dose risk and offsite economic cost risk are minimal and bounded by the 30 percent population sensitivity case (PSEG 2010a). This is based on the relatively even wind distribution profile surrounding the site, the tendency for lateral dispersion between sectors, and the use of mean values in the analysis. A sensitivity study was performed for the population growth at year 2040. A 30 percent increase in population resulted in a 30 percent increase in dose risk and a 29 percent increase in cost risk. In response to an NRC staff RAI, PSEG stated that the radial growth rates used in the MACCS2 analysis provides a more conservative population growth estimate than using ‘whole county’ data for averaging. PSEG also identified that the population sensitivity case of 30 percent growth was approximately equivalent to adding 6.8 percent to the 10-year growth rate (PSEG 2010a). The NRC staff considers the methods and assumptions for estimating population reasonable and acceptable for purposes of the SAMA evaluation.

The emergency evacuation model was modeled as a single evacuation zone extending out 16 kilometers (10 miles) from the plant (the emergency planning zone – EPZ). PSEG assumed that 95 percent of the population would evacuate. This assumption is conservative relative to the NUREG-1150 study (NRC 1990), which assumed evacuation of 99.5 percent of the population within the emergency planning zone. The evacuated population was assumed to move at an average radial speed of approximately 2.8 meters per second (6.3 miles per hour) with a delayed start time of 65 minutes after declaration of a general emergency (KLD 2004). A general emergency declaration was assumed to occur at the onset of core damage. The evacuation speed is a time-weighted average value accounting for season, day of week, time of day, and weather conditions. It is noted that the longest evacuation time presented in the study (i.e., full 10 mile EPZ, winter snow conditions, 99^{th} percentile evacuation) is 4 hours (from the issuance of the advisory to evacuate). Sensitivity studies on these assumptions indicate that there is minor impact to the population dose or offsite economic cost by the assumed variations. The sensitivity study reduced the evacuation speed by 50 percent to 1.4 m/s. This change resulted in a 4 percent increase in population dose risk and no change in offsite economic cost risk. The NRC staff concludes that the evacuation assumptions and analysis are reasonable and acceptable for the purposes of the SAMA evaluation.

Site specific agriculture and economic parameters were developed manually using data in the 2002 National Census of Agriculture (USDA 2004) and from the Bureau of Economic Analysis (BEA 2008) for each of the 23 counties surrounding SGS, to a distance of 50 miles. Therefore, recently discovered problems in SECPOP2000 do not impact the SGS analysis. The values used for each of the 160 sectors were the data from each of the surrounding counties multiplied by the fraction of that county's area that lies within that sector. Region-wide wealth data (i.e., farm wealth and non-farm wealth) were based on county-weighted averages for the region within 50-miles of the site using data in the 2002 National Census of Agriculture (USDA 2004) and the Bureau of Economic Analysis (BEA 2008). Food ingestion was modeled using the new MACCS2 ingestion pathway model COMIDA2 (NRC 1998). For SGS, less than one percent of the total population dose risk is due to food ingestion.

In addition, generic economic data that is applied to the region as a whole were revised from the MACCS2 sample problem input in order to account for cost escalation since 1986, the year that input was first specified. A factor of 1.96, representing cost escalation from 1986 to April 2008 was applied to parameters describing cost of evacuating and relocating people, land decontamination, and property condemnation.

The NRC staff concludes that the methodology used by PSEG to estimate the offsite consequences for SGS provides an acceptable basis from which to proceed with an assessment of risk reduction potential for candidate SAMAs. Accordingly, the NRC staff based its assessment of offsite risk on the CDF and offsite doses reported by PSEG.

F.3 Potential Plant Improvements

The process for identifying potential plant improvements, an evaluation of that process, and the improvements evaluated in detail by PSEG are discussed in this section.

F.3.1 Process for Identifying Potential Plant Improvements

PSEG's process for identifying potential plant improvements (SAMAs) consisted of the following elements:

- Review of the most significant basic events from the current, plant-specific PRA and insights from the SGS PRA group,
- Review of potential plant improvements identified in, and original results of, the SGS IPE and IPEEE,

- Review of SAMA candidates identified for license renewal applications for six other U.S. nuclear sites, and
- Review of generic SAMA candidates from NEI 05-01 (NEI 2005) to identify SAMAs that might address areas of concern identified in the SGS PRA.

Based on this process, an initial set of 27 candidate SAMAs, referred to as Phase I SAMAs, was identified. In Phase I of the evaluation, PSEG performed a qualitative screening of the initial list of SAMAs and eliminated SAMAs from further consideration using the following criteria:

- The SAMA is not applicable to SGS due to design differences
- The SAMA has already been implemented at SGS,
- The SAMA would achieve results that have already been achieved at SGS by other means, or
- The SAMA has estimated implementation costs that would exceed the dollar value associated with completely eliminating all severe accident risk at SGS.

Based on this screening, two SAMAs were eliminated leaving 25 for further evaluation. The results of the Phase I screening analysis is given in Table E.5-3 of Appendix E to the ER. The remaining SAMAs, referred to as Phase II SAMAs, are listed in Table E.6-1 of Appendix E to the ER. In Phase II, a detailed evaluation was performed for each of the 25 remaining SAMA candidates, as discussed in Sections F.4 and F.6 below. To account for the potential impact of external events, the estimated benefits based on internal events were multiplied by a factor of 2, as previously discussed.

F.3.2 Review of PSEG's Process

PSEG's efforts to identify potential SAMAs focused primarily on areas associated with internal initiating events, but also included explicit consideration of potential SAMAs for important fire and seismic initiated core damage sequences. The initial list of SAMAs generally addressed the accident sequences considered to be important to CDF from risk reduction worth (RRW) perspectives at SGS, and included selected SAMAs from prior SAMA analyses for other plants.

PSEG provided a tabular listing of the Level 1 PRA basic events sorted according to their RRW (PSEG 2009). SAMAs impacting these basic events would have the greatest potential for reducing risk. PSEG used a RRW cutoff of 1.01, which corresponds to about a one percent change in CDF given 100-percent reliability of the SAMA.[1] This equates to a benefit of

[1] Subsequently, PSEG extended the review down to a RRW of 1.006 based on the estimated cost of a procedure change per unit, as discussed below.

approximately $164,000 (after the benefits have been multiplied by a factor of 2 to account for external events).[2] PSEG also provided and reviewed the Level 2 PRA basic events, down to a RRW of 1.01, for the release categories contributing over 94 percent of the population dose-risk. The Level 2 basic events for the remainder of the release categories were not included in the review so as to prevent high frequency-low consequence events from biasing the importance listing. All of the basic events on the Level 1 and 2 importance lists were addressed by one or more of the SAMAs (PSEG 2009). As a result of the review of the Level 1 and Level 2 basic events, 19 SAMAs were identified.

The NRC staff requested PSEG to extend the review of the Level 1 and 2 basic events down to a RRW threshold of 1.003, which equates to a benefit of approximately $50,000, the assumed cost of a procedural change at SGS (NRC 2010a).[3] In response to the RAI, PSEG provided revised Level 1 and Level 2 importance lists using SGS PRA model of record Revision 4.3, which was discussed in Section F.2.2, and extended the review of the basic events down to an RRW of 1.006, which equates to a benefit of about $47,000 using PRA Revision 4.3. The review identified the following three additional SAMAs associated with new basic events added to the importance lists (PSEG 2010a):

- SAMA 30 – Automatic Start of Diesel-Powered Air Compressor
- SAMA 31 – Fully Automate Swapover to Sump Recirculation
- SAMA 32 – Enhance Flood Detection for 100-foot Auxiliary Building and Enhance Procedural Guidance for Responding to Internal Floods

A Phase II detailed evaluation was performed for each of these additional SAMAs, which is discussed in Section F.6.2.

The NRC staff asked PSEG to clarify the appropriateness of determining importance factors, and SAMAs, for initiators that are identified as flag events having an assigned probability of 1.0 (NRC 2010a). PSEG explained in response to the RAI that fault trees were developed for several loss of support system initiating events (PSEG 2010a). Those events that lead to the loss of a support system and are responsible for causing the modeled initiating event were identified as flag events. These events are representative of that initiating event's contribution

[2] NUREG/BR-0184 provides calculational techniques by which reductions in risk can be equated to monetary values. The reverse calculation can convert monetary values, such as the cost of a procedure, to a risk reduction for the specific plant under consideration. In this way, $164,000 equate to a RRW of 1.01, representing the potential to reduce risk by 1%. The subsequent use of a RRW of 1.006 represents the potential to reduce risk by 0.6% (NRC 1997a).

[3] Per site, the estimated cost of a procedure change is $100,000. Hope Creek uses this value since it is a single-unit site. Salem has two units, so this cost is halved per unit.

to CDF and were therefore considered appropriate by PSEG for risk ranking. PSEG further clarified that events whose failure leads to the occurrence of the modeled initiating event will also be listed in the importance list ranking and that the flag probability was therefore set to 1.0 to determine the appropriate CDF contribution of the cutsets. The RRW calculated for these flag events therefore correctly measures the risk significance of the initiating event modeled in this manner.

The NRC staff also asked PSEG to clarify the significance of determining importance factors, and SAMAs, for two split fraction events identified in the importance listing: “RCS-SLOCA-SPLIT” and “MFI-UNAVAILABLE” (NRC 2010a). PSEG explained in response to the RAI that the first event, “RCS-SLOCA-SPLIT,” is a flag event that indicates those cutsets in which an RCP seal LOCA has occurred and that the second event, “MFI-UNAVAILABLE,” is the conditional probability that the main feedwater system is unavailable given that a reactor trip signal has been generated, irrespective of whether an ATWS condition exists (PSEG 2010a). Because the first event is a flag event, it was assigned a probability of 1.0. SAMA 6, “Enhance Flood Detection for 84’ Auxiliary Building and Enhance Procedural Guidance for Responding to Service Water Flooding,” was identified because isolating a service water rupture early could help prevent the conditions that can lead to an RCP seal LOCA. The second event was assigned a conditional probability of 0.3. SAMA 14, “Expand ATWS Mitigation System Actuation Circuitry (AMSAC) Function to Include Backup Breaker Trip on Reactor Protection System (RPS) Failure,” was identified to use the AMSAC system to provide a redundant trip signal to help mitigate ATWS events. In over 60 percent of the scenarios in which MFI-UNAVAILABLE is a contributor, AMSAC maintenance is also a contributor. By mitigating ATWS events, SAMA 14 also mitigates scenarios having this combination of events.

PSEG reviewed the cost-beneficial Phase II SAMAs from prior SAMA analyses for five Westinghouse PWR and one General Electric BWR sites. PSEG’s review determined that all of the Phase II SAMAs reviewed were either already represented by a SAMA identified from the Level 1 and 2 importance list reviews, are already addressed by other means, have low potential for risk reduction at SGS, or were not applicable to the SGS design. This review resulted in no additional SAMAs being identified.

The NRC staff asked PSEG to review the cost beneficial SAMAs identified in the NRC-issued NUREG-1437 reports for each of the six nuclear sites and to provide an assessment any additional cost-beneficial SAMAs identified during these reviews for applicability to SGS (NRC 2010a). In response to this RAI, PSEG reviewed the cost-beneficial SAMAs identified in the NUREG-1437 reports and concluded the cost-beneficial SAMA either 1) was already identified and evaluated in the ER, 2) was already implemented at SGS, or 3) would not reduce SGS risk (PSEG 2010a). No additional SAMAs were identified from this review.

PSEG considered the potential plant improvements described in the IPE in the identification of plant-specific candidate SAMAs for internal events. Review of the IPE lead to no additional

SAMA candidates since the three improvements identified in the IPE have already been implemented at SGS (PSEG 2009).

As a sensitivity case to SAMA 5, PSEG identified and evaluated SAMA 5A, “Install Portable Diesel Generators to Charge Station Battery and Circulating Water Batteries.” This SAMA only addresses cases in which RCP seals remain intact, which occurs in a majority of the SBO scenarios. PSEG performed a Phase II evaluation of SAMA 5A, which is in addition to the Phase II evaluations performed for the 25 SAMAs discussed above that were not screened during the Phase I evaluation.

Based on this information, the NRC staff concludes that the set of SAMAs evaluated in the ER, together with those identified in response to NRC staff RAIs, addresses the major contributors to internal event CDF.

Although the IPEEE did not identify any fundamental vulnerabilities or weaknesses related to external events, the ER identified three improvements related to external events (PSEG 2009). The NRC staff noted that the IPEEE safety evaluation report (NRC 1999) identified five total improvements related to external events and requested PSEG review these improvements for potentially additional SAMAs (NRC 2010a). In response to the RAI, PSEG reviewed the five suggested improvements and reassessed the three improvements originally evaluated in the ER (PSEG 2010a). As a result of this review, two improvements related to fire events, three improvements related to seismic events, and three improvements related to HFO events were identified. The two suggested fire-related improvements have been implemented, two of the seismic-related improvements have been implemented, and two of the HFO-related improvements have been implemented. The remaining two improvements that have not been implemented are as follows:

- Seismic-related improvement – reinforcement of an 8-foot masonry wall in the 4kV switchgear room. PSEG described the results of an evaluation that determined there was no interaction between the wall and the switchgear bus during a seismic event and subsequent implementation of a corrective action to revise the associated calculation to clarify the lack of interaction. Based on this, PSEG concluded that reinforcement of the masonry wall was not necessary and no SAMA is suggested (PSEG 2010a).

- HFO-related improvement – improve hold downs for the hydrogen tanks to protect against tornados. In response to the RAI, PSEG performed a walk down of the hydrogen racks and determined that the IPEEE suggested improvements to the Unit 2 racks to make the design consistent with the Unit 1 racks was not implemented as indicated in the ER. PSEG further noted that the IPEEE states that these hydrogen tanks “will not have any significant impact on safety structures.” Based on this, PSEG concluded that, while the suggested change was prudent, it would not reduce plant risk and no SAMA is suggested.

In the ER PSEG also identified three post IPEEE site changes to determine if they could impact the IPEEE results and possibly lead to a SAMA. From this review, one plant change to replace CO_2 fire suppression with water sprinkler systems was determined to have an impact on fire CDF, which was discussed in Section F.2.2. No additional SAMAs were identified from this review.

In a further effort to identify external event SAMAs, PSEG reviewed the top 10 fire areas contributing to fire CDF based on the results of the IPEEE and interim SGS fire PRA models. These areas are all of the SGS fire areas having a maximum benefit equal to or greater than approximately $50,000, which is the approximate value of implementing a procedure change at a single unit at SGS. The maximum benefit for a fire area is the dollar value associated with completely eliminating the fire risk in that fire area, which is discussed in Section F.6.2. SAMAs having an implementation cost of less than that of a procedure change, or $50,000, are unlikely. As a result of this review, PSEG identified five Phase I SAMAs to reduce fire risk. The SAMAs identified included both procedural and hardware alternatives (PSEG 2009). The NRC staff concludes that the opportunity for fire-related SAMAs has been adequately explored and that it is unlikely that there are additional potentially cost-beneficial, fire-related SAMA candidates.

For seismic events, PSEG reviewed the top seven seismic sequences contributing to seismic CDF based on the results of the IPEEE seismic PRA model. These areas are all of the SGS seismic sequences having a benefit equal to or greater than approximately $50,000, which is the approximate value of implementing a procedure change at a single unit at SGS. The maximum benefit for a seismic sequence is the dollar value associated with completely eliminating the seismic risk for that sequence, which is discussed in Section F.6.2. SAMAs having an implementation cost of less than that of a procedure change, or $50,000, are unlikely. As a result of this review, PSEG identified three additional Phase I SAMAs to reduce seismic risk (PSEG 2009). The NRC staff concludes that the opportunity for seismic-related SAMAs has been adequately explored and that it is unlikely that there are additional potentially cost-beneficial, seismic-related SAMA candidates.

As stated earlier, other external hazards (high winds, external floods, transportation and nearby facility accidents, release of on-site chemicals, and detritus) are below the IPEEE threshold screening frequency, or met the 1975 SRP design criteria, and are not expected to represent vulnerabilities. Nevertheless, PSEG reviewed the IPEEE results and subsequent plant changes for each of these external hazards and determined that either 1) the maximum benefit from eliminating all associated risk was less than approximately $50,000, which is the approximate value of implementing a procedure change at a single unit at SGS, or 2) only hardware enhancements that would significantly exceed the maximum value of any potential risk reduction were available. As a result of this review, PSEG identified no additional Phase I

SAMAs to reduce HFO risk (PSEG 2009). The NRC staff concludes that the licensee's rationale for eliminating other external hazards enhancements from further consideration is reasonable.

The NRC staff noted that, while the generic SAMA list from NEI 05-01 (NEI 2005) was stated to have been used in the identification of SAMAs for SGS, it was not specifically reviewed to identify SAMAs that might be applicable to SGS but rather was used to identify SAMAs that might address areas of concern identified in the SGS PRA (NRC 2010a). The NRC staff asked PSEG to provide further information to justify that this approach produced a comprehensive set of SAMAs for consideration. In response to the RAI, PSEG explained that, based on the early SAMA reviews, both the industry and NRC came to realize that a review of the generic SAMA list was of limited benefit because they were consistently found to not be cost-beneficial and that the real benefit was considered to be in the development of SAMAs generated based on plant specific risk insights from the PRA models (PSEG 2010a).

Furthermore, while the generic list does include potential plant improvements for plants having a similar design to SGS, plant designs are sufficiently different that the specific plant improvements identified in the generic list are generally not directly applicable to SGS, and require alteration to specifically address the SGS design and risk contributors or otherwise would be screened as not applicable to the SGS design. The NRC staff considers PSEG initial use of the NEI 05-01 generic SAMA list as only an idea source to generate SAMAs that address important contributors to SGS risk reasonable for the SGC application.

The NRC staff questioned PSEG about potentially lower cost alternatives to some of the SAMAs evaluated (NRC 2010a), including:

- Operating the AFW AF11/21 valves closed.
- Install improved fire barriers in the 460V switchgear rooms to provide separation between the three power divisions.
- Install improved fire barriers to provide separation between the AFW pumps.

In response to the RAIs, PSEG addressed the suggested lower cost alternatives and determined that they were either not feasible or were not cost-beneficial (PSEG 2010a). This is discussed further in Section F.6.2.

The NRC staff notes that the set of SAMAs submitted is not all-inclusive, since additional, possibly even less expensive, design alternatives can always be postulated. However, the NRC staff concludes that the benefits of any additional modifications are unlikely to exceed the benefits of the modifications evaluated and that the alternative improvements would not likely cost less than the least expensive alternatives evaluated, when the subsidiary costs associated with maintenance, procedures, and training are considered.

The NRC staff concludes that PSEG used a systematic and comprehensive process for identifying potential plant improvements for SGS, and that the set of potential plant improvements identified by PSEG is reasonably comprehensive and, therefore, acceptable. This search included reviewing insights from the plant-specific risk studies, and reviewing plant improvements considered in previous SAMA analyses. While explicit treatment of external events in the SAMA identification process was limited, it is recognized that the prior implementation of plant modifications for fire and seismic risks and the absence of external event vulnerabilities reasonably justifies examining primarily the internal events risk results for this purpose.

F.4 Risk Reduction Potential of Plant Improvements

PSEG evaluated the risk-reduction potential of the 25 remaining SAMAs and one sensitivity case SAMA that were applicable to SGS. The SAMA evaluations were performed using realistic assumptions with some conservatism. On balance, such calculations overestimate the benefit and are conservative.

PSEG used model re-quantification to determine the potential benefits. The CDF, population dose reductions, and offsite economic cost reductions were estimated using the SGS PRA model. The changes made to the model to quantify the impact of SAMAs are detailed in Section E.6 of Appendix E to the ER (PSEG 2009). Table F-6 lists the assumptions considered to estimate the risk reduction for each of the evaluated SAMAs, the estimated risk reduction in terms of percent reduction in CDF and population dose, and the estimated total benefit (present value) of the averted risk. The estimated benefits reported in Table F-6 reflect the combined benefit in both internal and external events. The determination of the benefits for the various SAMAs is further discussed in Section F.6.

The NRC staff questioned the assumptions used in evaluating the benefit or risk reduction estimate of SAMA 24, “provide procedural guidance to cross-tie Salem 1 and 2 service water systems” (NRC 2010a). The ER assumed this SAMA did not benefit from a reduction in fire risk yet indicates that this SAMA was identified based on a review of the SGS IPEEE fire PRA model results. In response to an NRC staff RAI, PSEG clarified that this SAMA was actually identified from the review of the internal events importance list, that the procedural guidance suggested in this SAMA to perform the inter-unit service water cross-tie is already in place for fire events and that, therefore, implementation of this SAMA would have no additional benefits in fire events (PSEG 2010a). Based on this, PSEG concluded that this SAMA has been appropriately evaluated, with which the NRC staff agrees.

The NRC staff noted that the total of the risk reduction results calculated by summing the individual results for each release category for SAMAs 2, 4, 5A, 18, and 19 was different than the summary results that were used in the SAMA evaluation (NRC 2010a). In response to the RAI, PSEG explained that the release category results provided in the ER for these SAMAs were incorrect, due to typographical errors, and the correct results were provided (PSEG 2010a). PSEG further explained that the SAMA evaluation reported in the ER used the correct release category results and therefore no re-evaluation of the SAMAs was necessary. The NRC staff accepts PSEG's explanation based upon the staff's confirmation that the revised information is aligned with that reported in the ER.

For SAMAs that specifically addressed fire events (i.e., SAMA 21, "Seal the Category II and III Cabinets in the Relay Room," SAMA 22, "Install Fire Barriers between the 1CC1, 1CC2, and 1CC3 Consoles in the Control Room Enclosure (CRE)," and SAMA 23, "Install Fire Barriers and Cable Wrap to Maintain Divisional Separation in the 4160V AC Switchgear Room."), the reduction in fire CDF and population dose was not directly calculated (in Table F-5 this is noted as "Not Estimated"). For these SAMAs, an estimate of the impact was made based on general assumptions regarding: the approximate contribution to total risk from external events relative to that from internal events; the fraction of the external event risk attributable to fire events; the fraction of the fire risk affected by the SAMA (based on information from the IPEEE and interim SGS Fire Model results); and the assumption that SAMAs 21 and 22 completely eliminate the fire risk affected by the SAMA and that SAMA 23 eliminates 95 percent of the fire risk affected by the SAMA. Specifically, it is assumed that the contribution to risk from external events is approximately equal to that from internal events, and that internal fires contribute 72 percent of this external events risk. The fire areas impacted by the SAMA are identified and the portion of the total fire risk contributed by each of these fire areas determined. For SAMAs 21 and 22, the benefit or averted cost risk from reducing the fire risk affected by the SAMA is then calculated by multiplying the ratio of the fire risk affected by the SAMA to the internal events CDF by the total present dollar value equivalent associated with completely eliminating severe accidents from internal events at SGS. For SAMA 23, the benefit or averted cost risk from reducing the fire risk affected by the SAMA is then calculated by multiplying the ratio of 95 percent of the fire risk affected by the SAMA to the internal events CDF by the total present dollar value equivalent associated with completely eliminating severe accidents from internal events at SGS. These SAMAs were assumed to have no additional benefits for internal events.

In addition to those SAMAs that only addressed fire events, PSEG evaluated the additional benefits from reducing fire risk for the following SAMAs that also had internal events benefits: SAMA 1, "Enhance Procedures and Provide Additional Equipment to Respond to Loss of Control Area Ventilation," SAMA 8, "Install High Pressure Pump Powered with Portable Diesel Generator and Long-term Suction Source to Supply the AFW Header," and SAMA 20, "Fire Protection System to Provide Make-up to RCS and Steam Generators." The benefit or averted cost risk from reducing the fire risk affected by these SAMAs was calculated similar to the method described above with the exception that the fire risk affected by each of these SAMAs were assumed to be reduced based on the same failure probability as was assumed for internal events (i.e., 2.0×10^{-02} for SAMA 1, 1.0×10^{-02} for SAMA 8, and 1.0×10^{-01} for SAMA 20). In other words, SAMA 1 was assumed to eliminate 98 percent, SAMA 8 was assumed to eliminate 99 percent, and SAMA 20 was assumed to eliminate 90 percent of the fire risk affected by these SAMAs. The benefit or averted cost risk from reducing the fire risk affected by SAMA 1 is then calculated by multiplying the ratio of 98 percent of the fire risk affected by the SAMA to the internal events CDF by the total present dollar value equivalent associated with completely eliminating severe accidents from internal events at SGS. The benefit from reducing fire risk was calculated similarly for SAMAs 8 and 20. For SAMAs 1 and 8, PSEG added the calculated benefit from reducing fire risk to the benefit from internal events, which was doubled to account for all external events, to obtain the total benefit from internal and external events. This is discussed further in Section F.6.2.

PSEG also evaluated the additional benefits from reducing seismic risk for the following SAMAs that also had internal events benefits: SAMA 5, “Enhance Procedures and Provide Additional Equipment to Respond to Loss of Control Area Ventilation,” SAMA 5A, “Install Portable Diesel Generators to Charge Station Battery and Circulating Water Batteries,” SAMA 20, “Fire Protection System to Provide Make-up to RCS and Steam Generators,” and SAMA 27, “In addition to the Equipment Installed for SAMA 5, Install Permanently Piped Seismically Qualified Connections to Alternate AFW Water Sources.” For these SAMAs, an estimate of the seismic impact was made based on general assumptions regarding: the approximate contribution to total risk from external events relative to that from internal events; the fraction of the external event risk attributable to seismic events; the fraction of the seismic risk affected by the SAMA (based on information from the IPEEE); and the assumption that these SAMAs would reduce the contribution to the seismic CDF from the impacted seismic sequences by 90 percent. Specifically, it is assumed that the contribution to risk from external events is approximately equal to that from internal events, and that seismic events contribute 18 percent of this external events risk. The seismic sequences impacted by the SAMA are identified and the portion of the total seismic risk contributed by each of these seismic sequences determined. The benefit or averted cost risk from reducing the seismic risk affected by the SAMA is then calculated by multiplying the ratio of 90 percent of the seismic risk affected by the SAMA to the internal events CDF by the total present dollar value equivalent associated with completely eliminating severe accidents from internal events at SGS. For SAMAs 5, 5A, and 27, PSEG added the calculated benefit from reducing seismic risk to the benefit from internal events, which was doubled to account for all external events, to obtain the total benefit from internal and external events. This is discussed further in Section F.6.2.

For SAMA 20, PSEG multiplied the benefit from internal events by a factor of 1.1 to account for other (non-fire/non-seismic) events and added this to the benefits or averted cost risk from reducing fire risk and seismic risk to obtain the total benefit from internal and external events. This is discussed further in Section F.6.2.

The NRC staff has reviewed PSEG's bases for calculating the risk reduction for the various plant improvements and concludes, with the above clarifications, that the rationale and assumptions for estimating risk reduction are reasonable and generally conservative (i.e., the estimated risk reduction is higher than what would actually be realized). Accordingly, the NRC staff based its estimates of averted risk for the various SAMAs on PSEG's risk reduction estimates.

Table F-6. SAMA Cost/Benefit Screening Analysis for SGS[a] (PSEG 2009)

SAMA	Assumptions	% Risk Reduction		Total Benefit ($)		Cost ($)
		CDF	Population Dose	Baseline (Internal + External)	Baseline With Uncertainty[e]	
1 – Enhance Procedures and Provide Additional Equipment to Respond to Loss of Control Area Ventilation	Modify fault tree to include a new HEP event, having a failure probability of 2.0E-02, representing failure of the operator to open doors and align fans. In addition, reduce the fire CDF contribution from fires in Fire Area 1FA-EP-100G/1F1-PP-100H assuming the same failure probability.	34	30	4.8M	12M	475K
2 – Re-configure SGS 3 to Provide a More Expedient Backup AC Power Source for SGS 1 and 2	SGS 3 (gas turbine) credited for weather-related and switchyard LOOPs.	10	10	1.6M	4.0M	875K
3 – Install Limited EDG Cross-Tie Capability Between SGS 1 and 2	Modify fault tree to include a new basic event, having a failure probability of 5.0E-02, representing failure to cross-tie.	16	15	2.4M	6.0M	4.2M
4 – Install Fuel Oil Transfer Pump on “C” EDG & Provide Procedural Guidance for Using “C” EDG to Power Selected “A” and “B” Loads	Modify fault tree to include a new basic event, having a failure probability of 1.0E-02, representing failure of all three fuel oil transfer pumps. Also modify fault tree to cross-tie Train A, B, and C engineered safety feature (ESF) buses.	16	15	2.4M	6.0M	585K

Table F-6. SAMA Cost/Benefit Screening Analysis for SGS[a] (PSEG 2009)

SAMA	Assumptions	% Risk Reduction		Total Benefit ($)		Cost ($)
		CDF	Population Dose	Baseline (Internal + External)	Baseline With Uncertainty[e]	
5 – Install Portable Diesel Generators to Charge Station Battery and Circulating Water Batteries and Replace PDP with Air-Cooled Pump	Modify fault tree to include a new basic event, having a failure probability of 1.0E-01, representing hardware and operator failure of new charging pump. Also, as provided in response to an NRC staff RAI, likelihood of offsite power nonrecovery changed to 1.0E-02 from 2.4E-01 for grid and from 1.0E-01 for site/switchyard-related causes and to 3.0E-02 from 2.4E-01 for weather-related causes.	16	11	3.1M	7.6M	3.3M
5A[b] – Install Portable Diesel Generators to Charge Station Battery and Circulating Water Batteries	As provided in response to an NRC staff RAI, likelihood of offsite power nonrecovery changed to 1.0E-02 from 2.4E-01 for grid and from 1.0E-01 for site/switchyard-related causes and to 3.0E-02 from 2.4E-01 for weather-related causes.	10	10	2.4M	6.0M[d]	770K
6 – Enhance Flood Detection for 84' Auxiliary Building and Enhance Procedural Guidance for Responding to Service Water Flooding	The failure probabilities of existing operator actions to detect and isolate floods successfully were multiplied by a factor of 0.1.	6	1	300K	750K	250K
7 – Install "B" Train Auxiliary Feedwater Storage Tank (AFWST) Makeup Including Alternate Water Source	Modify fault tree to include a new basic event, having a failure probability of 1.0E-03, representing failure of the alternate water source.	7	1	410K	1.0M	470K

Table F-6. SAMA Cost/Benefit Screening Analysis for SGS[a] (PSEG 2009)

SAMA	Assumptions	% Risk Reduction		Total Benefit ($)		Cost ($)
		CDF	Population Dose	Baseline (Internal + External)	Baseline With Uncertainty[e]	
8 – Install High Pressure Pump Powered with Portable Diesel Generator and Long-term Suction Source to Supply the AFW Header	**Modify fault tree to include a new basic event, having a failure probability of 1.0E-02, representing failure of the new pump. In addition, reduce the fire CDF contribution from fires in Fire Areas 12FA-SB-100/1FA-TGA-88 and 1FA-AB-84B assuming the same failure probability.**	**15**	**6**	**1.6M**	**4.1M**	**2.5M**
9 – Connect Hope Creek Cooling Tower Basin to SGS Service Water System as Alternate Service Water Supply	**Reduce failure probabilities for all service water fouling events by a factor of 10.**	**13**	**11**	**1.7M**	**4.3M**	**1.2M**
10 – Provide Procedural Guidance for Faster Cooldown Loss of RCP Seal Cooling	**The probability that operators would fail to reduce reactor coolant system (RCS) pressure was reduced to 0.1 from 1.0.**	**1**	**<1**	**110K**	**280K**	**100K**
11 – Modify Plant Procedures to Make use of Other Unit's PDP for RCP Seal Cooling	**The probability that operators would fail to respond short/long-term seal injection demand was reduced to 0.1 from 1.0.**	**13**	**12**	**2.0M**	**5.0M**	**100K**
12 – Improve Flood Barriers Outside of 220/440VAC Switchgear Rooms	**Reduce likelihood that the drains would fail to remove the volume of water assumed in the flooding analysis from 1.0E-01 to 1.0E-03.**	**3**	**3**	**550K**	**1.4M**	**475K**
13 – Install Primary Side Isolation Valves on the Steam Generators	Reduce likelihood of a SGTR in each steam generator from 1.75E-03 to 1.75E-05.	6	30	5.2M	13M	18M

Table F-6. SAMA Cost/Benefit Screening Analysis for SGS[a] (PSEG 2009)

SAMA	Assumptions	% Risk Reduction		Total Benefit ($)		Cost ($)
		CDF	Population Dose	Baseline (Internal + External)	Baseline With Uncertainty[e]	
14 – Expand AMSAC Function to Include Backup Breaker Trip on Reactor Protection System (RPS) Failure	**Modify fault tree to AND the current event for electrical RPS trip failure with the top gate for AMSAC.**	**19**	**<1**	**530K**	**1.3M**	**485K**
15 – Automate RCP Seal Injection Realignment upon Loss of Component Cooling Water (CCW)	Reduce likelihood of failure to isolate letdown and realign suction source to the refueling water storage tank (RWST) from 1.0E-02 to 1.0E-03.	1	<1	42K	69K	210K
16 – Install Additional Train of Switchgear Room Cooling	Reduce likelihood of operator failure to open doors and establish alternate switchgear room cooling from 5.90E-03 to 5.90E-05.	1	1	180K	450K	2.5M
17 – Enhance Procedures and Provide Additional Equipment to Respond to Loss of EDG Control Room Ventilation	**As provided in response to an NRC staff RAI, reduce likelihood of failure of EDG control room HVAC fans from 4.80E-03 to 4.8E-04 for two fans and 2.3E-06 for the third fan.**	**3**	**3**	**510K**	**1.3M**	**200K**
18 – Redundant Service Water (SW) Turbine Header Isolation Valve	Reduce failure probability for the operator action to close the SW turbine header valves from 2.20E-02 to 1.0E-03.	<1	<1	140K	350K	635K
19 – Install Spray Shields on Residual Heat Removal (RHR) Pumps	Reduce initiating event frequency for the 45' elevation Auxiliary Building spray scenario from 7.60E-04 to 7.60E-06.	1	0	34K	84K	350K

Table F-6. SAMA Cost/Benefit Screening Analysis for SGS[a] (PSEG 2009)

SAMA	Assumptions	% Risk Reduction		Total Benefit ($)		Cost ($)
		CDF	Population Dose	Baseline (Internal + External)	Baseline With Uncertainty[e]	
20 – Fire Protection System to Provide Make-up to RCS and Steam Generators (SGs)	Modify fault tree to include two new basic events, having failure probabilities of 1.0E-02 and 1.0E-01, representing failure of the new AFW pump and independently-powered charging pump, respectively. In addition, reduce the fire CDF contribution from fires in Fire Areas 1FA-AB-84A, 1FA-EP-78C, 1FA-AB-64A, 1FA-AB-84B, and 12FA-SB-100/1FA-TGA-88 assuming the same failure probability of 1.0E-01.	21	7	5.1M	12.7M	13M
21 – Seal the Category II and III Cabinets in the Relay Room	Eliminate the fire CDF contribution from fire damage state 1RE2.	NOT ESTIMATED		870K	2.2M	3.2M
22 – Install Fire Barriers between the 1CC1, 1CC2, and 1CC3 Consoles in the CRE	Eliminate the fire CDF contribution from Fire Damage State CR16.	NOT ESTIMATED		330K	830K	1.6M
23 – Install Fire Barriers and Cable Wrap to Maintain Divisional Separation in the 4160V AC Switchgear Room	Reduce the fire CDF contribution from transient combustible fires in Fire Area 1FA-AB-64A, 4160 Switchgear Room, by 95 percent.	NOT ESTIMATED		300K	750K	975K
24 – Provide Procedural Guidance to Cross-tie SGS 1 and 2 Service Water Systems	**Modify fault tree to prevent a complete loss of service water event for events which can affect service water supply to one unit only.**	**9**	**4**	**700K**	**1.8M**	**175K**

Table F-6. SAMA Cost/Benefit Screening Analysis for SGS[a] (PSEG 2009)

SAMA	Assumptions	% Risk Reduction		Total Benefit ($)		Cost ($)
		CDF	Population Dose	Baseline (Internal + External)	Baseline With Uncertainty[e]	
27 – In addition to the Equipment Installed for SAMA 5, Install Permanently Piped Seismically Qualified Connections to Alternate AFW Water Sources	**Modify fault tree to include a new basic event, having a failure probability of 1.0E-01, representing hardware and operator failure of new charging pump. Also, as provided in response to an NRC staff RAI, likelihood of offsite power nonrecovery changed to 1.0E-02 from 2.4E-01 for grid and from 1.0E-01 for site/switchyard-related causes and to 3.0E-02 from 2.4E-01 for weather-related causes.**	**16**	**11**	**3.1M**	**7.7M**	**4.2M**
30[c] – Automatic Start of Diesel-Powered Air Compressor	The failure probability for the operator action to start the diesel-powered air compressor was reduced by a factor of 100 to 6.3E-04 from 6.3E-02.	1	<1	40K	83K	100K
31[c] – Fully Automate Swapover to Sump Recirculation	The failure probability for the operator action to swapover to sump recirculation was reduced by a factor of 100 to 5.3E-05 from 5.3E-03.	1	<1	27K	56K	100K
32[c] – Enhance Flood Detection for 100-foot Auxiliary Building and Enhance Procedural Guidance for Responding to Internal Floods	The failure probability for the operator action to isolate the flood source was reduced by a factor of 100 to 1.0E-03 from 1.0E-01.	1	<1	50K	100K	250K

Table F-6. SAMA Cost/Benefit Screening Analysis for SGS[(a)] (PSEG 2009)

SAMA	Assumptions	% Risk Reduction		Total Benefit ($)		Cost ($)
		CDF	Population Dose	Baseline (Internal + External)	Baseline With Uncertainty[(e)]	

(a) SAMAs in bold are potentially cost-beneficial.

(b) SAMA 5A added as a sensitivity case to SAMA 5 to provide a comprehensive, long term mitigation strategy for SBO scenarios.

(c) SAMAs 30, 31, and 32 were identified and evaluated in response to an NRC staff RAI (PSEG 2010a). The RAI response stated that the percent risk reduction was developed using SGS PRA Model Version 4.3 and that the implementation costs for SAMAs 30 and 31 are expected to be significantly greater than the $100K assumed in the SAMA evaluation.

(d) Value estimated by NRC staff using information provided in the ER.

(e) Using a factor of 2.5.

F.5 Cost Impacts of Candidate Plant Improvements

PSEG estimated the costs of implementing the 25 candidate SAMAs through the development of site-specific cost estimates. The cost estimates conservatively did not include the cost of replacement power during extended outages required to implement the modifications (PSEG 2009).

The NRC staff reviewed the bases for the applicant's cost estimates (presented in Table E.5-3 of Attachment E to the ER). For certain improvements, the NRC staff also compared the cost estimates to estimates developed elsewhere for similar improvements, including estimates developed as part of other licensees' analyses of SAMAs for operating reactors.

The ER stated that plant personnel developed SGS-specific costs to implement each of the SAMAs. The NRC staff requested more information on the process PSEG used to develop the SAMA cost estimates (NRC 2010a). PSEG responded to the RAI by explaining that the cost estimates were developed in a series of meetings involving personnel responsible for development of the SAMA analysis and the two PSEG license renewal site leads who are engineering managers each having over 25 years of plant experience, including project management, operations, plant engineering, design engineering, procedure support, simulators, and training (PSEG 2010a). During these meetings, each SAMA was validated against the plant configuration, a budget-level estimate of its implementation cost was developed, and, in some instances, lower cost approaches that would achieve the same objective were developed. The SAMA implementation costs were then reviewed by the Design Engineering Manager for both technical and cost perspectives and revised accordingly. PSEG further explained that seven general cost categories were used in development of the budget-level cost estimates: engineering, material, installation, licensing, critical path impact, simulator modification, and procedures and training. For costs that could be shared between the two SGS units, the total estimated cost was evenly divided between the two units to develop a per unit cost. Based on the use of personnel having significant nuclear plant engineering and operating experience, the NRC staff considers the process PSEG used to develop budget-level cost estimates reasonable.

In response to an RAI requesting a more detailed description of the changes associated with SAMAs 3, 5, 8, 13, 20, and 23, PSEG provided additional information detailing the analysis and plant modifications included in the cost estimate of each improvement (PSEG 2010a). The staff reviewed the costs and found them to be reasonable, and generally consistent with estimates provided in support of other plants' analyses.

The NRC staff also noted that the ER reported an implementation cost for SAMA 3, "Install Limited EDG Cross-Tie Capability Between SGS 1 and 2," of $4.175M in Section E.6.3 and $525K in Section E.5-3 and requested clarification on which was the correct value (NRC

2010a). SEG responded that $4.175K was the correct value and stated that this value was used in the SAMA evaluation (PSEG 2010a).

The NRC staff requested PSEG provide justification for the differences in the cost estimates for SAMA 1, “Enhance Procedures and Provide Additional Equipment to Respond to Loss of Control Area Ventilation,” having a cost of $475K, and SAMA 17, “Enhance Procedures and Provide Additional Equipment to Respond to Loss of Emergency Diesel Generator (EDG) Control Room Ventilation,” having a cost of $200K, which are similar in that each involves opening doors to provide ventilation and using portable fans to enhance natural circulation (NRC 2010a). In response to the RAI, PSEG stated that SAMA 1 has a higher cost because it is a more complicated modification involving three rooms having differing requirements while SAMA 17 involves four rooms that are basically identical (PSEG 2010a). The NRC staff considers the basis for the differences in cost estimates reasonable.

The NRC staff noted that SAMA 21, “Seal the Category II and III Cabinets in the Relay Room,” and SAMA 22, “Install Fire Barriers between the 1CC1, 1CC2, and 1CC3 Consoles in the CRE,” are similar in that each involves installing fire barriers to prevent the propagation of a fire between cabinets and requested an explanation for why the estimated cost of $3.23M for SAMA 21 to modify 48 cabinets is similar to the estimated cost of $1.6M for SAMA 22 to modify just three consoles (NRC 2010a). PSEG responded that the cost per console ($400K) in SAMA 22, is much higher than the cost per cabinet ($35K - $70K) in SAMA 21 because making the modifications to the Control Room consoles is more complicated than making the modifications to the Relay Room cabinets (PSEG 2010a). Specifically, SAMA 22 requires making ventilation modifications due to the significant heat loads in addition to adding fire barrier materials. The NRC staff considers the basis for the differences in cost estimates reasonable.

The NRC asked PSEG to justify the estimated cost of $100K for SAMA 10, “Provide Procedural Guidance for Faster Cooldown Loss of RCP Seal Cooling,” and SAMA 11, “Modify Plant Procedures to Make use of Other Unit’s Positive Displacement Pump (PDP) for RCP Seal Cooling,” in light of the statement made in the ER that the minimum expected implementation cost is assumed to be a procedure change at $50K per site, based on a cost of $100K for the site (NRC 2010a). In response to the RAI, PSEG explained that the cost for SAMA 10 includes 1) $50K to perform a feasibility study to confirm that there is no technical basis preventing implementation of a more rapid cooldown on loss of RCP seal cooling and 2) $150K to revise the emergency operating procedures (EOPs), which are more expensive to revise and require more extensive training than other plant procedures (PSEG 2010a). PSEG also explained that the cost for SAMA 11 includes 1) $50K to perform a feasibility study to confirm that there is no technical basis preventing PDP cross-tie when RCP seal cooling is lost, 2) $50K to revise the plant procedures, and 3) $50K for each unit to involve plant licensing staff. The total of $200K for both SAMAs is divided evenly between the two units. The NRC staff considers the bases for the estimated costs for these SAMAs reasonable.

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

F.6 Cost-Benefit Comparison

PSEG's cost-benefit analysis and the NRC staff's review are described in the following sections.

F.6.1 PSEG's Evaluation

The methodology used by PSEG was based primarily on NRC's guidance for performing cost-benefit analysis, i.e., NUREG/BR-0184, *Regulatory Analysis Technical Evaluation Handbook* (NRC 1997a). The guidance involves determining the net value for each SAMA according to the following formula:

Net Value = (APE + AOC + AOE + AOSC) – COE

where
APE = present value of averted public exposure ($)
AOC = present value of averted offsite property damage costs ($)
AOE = present value of averted occupational exposure costs ($)
AOSC = present value of averted onsite costs ($)
COE = cost of enhancement ($)

If the net value of a SAMA is negative, the cost of implementing the SAMA is larger than the benefit associated with the SAMA and it is not considered cost-beneficial. PSEG's derivation of each of the associated costs is summarized below.

NUREG/BR-0058 has recently been revised to reflect the agency's policy on discount rates. Revision 4 of NUREG/BR-0058 states that two sets of estimates should be developed, one at 3 percent and one at 7 percent (NRC 2004). PSEG provided a base set of results using the 3 percent discount rate and a sensitivity study using the 7 percent discount rate (PSEG 2009).

<u>Averted Public Exposure (APE) Costs</u>

The APE costs were calculated using the following formula:

APE = Annual reduction in public exposure (Δperson-rem/year)

× monetary equivalent of unit dose ($2,000 per person-rem)
× present value conversion factor (15.04 based on a 20-year period with a 3-percent discount rate)

As stated in NUREG/BR-0184 (NRC 1997a), it is important to note that the monetary value of the public health risk after discounting does not represent the expected reduction in public health risk due to a single accident. Rather, it is the present value of a stream of potential losses extending over the remaining lifetime (in this case, the renewal period) of the facility. Thus, it reflects the expected annual loss due to a single accident, the possibility that such an accident could occur at any time over the renewal period, and the effect of discounting these potential future losses to present value. For the purposes of initial screening, which assumes elimination of all severe accidents, PSEG calculated an APE of approximately $2,350,000 for the 20-year license renewal period (PSEG 2009).

<u>Averted Offsite Property Damage Costs (AOC)</u>

The AOCs were calculated using the following formula:

AOC = Annual CDF reduction
x offsite economic costs associated with a severe accident (on a per-event basis)
x present value conversion factor.

This term represents the sum of the frequency-weighted offsite economic costs for each release category, as obtained for the Level 3 risk analysis. For the purposes of initial screening, which assumes elimination of all severe accidents caused by internal events, PSEG calculated an AOC of about $306,000 based on the Level 3 risk analysis. This results in a discounted value of approximately $4,600,000 for the 20-year license renewal period.

<u>Averted Occupational Exposure (AOE) Costs</u>

The AOE costs were calculated using the following formula:

AOE = Annual CDF reduction
× occupational exposure per core damage event
× monetary equivalent of unit dose
× present value conversion factor

PSEG derived the values for averted occupational exposure from information provided in Section 5.7.3 of the regulatory analysis handbook (NRC 1997a). Best estimate values provided for immediate occupational dose (3,300 person-rem) and long-term occupational dose (20,000 person-rem over a 10-year cleanup period) were used. The present value of these doses was calculated using the equations provided in the handbook in conjunction with a monetary equivalent of unit dose of $2,000 per person-rem, a real discount rate of 3 percent, and a time period of 20 years to represent the license renewal period. For the purposes of initial screening, which assumes elimination of all severe accidents caused by internal events, PSEG calculated an AOE of approximately $31,000 for the 20-year license renewal period (PSEG 2009).

Averted Onsite Costs

Averted onsite costs (AOSC) include averted cleanup and decontamination costs and averted power replacement costs. Repair and refurbishment costs are considered for recoverable accidents only and not for severe accidents. PSEG derived the values for AOSC based on information provided in Section 5.7.6 of NUREG/BR-0184, the regulatory analysis handbook (NRC 1997a).

PSEG divided this cost element into two parts – the onsite cleanup and decontamination cost, also commonly referred to as averted cleanup and decontamination costs (ACC), and the replacement power cost (RPC).

ACCs were calculated using the following formula:

ACC = Annual CDF reduction
x present value of cleanup costs per core damage event
× present value conversion factor

The total cost of cleanup and decontamination subsequent to a severe accident is estimated in NUREG/BR-0184 to be $\$1.5 \times 10^9$ (undiscounted). This value was converted to present costs over a 10-year cleanup period and integrated over the term of the proposed license extension. For the purposes of initial screening, which assumes elimination of all severe accidents caused by internal events, PSEG calculated an ACC of approximately $965,000 for the 20-year license renewal period.

Long-term RPCs were calculated using the following formula:

RPC = Annual CDF reduction
x present value of replacement power for a single event
× factor to account for remaining service years for which replacement power is required
× reactor power scaling factor

PSEG based its calculations on a SGS net output of 1115 megawatt electric (MWe) and scaled up from the 910 MWe reference plant in NUREG/BR-0184 (NRC 1997a). Therefore PSEG applied a power scaling factor of 1115/910 to determine the replacement power costs. For the purposes of initial screening, which assumes elimination of all severe accidents caused by internal events, PSEG calculated an RPC of approximately $335,000 and an AOSC of approximately $1,300,000 for the 20-year license renewal period.

Using the above equations, PSEG estimated the total present dollar value equivalent associated with completely eliminating severe accidents from internal events at SGS to be about $8.28M. Use of a multiplier of 2 to account for external events increases the value to $16.56M and represents the dollar value associated with completely eliminating all internal and external event severe accident risk for a single unit at SGS, also referred to as the Single Unit Maximum Averted Cost Risk (MACR).

PSEG's Results

If the implementation costs for a candidate SAMA exceeded the calculated benefit, the SAMA was considered not to be cost-beneficial. In the baseline analysis contained in the ER (using a 3 percent discount rate and considering the impact of external events), PSEG identified 11 potentially cost-beneficial SAMAs. PSEG performed additional analyses to evaluate the impact of parameter choices (alternative discount rates and variations in MACCS2 input parameters) and uncertainties on the results of the SAMA assessment and, as a result of this analysis, identified five additional potentially cost-beneficial SAMAs. PSEG also performed an analysis on a less costly alternative to SAMA 5 (SAMA 5A) and found it to be potentially cost-beneficial.

The potentially cost-beneficial SAMAs for SGS are the following:

- SAMA 1 – Enhance Procedures and Provide Additional Equipment to Respond to Loss of Control Area Ventilation
- SAMA 2 – Re-configure Salem 3 to Provide a More Expedient Backup AC Power Source for Salem 1 and 2
- SAMA 3 – Install Limited EDG Cross-tie Capability Between Salem 1 and 2
- SAMA 4 – Install Fuel Oil Transfer Pump on "C" EDG & Provide Procedural Guidance for Using "C" EDG to Power Selected "A" and "B" Loads
- SAMA 5 – Install Portable Diesel Generators to Charge Station Battery and Circulating Water Batteries & Replace PDP with Air-Cooled Pump
- SAMA 5A – Install Portable Diesel Generators to Charge Station Battery and Circulating Water Batteries
- SAMA 6 – Enhance Flood Detection for 84' Aux Building and Enhance Procedural Guidance for Responding to Service Water Flooding
- SAMA 7 – Install "B" Train AFWST Makeup Including Alternate Water Source

- SAMA 8 – Install High Pressure Pump Powered with Portable Diesel Generator and Long-term Suction Source to Supply the AFW Header
- SAMA 9 – Connect Hope Creek Cooling Tower Basin to Salem Service Water System as Alternate Service Water Supply
- SAMA 10 – Provide Procedural Guidance for Faster Cooldown on Loss of RCP Seal Cooling
- SAMA 11 – Modify Plant Procedures to Make Use of Other Unit's PDP for RCP Seal Cooling
- SAMA 12 – Improve Flood Barriers Outside of 220/440VAC Switchgear Rooms
- SAMA 14 – Expand AMSAC Function to Include Backup Breaker Trip on RPS Failure
- SAMA 17 – Enhance Procedures and Provide Additional Equipment to Respond to Loss of EDG Control Room Ventilation
- SAMA 24 – Provide Procedural Guidance to Cross-tie Salem 1 and 2 Service Water Systems
- SAMA 27 –In Addition to the Equipment Installed for SAMA 5, Install Permanently Piped Seismically Qualified Connections to Alternate AFW Water Sources

PSEG indicated that they plan to further evaluate these SAMAs for possible implementation using existing action-tracking and design change processes (PSEG 2009).

The potentially cost-beneficial SAMAs, and PSEG's plans for further evaluation of these SAMAs, are discussed in detail in Section F.6.2.

F.6.2 Review of PSEG's Cost-Benefit Evaluation

The cost-benefit analysis performed by PSEG was based primarily on NUREG/BR-0184 (NRC 1997a) and discount rate guidelines in NUREG/BR-0058 (NRC 2004) and was executed consistent with this guidance.

SAMAs identified primarily on the basis of the internal events analysis could provide benefits in certain external events, in addition to their benefits in internal events. To account for the additional benefits in external events, PSEG multiplied the internal event benefits for all but one internal event SAMA (SAMA 20, discussed further below) by a factor of 2, which is approximately the ratio of the total CDF from internal and external events to the internal event

CDF (PSEG 2009). As discussed in Section F.2.2, this factor was based on a seismic CDF of 9.5×10^{-6} per year, plus a fire CDF of 3.8×10^{-5} per year, plus the screening values for high winds, external flooding, transportation, detritus, and chemical release events (1×10^{-6} per year for each). The external event CDF of 5.3×10^{-5} per year is thus about 110 percent of the internal events CDF used in the SAMA analysis (5.0×10^{-5} per year). The total CDF is 2.1 times the internal events CDF and this was rounded to 2. Eleven SAMAs were determined to be cost-beneficial in PSEG's analysis (SAMAs 1, 2, 4, 6, 9, 10, 11, 12, 14, 17, and 24 as described above).

PSEG did not multiply the internal event benefits by the factor of 2 for three SAMAs that specifically address fire risk (SAMAs 21, 22, and 23). Doubling the internal event estimate for SAMAs 21, 22, and 23 would not be appropriate because these SAMAs are specific to fire risks and would not have a corresponding benefit on the risk from internal events.

For all but one internal event SAMA also having benefits in fire and seismic risk (i.e., SAMAs 1, and 8 for fire and SAMAs 5, 5A, and 27 for seismic), PSEG separately quantified the benefits for fire and seismic events and added these results to the benefits from internal events and external events developed from applying the factor of 2 (as discussed in Section F.4 above). The NRC staff noted that this process appeared to be double counting the benefits from external events and requested clarification (NRC 2010a). In response to the RAI, PSEG acknowledged that this process results in "double counting" of some external event contributions to the total averted cost risk and stated that this approach was retained, unless it resulted in a gross misrepresentation of a SAMA's benefit, in order to avoid underestimating the external events averted cost risk (PSEG 2010a). PSEG further concluded that this process does not impact the conclusions of the SAMA analysis. Since the process that PSEG used over-estimates the benefits from external events and therefore results in conservative estimates of the SAMA benefits, the NRC staff considers the process PSEG used acceptable for the SAMA evaluation.

For SAMA 20, "Fire Protection System to Provide Make-up to RCS and Steam Generators," PSEG multiplied the estimated benefits for internal events by a factor of 2.0 to account for external events in the Phase I analysis. In the Phase II analysis, PSEG separately quantified the internal event, fire event, and seismic event benefits, as described in Section F.4 above, and to account for the additional benefits in other (non-fire/non-seismic) external events, PSEG multiplied the internal event benefits by a factor of 1.1, which is the ratio of the total CDF from internal and other external events to the internal event CDF (based on an HFO CDF of 5.0×10^{-6} per year and an internal events CDF of 5.0×10^{-5} per year used in the SAMA analysis). The estimated SAMA benefits for internal events with the factor of 1.1 applied to account for other external events, fire events, and seismic events were then summed to provide an overall benefit. Since the methodology PSEG used accounts for both internal events and external events, the NRC staff considers the methodology PSEG used for SAMA 20 acceptable for the SAMA evaluation.

PSEG considered the impact that possible increases in benefits from analysis uncertainties would have on the results of the SAMA assessment. In the ER, PSEG presents the results of an uncertainty analysis of the internal events CDF which indicates that the 95th percentile value is a factor of 1.64 times the point estimate CDF for SGS. Since the one Phase I SAMA that was screened based on qualitative criteria was screened due to not being applicable to SGS, a re-examination of the Phase I SAMAs based on the upper bound benefits was not necessary. PSEG considered the impact on the Phase II screening if the estimated benefits were increased by a factor of 1.64 (in addition to the multiplier of 2 for external events). Four additional SAMAs became cost-beneficial in PSEG's analysis (SAMAs 5, 7, 8, and 27 as described above).

PSEG noted that the 95th percentile value for CDF may be underestimated because uncertainty distributions are not applied to all basic events in the SGS PRA model. Based on this, PSEG used a factor of 2.5 times the point estimate CDF to represent the 95th percentile value, which is stated to be typical of most light water reactor CDF uncertainty analyses. PSEG considered the impact on the Phase II screening if the estimated benefits were increased by a factor of 2.5 (in addition to the multiplier of 2 for external events). One additional SAMA became cost-beneficial (SAMA 3). The NRC staff notes that while the factor of 2.5 does not represent an upper bound, it is typical of factors used in prior SAMA analyses, is higher than the factor calculated for other Westinghouse 4-loop plants and used in prior SAMA analysis, and is therefore considered by the NRC staff to be appropriate for use in the SAMA sensitivity analyses.

PSEG provided the results of additional sensitivity analyses in the ER, including use of a 7 percent discount rate and variations in MACCS2 input parameters. These analyses did not identify any additional potentially cost-beneficial SAMAs (PSEG 2009).

The NRC staff noted that the ER reported that the licensed thermal power for SGS Unit 1 is 3,459 MWt, which equates to a net electrical output of 1,195 MWe when operating at 100 percent power, while 1,115 MWe was used to calculate long-term replacement power costs for the SAMA analysis (NRC 2010a). In response to the RAI, PSEG clarified that 1,115 MWe used in the SAMA analysis was incorrect and provided a revised replacement power cost estimate of $359,000 using the correct 1,195 MWe, which is an approximately 7 percent increase over that used in the SAMA analysis (PSEG 2010a). PSEG also provided a revised MACR of $16.61M, which is an increase of about 0.3 percent over the MACR used in the SAMA analysis and concluded that the small error would have a negligible impact on the conclusions of the SAMA analysis. The NRC staff agrees with this assessment.

As indicated in Section F.3.2, in response to an NRC staff RAI, PSEG extended the review of Level 1 and Level 2 basic events down to an RRW of 1.006, which equates to a benefit of about $47,000, using SGS PRA MOR Revision 4.3 (PSEG 2010a). The review identified the following three additional SAMAs associated with new basic events added to the importance lists: 1) SAMA 30, "Automatic Start of Diesel-Powered Air Compressor," 2) SAMA 31, "Fully Automate

Swapover to Sump Recirculation," and 3) SAMA 32, "Enhance Flood Detection for 100-foot Auxiliary Building and Enhance Procedural Guidance for Responding to Internal Floods." Each of these new SAMAs is included in Table F-6. PSEG performed a Phase II evaluation using results for SGS PRA MOR Revision 4.3 and the process described above. PSEG stated that the release frequency for MOR Revision 4.3 is 2.2×10^{-5} per year, a decrease of over 50 percent from MOR Revision 4.1, and that the 95th percentile value for CDF is a factor of 2.1 times the point estimate CDF. Based on information provided in the RAI response, the NRC staff estimated, for the MOR Revision 4.3 results, the total present dollar value equivalent associated with completely eliminating severe accidents from internal events at SGS to be about $2.3M, a revised external event multiplier of about 3.4, and a revised MACR of about $7.9M. These results represent a decrease of more than 50 percent compared to the SGS PRA MOR 4.1 results reported in the ER. PSEG's analysis determined that none of the three SAMA candidates was cost-beneficial in either the baseline analysis or the uncertainty analysis.

Based on these results for MOR Revision 4.3 and the changes in the importance lists, the NRC staff asked PSEG to assess the impact on the SAMA evaluation of the PRA model changes made since MOR Revision 4.1 (NRC 2010b). In response to the RAI, PSEG re-evaluated each potentially cost-beneficial SAMA using MOR Revision 4.3 and determined that SAMA benefits both increased (up to 42 percent) and decreased (up to 99 percent) from the results using MOR Revision 4.1 and that five SAMA candidates (SAMA 3, 5, 11, 14, and 27) would no longer be cost-beneficial (PSEG 2010b). PSEG also qualitatively evaluated each SAMA determined to not be cost-beneficial and concluded that none would become cost-beneficial using MOR Revision 4.3 based on the following:

- The implementation cost is greater than the revised MACR even after accounting for uncertainty (SAMA 13).

- For SAMAs that address fire events only, the maximum averted cost risk for external events decreased, which would result in a corresponding decrease in the maximum calculated benefit for these SAMAs (SAMAs 21, 22, and 23).

- The cost of implementation was sufficiently greater than the MOR Revision 4.1 benefit that changes in MOR Revision 4.3 would not be expected to overcome the difference (SAMAs 15, 16, 18, and 19). The NRC staff notes that this difference, even after accounting for uncertainty, is on the order of 50 percent or more for all of these SAMAs and agrees that it is unlikely that a revised evaluation would result in a change to the cost-beneficial status for these SAMAs.

- The cost of implementation is greater than the revised MACR (SAMA 20). The NRC staff notes that MOR Revision 4.1 results indicate that the fire and seismic events contributors to the MACR are four times the internal events contribution and, since the maximum averted cost risk for external events has decreased with MOR Revision 4.3, agrees that it is unlikely that a revised evaluation would result in a change to cost-beneficial status for this SAMA.

As indicated in Section F.3.2, the NRC staff asked the licensee to evaluate several potentially lower cost alternatives to the SAMAs considered in the ER (NRC 2010a), as summarized below:

- Operating the AFW AF11/21 valves closed in lieu of SAMA 8, "Install High Pressure Pump Powered with Portable Diesel Generator and Long-term Suction Source to Supply the AFW Header." In response to the RAI, PSEG stated that the AF11 valves on the discharge side of the motor-driven AFW pumps are already operated closed, leaving only the AF21 valves on the discharge side of the turbine-driven AFW pump operating open (PSEG 2010a). Steam binding of the common suction line to all three AFW pumps could therefore only occur as a result of high temperature water leaks through three check valves in series on the discharge to the turbine-driven AFW pump. PSEG concluded that the proposed improvement would not be feasible because 1) industry data used to represent common-cause steam binding of all three AFW pumps appears to be conservative relative to the SGS configuration, thereby overstating the risk significance of this failure at SGS, 2) operating all of the AF11/21 valves closed could actually provide a negative risk benefit based on a new failure event to represent common-cause failure of the valves to open, and 3) operating all of the AF11/21 valves closed could have a potentially adverse effect on the SGS design basis because design-basis calculations and assumptions would need to be modified to reflect this change in AFW strategy.

- Install improved fire barriers in the 460V switchgear rooms to provide separation between the three power divisions in lieu of SAMA 20, "Fire Protection System to Provide Make-up to RCS and Steam Generators." In response to the RAI, PSEG explained that the configuration of Fire Area 1FA-AB-84A, addressed by SAMA 20, is significantly more complex than Fire Area 1FA-AB-64A, addressed by SAMA 23, "Install Fire Barriers and Cable Wrap to Maintain Divisional Separation in the 4160V AC Switchgear Room" (PSEG 2010a). The SAMA 23 estimated implementation cost of $975K only addresses the risk associated with preventing the spread of transient fires between divisions and did not address the entire fire risk in the fire area, which would include protecting the overhead cables. PSEG estimates that the cost of addressing the entire fire risk in Fire Area 1FA-AB-64A would be at least an order of magnitude greater than the estimated implementation cost for SAMA 23. PSEG further estimates that the cost of addressing the fire risk in Fire Area 1FA-AB-84A could be double that for Fire Area 1FA-AB-64A. The maximum benefit of the proposed SAMA, which assumes elimination of all fire risk for Fire Area 1FA-AB-84A, is estimated to be $2.0M in the baseline analysis, or $5.1M accounting for uncertainties, using the MOR Rev. 4.1 PRA model. Furthermore, PSEG determined that the maximum benefit would be about 30 percent lower if the MOR Rev. 4.3 PRA model were used. Because the estimated implementation cost is significantly greater than the maximum potential benefit, PSEG concluded that the proposed SAMA would not be cost-beneficial.

- Install improved fire barriers to provide separation between the AFW pumps in lieu of SAMA 8, "Install High Pressure Pump Powered with Portable Diesel Generator and Long-term Suction Source to Supply the AFW Header." In response to the RAI, PSEG estimated the cost to implement the proposed SAMA to be $750K (PSEG 2010a). Failure of multiple AFW pumps accounted for about 67 percent of the Fire Area 1FA-AB-84B fire risk. The maximum benefit of the proposed SAMA, which assumes elimination of all of this fire risk, is estimated to be $120K in the baseline analysis, or $290K accounting for uncertainties, using the MOR Rev. 4.1 PRA model. Furthermore, PSEG determined that the maximum benefit would be about 30 percent lower if the MOR Rev. 4.3 PRA model were used. Because the estimated implementation cost is significantly greater than the maximum potential benefit, PSEG concluded that the proposed SAMA would not be cost-beneficial.

PSEG indicated that the 17 potentially cost-beneficial SAMAs (SAMAs 1, 2, 3, 4, 5, 5A, 6, 7, 8, 9, 10, 11, 12, 14, 17, 24, and 27) will be considered for implementation through the established Salem Plant Health Committee (PHC) process (PSEG 2009). In response to an NRC staff RAI, PSEG described the PHC as being chaired by the Plant Manager and includes as members the Plant Engineering Manager and the Directors of Operations, Engineering, Maintenance, and Work Management (PSEG 2010a). The PHC is chartered with reviewing issues that require special plant management attention to ensure effective resolution and, with respect to each of the potentially cost-beneficial SAMAs, will decide on one of the following courses of actions: 1) approve for implementation, 2) conditionally approved for implementation pending the results of requested evaluations, 3) not approved for implementation, or 4) tabled until additional information needed to make a final decision is provided to the PHC. Additional requests may include 1) updating the SAMA analysis, 2) examining an alternate solution, 3) performing sensitivity studies to determine the effect of implementing a sub-set of SAMAs, already approved SAMAs, or already approved non-SAMA design changes on the SAMA, or 4) coordinating the SAMA with related Mitigating System Performance Index (MSPI) margin recovery activities. If approved or conditionally approved for implementation, the SAMA will be ranked with respect to priority and assigned target years for implementation.

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

F.7 Conclusions

PSEG compiled a list of 27 SAMAs based on a review of: the most significant basic events from the plant-specific PRA and insights from the SGS PRA group, insights from the plant-specific IPE and IPEEE, Phase II SAMAs from license renewal applications for other plants, and the generic SAMA candidates from NEI 05-01. A qualitative screening removed SAMA candidates that: (1) are not applicable to SGS due to design differences, (2) have already been implemented at SGS, (3) would achieve results that have already been achieved at SGS by other means, and (4) have estimated implementation costs that would exceed the dollar value associated with completely eliminating all severe accident risk at SGS. Based on this screening, 2 SAMAs were eliminated leaving 25 candidate SAMAs for evaluation. One additional SAMA candidate was identified and evaluated as a sensitivity case. Three additional SAMA candidates were identified and evaluated in response to an NRC staff RAI.

For the remaining SAMA candidates, including the sensitivity case SAMA and three SAMAs added in response to the NRC staff RAI, a more detailed design and cost estimate were developed as shown in Table F-6. The cost-benefit analyses in the ER and RAI response showed that 11 of the SAMA candidates were potentially cost-beneficial in the baseline analysis (Phase II SAMAs 1, 2, 4, 6, 9, 10, 11, 12, 14, 17, and 24). PSEG performed additional analyses to evaluate the impact of parameter choices and uncertainties on the results of the SAMA assessment. As a result, five additional SAMA candidates (SAMA 3, 5, 7, 8, and 27) were identified as potentially cost-beneficial in the ER. The ER also showed that the sensitivity case SAMA (SAMA 5A) was potentially cost-beneficial. PSEG has indicated that all 17 potentially cost-beneficial SAMAs will be considered for implementation through the established Salem Plant Health Committee process.

The NRC staff reviewed the PSEG analysis and concludes that the methods used and the implementation of those methods was sound. The treatment of SAMA benefits and costs support the general conclusion that the SAMA evaluations performed by PSEG are reasonable and sufficient for the license renewal submittal. Although the treatment of SAMAs for external events was somewhat limited, the likelihood of there being cost-beneficial enhancements in this area was minimized by improvements that have been realized as a result of the IPEEE process, and inclusion of a multiplier to account for external events.

The NRC staff concurs with PSEG's identification of areas in which risk can be further reduced in a cost-beneficial manner through the implementation of the identified, potentially cost-beneficial SAMAs. Given the potential for cost-beneficial risk reduction, the NRC staff agrees that further evaluation of these SAMAs by PSEG is warranted. However, these SAMAs do not relate to adequately managing the effects of aging during the period of extended operation. Therefore, they need not be implemented as part of license renewal pursuant to Title 10 of the *Code of Federal Regulations*, Part 54.

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Appendix G

U.S. Nuclear Regulatory Commission Staff Evaluation of Severe Accident Mitigation Alternatives for Hope Creek Nuclear Generating Station In Support of License Renewal Application Review

G. U.S. Nuclear Regulatory Commission Staff Evaluation of Severe Accident Mitigation Alternatives for Hope Creek Nuclear Generating Station in Support of License Renewal Application Review

G.1 Introduction

PSEG Nuclear, LLC, (PSEG) submitted an assessment of severe accident mitigation alternatives (SAMAs) for the Hope Creek Generating Station (HCGS) as part of the environmental report (ER) (PSEG 2009). This assessment was based on the most recent HCGS probabilistic risk assessment (PRA) available at that time, a plant-specific offsite consequence analysis performed using the MELCOR Accident Consequence Code System, Version 2 (MACCS2) computer code, and insights from the HCGS individual plant examination (IPE) (PSEG 1994) and individual plant examination of external events (IPEEE) (PSEG 1997). In identifying and evaluating potential SAMAs, PSEG considered SAMAs that addressed the major contributors to core damage frequency (CDF) and release frequency at HCGS, as well as SAMA candidates for other operating plants that have submitted license renewal applications. PSEG initially identified 23 potential SAMAs. This list was reduced to 21 unique SAMA candidates by eliminating SAMAs that are not applicable to HCGS due to design differences, have already been implemented at HCGS, would achieve the same risk reduction results that had already been achieved at HCGS by other means, have excessive implementation cost or could be combined with another SAMA candidate. PSEG assessed the costs and benefits associated with each of the potential SAMAs, and concluded in the ER that several of the candidate SAMAs evaluated are potentially cost-beneficial.

Based on a review of the SAMA assessment, the U.S. Nuclear Regulatory Commission (NRC) issued a request for additional information (RAI) to PSEG by letter dated May 20, 2010 (NRC 2010a) and, based on a review of the RAI responses, a request for RAI response clarification by teleconference dated July 29, 2010 (NRC 2010b). The staff's requests concerned the following:

- discussing internal and external review comments on the PRA model, including the impact of the 2008 PRA peer review comments on the SAMA analysis results;
- the process and criteria used to assign containment event tree (CET) end states to release categories;
- additional details on the seismic analysis;
- the SAMA screening process and additional potential SAMAs not previously considered; and
- further information on the costs and benefits of several specific candidate SAMAs and low cost alternatives.

PSEG submitted additional information in response to the NRC requests by letters dated June 1, 2010 (PSEG 2010a) and August 18, 2010 (PSEG 2010b). In these response letters, PSEG provided the following:

- a listing of open gaps and findings from the 2008 PRA peer review and an assessment of their impact on the SAMA analysis;
- additional description of how CET end states were assigned to release categories and how representative sequences were selected for each release category;
- clarification of certain elements of the seismic analysis and an assessment of the impact of seismic assumptions on the external events multiplier;
- analyses of additional SAMAs; and
- additional information regarding several specific SAMAs.

PSEG's responses addressed the NRC staff's concerns, and resulted in the identification of additional potentially cost-beneficial SAMAs.

An assessment of SAMAs for HCGS is presented below.

G.2 Estimate of Risk for HCGS

PSEG's estimates of offsite risk at HCGS are summarized in Section G.2.1. The summary is followed by the NRC staff's review of PSEG's risk estimates in Section G.2.2.

G.2.1 PSEG's Risk Estimates

Two distinct analyses are combined to form the basis for the risk estimates used in the SAMA analysis: (1) the HCGS Level 1 and Level 2 PRA model, which is an updated version of the IPE (PSEG 1994), and (2) a supplemental analysis of offsite consequences and economic impacts (essentially a Level 3 PRA model) developed specifically for the SAMA analysis. The SAMA analysis is based on the most recent HCGS Level 1 and Level 2 PRA model available at the time of the ER, referred to as the HC108B update. The scope of this HCGS PRA does not include external events.

The HCGS CDF is approximately 5.1×10^{-6} per year as determined from quantification of the Level 1 PRA model at a truncation of 1×10^{-12} per year. When determining the frequency of the source term categories from the sum of the containment event tree (CET) sequences, or Level 2 PRA model, a higher truncation of 5×10^{-11} per year was used and the resulting release frequency (from all release categories, which consist of intact containment, late release, and early release) is approximately 4.4×10^{-6} per year. The latter value was used as the baseline CDF in the SAMA evaluations (PSEG 2009). The CDF is based on the risk assessment for internally-initiated events, which includes internal flooding. PSEG did not explicitly include the contribution from external events within the HCGS risk estimates; however, it did account for the potential risk reduction benefits associated with external events by multiplying the estimated benefits for internal events by a factor of 6.3. This is discussed further in Sections G.2.2 and G.6.2.

The breakdown of CDF by initiating event is provided in Table G-1 (PSEG 2009). As shown in this table, events initiated by loss of offsite power, loss of service water and other transients (manual shutdown and turbine trip with bypass) are the dominant contributors to the CDF.

Anticipated transient without scram (ATWS) sequences account for 3% of the CDF, station blackout accounts for 12% of the CDF (PSEG 2010a).

Table G-1. HCGS Core Damage Frequency for Internal Events (PSEG 2009)

Initiating Event	CDF (per year)	% Contribution to CDF[1]
Loss of Offsite Power	9.3×10^{-7}	18
Loss of Service Water (SW)	8.1×10^{-7}	15
Manual Shutdown	7.7×10^{-7}	15
Turbine Trip with Bypass	6.2×10^{-7}	12
Small Loss of Coolant Accident (LOCA) – Water (Below Top of Active Fuel)	2.8×10^{-7}	5
Small LOCA – Steam (Above Top of Active Fuel)	2.3×10^{-7}	4
Loss of Condenser Vacuum	2.0×10^{-7}	4
Fire Protection System Rupture Outside Control Room	1.9×10^{-7}	4
Isolation LOCA in Emergency Core Cooling System (ECCS) Discharge Paths	1.1×10^{-7}	2
Main Steam Isolation Valve (MSIV) Closure	1.1×10^{-7}	2
Internal Flood Outside Lower Relay Room	9.7×10^{-8}	2
Loss of Feedwater	8.8×10^{-8}	2
Loss of Safety Auxiliaries Cooling System	7.9×10^{-8}	2
Reactor Auxiliaries Cooling System (RACS) Common Header Unisolable Rupture	7.6×10^{-8}	1
Unisolable SW A Pipe Rupture in RACS Room	5.7×10^{-8}	1
Unisolable SW B Pipe Rupture in RACS Room	5.7×10^{-8}	1
Others (less than 1% each)	4.1×10^{-7}	8
Total CDF (internal events)	$\mathbf{5.1 \times 10^{-6}}$	**100**

[1]Column totals may be different due to round off.

The Level 2 HCGS PRA model that forms the basis for the SAMA evaluation is essentially a complete revision to the IPE model. The Level 2 model utilizes three containment event trees (CETs) containing both phenomenological and systemic events. The Level 1 core damage sequences are binned into accident classes that provide the interface between the Level 1 and Level 2 CET analysis. The CETs are linked directly to the Level 1 event trees and CET nodes are evaluated using supporting fault trees.

The result of the Level 2 PRA is a set of 11 release or source term categories, with their respective frequency and release characteristics. The results of this analysis for HCGS are provided in Table E.3-6 of ER Appendix E (PSEG 2009). The categories were defined based on the timing of the release, the magnitude of the release, and whether or not the containment remains intact or fails. The frequency of each release category was obtained by summing the frequency of the individual accident progression CET endpoints binned into the release category. Source terms were developed for each of the 11 release categories using the results of Modular Accident Analysis Program (MAAP 4.0.6) computer code calculations.

The offsite consequences and economic impact analyses use the MACCS2 code to determine the offsite risk impacts on the surrounding environment and public. Inputs for these analyses include plant-specific and site-specific input values for core radionuclide inventory, source term and release characteristics, site meteorological data, projected population distribution (within a 50-mile radius) for the year 2046, emergency response evacuation modeling, and economic data. The core radionuclide inventory corresponds to the end-of-cycle values for HCGS operating at 3917 MWt, which is two percent above the current extended power uprate (EPU) licensed power level of 3,840 MWt. The magnitude of the onsite impacts (in terms of clean-up and decontamination costs and occupational dose) is based on information provided in NUREG/BR-0184 (NRC 1997a).

In the ER, PSEG estimated the dose to the population within 80-kilometers (50-miles) of the HCGS site to be approximately 0.23 person-Sievert (Sv) (22.9 person-roentgen equivalent man [rem]) per year. The breakdown of the total population dose by containment release mode is summarized in Table G-2. Releases from the containment within the early time frame (0 to less than 4 hours following event initiation) and intermediate time frame (4 to less than 24 hours following event initiation) dominate the population dose risk at HCGS.

Table G-2. Breakdown of Population Dose by Containment Release Mode

Containment Release Mode	**Population Dose (Person-Rem[1] Per Year)**	**Percent Contribution[2]**
Early Releases (< 4hrs)	11.9	52
Intermediate Releases (4 to <24 hrs)	9.9	43
Late Releases (≥24 hrs)	1.1	5
Intact Containment	<0.1	negligible
Total	**22.9**	**100**

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

[2]Derived from Table E.3-7 of the ER (PSEG 2009)

G.2.2 Review of PSEG's Risk Estimates

PSEG's determination of offsite risk at HCGS is based on the following three major elements of analysis:

- The Level 1 and 2 risk models that form the bases for the 1994 IPE submittal (PSEG1994), and the external event analyses of the 1997 IPEEE submittal (PSEG 1997),
- The major modifications to the IPE model that have been incorporated in the HCGS PRA, and
- The MACCS2 analyses performed to translate fission product source terms and release frequencies from the Level 2 PRA model into offsite consequence measures (essentially this equates to a Level 3 PRA).

Each of these analyses was reviewed to determine the acceptability of PSEG's risk estimates for the SAMA analysis, as summarized below.

The NRC staff's review of the HCGS IPE is described in an NRC report dated April 23, 1996 (NRC 1996). Based on a review of the IPE submittal and responses to RAIs, the NRC staff concluded that the IPE process is capable of identifying the most likely severe accidents and severe accident vulnerabilities, and therefore, that the HCGS IPE has met the intent of GL 88-20 (NRC 1988).

During the performance of the IPE, transients involving heating, ventilation, and air conditioning (HVAC) failure were determined to contribute inordinately to the CDF. This was labeled a vulnerability and a procedure to provide alternate ventilation was developed. The implementation of this procedure removed this vulnerability. Credit for this procedure was taken in the HCGS IPE submittal. No other vulnerabilities were identified. In the ER, PSEG indicated that there were three improvements identified in the process of performing the IPE. Two of the improvements were performing refined calculations to allow increased credit for existing plant design features. The third was developing a procedure for operation of the Safety Auxiliaries Cooling System in severe accident conditions. All of these improvements are stated to have been implemented (PSEG 2009).

There have been twelve revisions to the IPE model since the 1994 IPE submittal. A listing of the changes made to the HCGS PRA since the original IPE submittal was provided in the ER (PSEG 2009) and in response to an RAI (PSEG 2010a) and is summarized in Table G-3. A comparison of internal events CDF between the 1994 IPE and the current PRA model indicates a decrease of about a factor of ten in the total CDF (from 4.7×10^{-5} per year to 5.1×10^{-6} per year). This reduction can be attributed to significant changes in success criteria, modeling details and removal of conservatism.

1 **Table G-3**. HCGS PRA Historical Summary (PSEG 2009)

PRA Version	Summary of Changes from Prior Model	Total CDF[1] (per year)
1994	IPE Submittal	4.7×10^{-5}
Model 0 9/1994	- Credit taken for beyond design basis performance of Safety Auxiliaries Cooling System (SACS) and Station Service Water System (SSWS) based on updated success criteria calculations.	1.3×10^{-5}
Model 1.0 7/1999	- Integrated the Level I and II models - Updated the database - Further developed sequence end states - Developed fault trees for special initiators - Reviewed dependent operator actions	1.9×10^{-5}
Model 1.3[2] 10/2000	- Requantified two important human error probabilities - Revised treatment of disallowed maintenance to credit plant procedures and operating practices. - Revised common cause failure assessment - Eliminated core spray room cooling dependency on SACS based on review of room heat up calculations - Added models for breaks outside containment and manual shutdown - Updated ATWS analysis	9.3×10^{-6}
Model 2003A 8/2003	- Incorporated resolution of 1999 BWROG peer review Facts and Observations (Attachment 14 to PSEG 2005) - Converted from NUPRA to CAFTA software - Performed completely new human reliability assessment - Revised accident sequence definitions - Performed new MAAP calculations for extended power uprate (EPU) conditions - Updated data - Modified system models - Updated common cause failure analysis - Added internal flood accident sequences	3.1×10^{-5}
Rev. 2.0 10/2004	- Modified 480 VAC dependencies - Modified SACS success criteria - Modified SACS-SW Human Error Probabilities	1.7×10^{-5}
Model 2005C[3] 2/2006	- Removed conservatism in the SACS-SW success criteria - Included more detailed logic for AC power supplies - Removed conservatism in operator action human error probabilities (HEPs) - Reduced turbine trip initiating event frequency	9.8×10^{-6}

PRA Version	Summary of Changes from Prior Model	Total CDF[1] (per year)
HC108A 8/2008	BWROG Peer Reviewed - Incorporated seasonal success criteria for SACS and SSWS - Updated internal flooding scenarios and initiating event frequencies to be consistent with ASME PRA standard - Credited use of portable battery charger for Station Blackout scenarios - Reassessed human error probabilities using Electric Power Research Institute (EPRI) human reliability analysis (HRA) calculator - Updated evaluation of dependent operator actions	7.6×10^{-6}
HC108B 12/2008	- Credited procedure changes for local manual manipulation of SSWS valves under LOOP conditions - Removed conservatism in modeling of 120 VAC inverter room cooling logic - Updated SACS pump failure probabilities to be consistent with Bayesian update values	5.1×10^{-6} (4.4×10^{-6})[4]

[1]Total CDF includes internal floods. Prior to Model 2003A, IPE internal flood analysis was retained.

[2]Changes for Model 1.3 includes those for prior intermediate Models 1.1 and 1.2. All changes were considered minor.

[3]Changes for Model 2005C includes those for prior intermediate Models 2005A and 2005B. All changes to Models 2005A and 2005B were considered minor.

[4]Model HC108B truncation limit was decreased to 1×10^{-12} per year from 5×10^{-11} per year utilized for the HC108A and 2005 models. The CDF in parentheses is the result based on the higher truncation limit.

The CDF value from the 1994 IPE (4.7×10^{-5} per year) is in the upper third of the values reported for other BWR 3/4 plants. Figure 11.2 of NUREG-1560 shows that the IPE-based total internal events CDF for BWR 3/4 plants ranges from 9×10^{-8} per year to 8×10^{-5} per year, with an average CDF for the group of 2×10^{-5} per year (NRC 1997b). It is recognized that other plants have updated the values for CDF subsequent to the IPE submittals to reflect modeling and hardware changes. The current internal events CDF results for HCGS (5.1×10^{-6} per year) are comparable to that for other plants of similar vintage and characteristics.

The NRC staff considered the peer reviews performed for the HCGS PRA, and the potential impact of the review findings on the SAMA evaluation. In the ER (PSEG 2009) and in response to an NRC staff RAI (PSEG 2010a) and in other unrelated submittals (PSEG 2005), PSEG described three BWROG Peer Reviews for the HCGS PRA. The first was a pilot of the BWROG peer review process conducted in 1996 of PRA Model 0. The second, conducted in 1999, reviewed PRA Model 1.0. The third, conducted in 2008, reviewed the HC108A Model.

The 1999 peer review identified no Level A (extremely important) and 80 Level B (important) Facts and Observations (F&Os). It was stated that these F&Os were resolved and incorporated in the 2003A PRA Model (PSEG 2005).

The 2008 peer review of the HC108A model was requested by PSEG because of the significant changes in PRA methods since the prior peer review. This peer review was performed using the Nuclear Energy Institute peer review process (NEI 2007) and the ASME PRA Standard (ASME 2005) as endorsed by the NRC in Regulatory Guide 1.200, Rev. 1 (NRC 2007). In the

ER PSEG summarizes the results of the peer review by reporting the number of ASME Standard's supporting requirements (SRs) that were assessed to meet each of the standard's Capability Categories. Of the 301 SRs applicable to HCGS, 286 were found to meet the requirements for Capability Category II or higher, seven met Capability Category I and eight did not meet any Capability Category. The 2005 ASME PRA standard describes Capability Category II as follows: 1) the scope and level of detail has resolution and specificity sufficient to identify the relative importance of significant contributors at the *component* level including human actions, as necessary, 2) *plant-specific* data/models are used for significant contributors, and 3) departures from realism will have *small* impact on the conclusions and risk insights as supported by good practices. Similarly, it describes Capability Category I as follows: 1) the scope and level of detail has resolution and specificity sufficient to identify the relative importance of significant contributors at the *system or train* level including human actions, 2) *generic* data/models are acceptable except for the need to account for the unique design and operational features of the plant, and 3) departures from realism will have *moderate* impact on the conclusions and risk insights as supported by good practices (ASME 2005)

In the ER, PSEG indicated that the SRs identified as "not met" were addressed in the HC108B model. In response to an NRC staff RAI, PSEG provided a listing and discussion of the resolution of the SRs that only met Capability Category I and of other Peer Review Finding-level F&Os (PSEG 2010a). It should be noted that a Finding-level F&O is essentially equivalent to and replaces the previously used Level A and B F&Os[1] and is defined as an observation that is necessary to address to ensure 1) the technical adequacy of the PRA, 2) the capability/robustness of the PRA update process, and 3) the process for evaluating the necessary capability of the PRA technical elements (NEI 2007).

Of the seventeen identified SRs and findings, thirteen were stated to have been resolved as part of the HC108B PRA update and re-assessed as meeting Capability Category II at a minimum as a result of additional investigation, analysis and/or documentation. Four of the SRs and findings remain open. In the discussion of the status and impact of these open items, PSEG concluded that the resolution of each would not impact the conclusions of the SAMA risk assessment. Two of the open items were documentation issues. One issue was related to the need for additional plant-specific data for important events. PSEG indicated that a review of HCGS recent experience indicates "no anomalous behavior" and that minor changes to component unavailability and unreliability values would not change the conclusions of the SAMA risk evaluation. The fourth issue was related to the identification, characterization and documentation of model uncertainties. PSEG indicated that a number of sensitivity evaluations were performed and that other areas of the HCGS PRA were investigated for potential impact on the PRA results but none were found to rise to the level of being candidates for modeling uncertainty. PSEG concluded that the resolution of this open item would not impact the conclusions of the SAMA evaluation (PSEG 2010a). PSEG further states that the HCGS PRA treatment of model uncertainty is considered to meet the requirements of the latest NRC guidance on model uncertainty, NUREG-1855 (NRC 2009).

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[1] Earlier in the history of the PRA Peer Review process, F&Os were divided into four categories, from most (A) to least significant (D). "Findings" have taken the place of the former A and B level F&Os, while "Suggestions" are now used when citing what formerly would have been F&Os at the C and D level.

In the initial response to the NRC staff's RAIs (PSEG 2010a) PSEG's discussion of the resolution of the supporting requirements that were not met addressed only six items whereas the initial listing in the ER indicated that there were eight SRs that were not met. In response to the request for clarification PSEG stated that the final review report identified six SRs as not being met, but that the draft had cited eight (PSEG 2010b).

Based on review with respect to the requirements of the ASME PRA Standard, the NRC staff considers PSEG's disposition of the peer review findings to be reasonable and that final resolution of the findings is not likely to impact the results of the SAMA analysis.

The Revision HC108B model reflects the current (as of the date of the ER submittal) HCGS configuration and design. The licensee states that HCGS risk management personnel have reviewed plant modifications and procedure changes since the HC108B model freeze date. No changes were identified that required PRA model updates and therefore the licensee concluded that none of the plant modifications and procedure changes since the HC108B PRA update would impact the conclusions of the SAMA analysis. (PSEG 2010a, PSEG 2010b)

In response to an RAI, PSEG described the overall quality assurance program applicable to the HCGS PRA and its updates by providing descriptions of significant governing PSEG procedures. These procedures address the overall risk management program, risk management documentation including quality requirements for preparation, review and approval, configuration control and PRA model updates. Based on PSEG's procedures, the HCGS PRA is controlled with the appropriate requirements.

Given that the HCGS internal events PRA model has been peer-reviewed and the peer review findings with potential to impact SAMA evaluations were all dispositioned, and that PSEG has satisfactorily addressed NRC staff questions regarding the PRA, the NRC staff concludes that the internal events Level 1 PRA model is of sufficient quality to support the SAMA evaluation.

As indicated above, PSEG does not maintain a current HCGS external events PRA that explicitly models seismic and fire initiated core damage accidents that can be linked with the current Level 2 and 3 PRA. However, the models developed for seismic and fire events in the IPEEE were partially updated in 2003 to utilize revised initiating event frequencies and conditional core damage probabilities based on the 2003A internal events PRA Model. These results were used to identify SAMAs that address important fire and seismic risk contributors, as discussed below in Section G.3.2. The updated seismic and fire core damage results are described in ER Section E.5.1.7

The HCGS IPEEE was submitted in July 1997 (PSEG 1997), in response to Supplement 4 of Generic Letter 88-20 (NRC 1991a). The submittal included a seismic PRA, an internal fire PRA, and an evaluation of high winds, external flooding, and other hazards. While no fundamental weaknesses or vulnerabilities to severe accident risk in regard to the external events were identified, two potential enhancements were identified as discussed below. In a letter dated July 26, 1999 (NRC 1999), the NRC staff concluded that PSEGs IPEEE process is capable of identifying the most likely severe accidents and severe accident vulnerabilities, and therefore, that the HCGS IPEEE has met the intent of Supplement 4 to Generic Letter 88-20.

The HCGS IPEEE seismic analysis utilized a seismic PRA following NRC guidance (NRC 1991a). The seismic PRA included: a seismic hazard analysis, a seismic fragility assessment, a seismic systems analysis, and quantification of seismic CDF.

The seismic hazard analysis estimated the annual frequency of exceeding different levels of ground motion. Seismic CDFs were determined for both the EPRI (EPRI 1989) and the Laurence Livermore National Laboratory (LLNL) (NRC 1994) hazard assessments. The seismic fragility assessment utilized the walkdown procedures and screening caveats in EPRI's seismic margin assessment methodology (EPRI 1991). Fragility calculations were made for about 90 components and, using a screening criterion of median peak ground acceleration (pga) of 1.5 g which corresponds to a 0.5 pga high confidence low probability of failure (HCLPF) capacity, a total of 17 components were screened in. The seismic systems analysis defined the potential seismic induced structure and equipment failure scenarios that could occur after a seismic event and lead to core damage. The HCGS IPE event tree and fault tree models were used as the starting point for the seismic analysis. Quantification of the seismic models consisted of convoluting the seismic hazard curve with the appropriate structural and equipment seismic fragility curves to obtain the frequency of the seismic damage state. The conditional probability of core damage given each seismic damage state was then obtained from the IPE models with appropriate changes to reflect the seismic damage state. The CDF was then given by the product of the seismic damage state probability and the conditional core damage probability.

The seismic CDF resulting from the HCGS IPEEE was calculated to be 3.6×10^{-6} per year using the LLNL seismic hazard curve and 1.0×10^{-6} per year using the EPRI seismic hazard curve. Both utilized the HCGS Model 0 internal events PRA, with a CDF of 1.3×10^{-5} per year for quantification of non-seismic failures.

The HCGS IPEEE did not identify any vulnerability due to seismic events or any potential improvements to reduce seismic risk. The IPEEE noted, however, that fire water tanks are not seismically robust and hence no credit was taken for the fire protection system in the seismic PRA. This is discussed further in Section G.3.2.

Subsequent to the IPEEE, PSEG updated the seismic PRA utilizing conditional core damage probabilities from the 2003A PRA model modified to reflect the seismic human reliability assessment that was performed to support the IPEEE, referred to as the HCGS 2003 External Events Update (PSEG 2009). The resulting seismic CDF using the EPRI seismic hazard curves is 1.1×10^{-6} per year. In the ER, PSEG provided a listing and description of the top ten seismic core damage contributors. The dominant seismic core damage contributors with a CDF of 1×10^{-8} per year or more are listed in Table G-4. In response to an NRC staff RAI, PSEG also determined the updated seismic CDF using the LLNL seismic hazard curve and the total seismic CDF was determined to be 3.6×10^{-6} per year. The seismic CDF utilizing the LLNL hazard curves for dominant seismic core damage contributors are also listed in Table G-4.

Table G-4. Dominant Contributors to the Seismic CDF (PSEG 2009)

		Based on EPRI Seismic Hazard Curves		Based on LLNL Seismic Hazard Curves	
Basic Event ID	**Seismic Sequence Description**	**CDF (per year)**	**% Contribution to Seismic CDF**	**CDF (per year)**	**% Contribution to Seismic CDF**
%IE-SET36	Seismic-Induced Equipment Damage State SET-36 (Impacts – 120V PNL481)	6.7×10^{-7}	60	2.5×10^{-6}	70
%IE-SET18	Seismic-Induced Equipment Damage State SET-18 (Impacts – LOOP)	3.1×10^{-7}	27	3.3×10^{-7}	9
%IE-SET37	Seismic-Induced Equipment Damage State SET-37 (Impacts – 125V)	6.8×10^{-8}*	6	4.4×10^{-7}	12
%IE-SET35	Seismic-Induced Equipment Damage State SET-35 (Impacts – 120V PNL482, RSP)	4.6×10^{-8}	4	1.6×10^{-7}	5
%IE-SET38	Seismic-Induced Equipment Damage State SET-38 (Impacts – 1E panel room Ventil.)	2.1×10^{-8}	2	5.4×10^{-8}	2

* In response to an RAI, PSEG indicated that the value reported in the ER page E-99 for this contributor was in error and should be that given in the IPEEE - 6.8×10^{-8} per year (PSEG 2010a).

For both hazard curves, the largest contributor to seismic CDF is a seismic-induced loss of all four divisions of 1E 120 VAC instrumentation distribution panels that leads directly to core damage. Other significant contributors are: for the EPRI hazard curves, a seismic-induced loss of offsite power which together with non-seismic random failures leads to core damage and, for the LLNL hazard curves, a seismic induced failure of all 125 VDC 1E power to loads that lead directly to core damage. The failure of all four 1E 120 VAC divisions and failure of all 125 VDC occur at a relatively high ground acceleration (a median failure at 1.08g and 1.47g, respectively) while the loss of offsite power occurs at a relatively low ground acceleration (a median failure of 0.31g) (PSEG 1997).

The NRC staff requested the applicant assess the impact the higher seismic CDF resulting from the use of the LLNL hazard curves would have on the external events multiplier and the results of the SAMA analysis as well as the impact of the increased CDF for important seismic sequences on the identification and evaluation of SAMAs for these sequences. This is discussed further below and in Sections G.3.2 and G.6.2.

The HCGS IPEEE fire analysis employed EPRI's fire-induced vulnerability evaluation (FIVE) methodology (EPRI 1993) to perform a fire compartment interaction analysis (FCIA) and a quantitative screening analysis. This was then followed by a PRA quantification of the unscreened compartments.

The FCIA identified 209 fire compartments meeting the FIVE criteria for the entire plant. The quantitative screening utilized a threshold fire ignition frequency obtained using the FIVE methodology and the assumptions that all fires resulted in a reactor trip or more severe transient and that any fire in a compartment damaged all the equipment and cables in the compartment. Using the assessed screening fire frequency and conservatively determined screening conditional core damage probabilities (CCDPs) from the Model 0 internal events PRA resulted in screening out (at a CDF of less than 1×10^{-6} per year) of all but 38 fire compartments.

The analysis for the unscreened areas employed a detailed probabilistic assessment of each possible fire initiator/target combination including intermediate fire growth stages. Fire damage calculations used a modified version of the FIVE fire propagation methodology. No explicit credit was taken for manual or automatic fire suppression. Final quantification utilized FIVE fire data and refined CCDPs from the Model 0 internal events PRA. The resulting fire induced CDF was calculated to be 8.1×10^{-5} per year. A walkdown and verification process was employed to verify that the assumptions and calculations were supported by the physical condition of the plant.

The HCGS IPEEE did not identify any vulnerabilities due to internal fires or any potential improvements to reduce internal fire risk.

Subsequent to the IPEEE, PSEG updated the fire PRA to incorporate more recent fire initiating event frequencies based on information in the 2002 NRC fire database and conditional core damage probabilities from the 2003A PRA model, referred to as the 2003 HCGS External Events Update. The resulting fire CDF is 1.7×10^{-5} per year.

In the ER, PSEG provided a listing and description of the top ten fire core damage contributors. The important fire core damage contributors with a CDF of 1×10^{-7} per year or more are listed in Table G-5. As can be seen from these results the fire risk at HCGS is dominated by panel fires in the control room.

Table G-5. Important Contributors to Fire CDF (PSEG 2009)

Basic Event ID	Fire Area Description	CDF per year	% Contribution to Fire CDF
%IE-FIRE03	Control Room Fire Scenario Small Cab_3 (Loss of Emer. Bat.)	5.3×10^{-6}	31
%IE-FIRE02	Control Room Fire Scenario Small Cab_2 (Loss of SSWS)	4.4×10^{-6}	25
%IE-FIRE01	Control Room Fire Scenario Small Cab_1 (Loss of SACS)	3.8×10^{-6}	22
%IE-FIRE28	Compartment 5339 Fire Scenario 5339_2	7.5×10^{-7}	4
%IE-FIRE37	DG room (D) Fire Scenario 5304_2	7.0×10^{-7}	4
%IE-FIRE20	DG room (C) Fire Scenario 5306_2	6.7×10^{-7}	4

Basic Event ID	Fire Area Description	CDF per year	% Contribution to Fire CDF
%IE-FIRE38	Compartment 3425/5401 Fire Scenario 5401_1	5.9×10^{-7}	3
%IE-FIRE06	Control Room Fire Scenario Large Cab_1 (MSIV Closure)	5.1×10^{-7}	3

In the ER, PSEG states that an effective comparison between the internal events PRA results and the fire analysis results is not possible because neither the plant response model nor the fire modeling methodology used in the updated fire model is current. PSEG identified in the ER areas where fire CDF quantification may introduce levels of uncertainty different from those expected in the internal events PRA, including a number of conservatisms in the fire modeling, as follows:

- Several system models assume the systems are unavailable or are unrecoverable in a fire. For example, any fire is assumed to result in a plant trip, even if it is not severe. Bounding fire modeling assumptions are used for many fire scenarios. For example, all cables are damaged in a fire even if they are enclosed in cable trays or conduit. Because of a lack of industry experience with regard to crew performance during the types of fires modeled in the fire PRA, the characterization of crew actions in the fire PRA is generally considered to be conservative.

PSEG's conclusion is that while some of the conservatisms have been addressed in the updated fire model, the result is still believed to be conservative.

Considering the above discussion, the conservatisms in the updated fire PRA model as currently understood, and the response to the NRC staff RAIs, the NRC staff concludes that the fire CDF of 1.7×10^{-5} per year is reasonable for the SAMA analysis.
The IPEEE analysis of high winds, floods and other (HFO) external events indicated that each of the events identified in NUREG-1407 (NRC 1991b) had a core damage contribution of less than the screening criterion of 1×10^{-6} per year. This was done by either showing compliance with the 1975 Standard Review Plan criteria or by a bounding analysis that demonstrated that the CDF contribution was less than the screening criterion. For the SAMA analysis, PSEG assumed a CDF contribution of 1×10^{-6} per year for each of high winds, external floods, transportation and nearby facilities, detritus, and chemical releases, for a total HFO CDF contribution of 5×10^{-6} per year (PSEG 2009).

Although the HCGS IPEEE did not identify any vulnerabilities due to HFO events, two improvements to reduce risk were identified as described below.

For high winds, the HCGS design was compared to the SRP criteria and found to have a CDF contribution less than the screening criterion. A walkdown was performed to evaluate high wind hazards and as a result work was initiated to install a missile shield in front of a door into the Technical Support Center. This improvement has been implemented.

For external floods the HCGS was found to be adequately protected from the postulated occurrence of the probable maximum hurricane surge with wave run-up coincident with the high tide at the 10% exceedance level. HCGS was also found to comply with the latest probable maximum precipitation criteria. A walkdown confirmed that there were no severe accident vulnerabilities due to external floods.

A review of transportation and nearby facility accidents confirmed that there were no severe accident vulnerabilities from these accidents. During the review it was discovered that in a single year there had been some unauthorized shipments of explosives on the Delaware River in the vicinity of the HCGS. The U.S. Coast Guard (USCG), which controls such shipments, was contacted and procedures were put in place to prevent such shipments in the future. This improvement has been implemented.

The NRC staff asked about the status and potential impact on the SAMA analysis of a liquefied natural gas (LNG) terminal planned for Logan Township, New Jersey, upstream on the Delaware River from the HCGS site (NRC 2010a). In response to the RAI, PSEG discussed the current status of the LNG terminal as well as the regulatory controls for LNG marine traffic and LNG ship design and the safety record for LNG shipping (PSEG 2010a). The LNG terminal remains in the planning stage and no construction has begun. Further, the state of Delaware has denied applications for several required environmental permits and approvals. PSEG concluded that based on the regulatory process and controls for assuring the safety and security of LNG ships, the safety record of LNG ships and the uncertainty of the planned terminal, consideration of potential SAMAs associated with the possible future terminal is not warranted. The NRC staff agrees with this conclusion.

As indicated in the ER (PSEG 2009), a multiplier of 6.3 was used to adjust the internal event risk benefit associated with a SAMA to account for external events. This multiplier was based on a total external event CDF of 2.3×10^{-5} per year. This CDF is the sum of the updated fire CDF of 1.7×10^{-5} per year, the updated seismic CDF of 1.1×10^{-6} per year, and the HFO CDF of 5×10^{-6} per year. The external event CDF is thus approximately 5.3 times the internal events CDF of 4.4×10^{-6} per year used in the SAMA analysis at a truncation of 5×10^{-11} per year. The higher truncation used for determining the multiplier is to be consistent with that used to determine the release category frequencies and that used to evaluate the fire and seismic CDFs. The total CDF is thus 6.3 times the internal events CDF (PSEG 2009).

As indicated above, in response to an NRC staff RAI, PSEG determined the seismic CDF based on the LLNL hazard curve to be 3.6×10^{-6} per year (PSEG 2010a). If this is utilized instead of the value using the EPRI hazard curve, the total external events CDF is 2.6×10^{-5} per year and the external events multiplier is 6.8. The impact of this revised multiplier on the SAMA assessment is discussed further in Section G.3.2 and Section G.6.2.

The NRC staff reviewed the general process used by PSEG to translate the results of the Level 1 PRA into containment releases, as well as the results of the Level 2 analysis, as described in the ER and in response to NRC staff requests for additional information (PSEG 2010a, PSEG 2010b). The HCGS Level 2 PRA model is essentially a complete revision of the IPE Level 2 model, including completely revised containment event trees and system fault trees and completely updated thermal hydraulic analyses, incorporating the latest emergency operating procedures (EOPs), severe accident guidelines (SAGs), and emergency action level (EAL) and implementation using the Computer-Aided Fault Tree Analysis (CAFTA) software.

The current Level 2 model utilizes a set of three containment event trees (CETs) containing both phenomenological and systemic events. The Level 1 core damage sequences are grouped into core damage accident classes with similar characteristics. All the sequences in an accident class are then input to one of the three CETs by linking the level 1 event tree sequences with the level 2 CET. The CETs are analyzed by the linking of fault trees that represent each CET node. These fault trees are based on the Level 1 models for the system or function as modified for Level 2 considerations of timing, procedures, access or dependencies including recovery actions as documented in the HCGS emergency Operating Procedures and Severe Accident Management Guidelines.

Each CET end state represents a radionuclide release to the environment and is characterized by one of thirteen release bins based on magnitude and timing of release. Magnitude is given by cesium iodide (CsI) release fraction: High (H) > 10%, Moderate (M) 1% to 10%, Low (L) 0.1% to 1%, Low-Low (LL) <0.1% and negligible or no release<< 0.1%. Timing is given by time of initial release from the time of declaration of a General Emergency: Early (E) < 4 hours, Intermediate (I), 4 to 24 hours and Late (L) > 24 hours. The assignment of each end state to a given release bin is made on the basis of a MAAP calculation for the accident sequence or a similar MAAP calculated sequence. The thirteen release bins were subsequently refined into eleven release categories for input to the MELCOR Accident Consequence Code Systems (MACCS) consequence calculations by dividing the high early release bin into three release categories (high pressure, low pressure and breaks outside containment) and combining several of the end states with Low and Low-Low release magnitudes.

The frequency of each release category was obtained by summing the frequency of the contributing CET end states. The release characteristics for each release category were developed by using the results of Modular Accident Analysis Program (MAAP 4.0.6) computer code calculations. A representative MAAP case for each of the release categories was chosen based on a review of the Level 2 cutsets and the dominant types of scenarios that contribute to the results. The MAAP case chosen for each release category was generally the case with the highest consequence (PSEG 2010a). A description of the representative MAAP case for each release or source term category is provided in Table E.3-5 of the ER. The release categories, their frequencies, and release characteristics are presented in Table E.3-6 of the ER (PSEG 2009).

It is noted for the SAMA analysis the CET end state and release category frequencies were determined using a truncation value of 5×10^{-11} per year. This results in a total CDF of approximately 4.4×10^{-6} per year, which is about 16 percent less that the internal events CDF of 5.1×10^{-6} per year obtained when a truncation of 1×10^{-12} per year. The NRC staff considers that use of the release frequency rather than the Level 1 CDF will have a negligible impact on the results of the SAMA evaluation because the external event multiplier and uncertainty multiplier used in the SAMA analysis (discussed in Section G.6.2) have a much greater impact on the SAMA evaluation results than the small error arising from the model quantification approach.

The NRC staff review of release category information noted an apparent discrepancy in the release magnitude and release timing assigned for ST5 and ST7 and requested the applicant to clarify the reasons for these discrepancies (NRC 2010a). Both these release categories involve loss of containment heat removal with subsequent containment failure, core damage and fission product release. For ST5 the containment failure is in the wet well while for ST7 the containment failure is in the drywell. While the drywell failure would be expected to result in a higher release than a wet well failure, the reverse is true for the results provided in the ER. Further, the release timings were found to be slightly different even though the core damage times were the same. In response to the RAI, PSEG pointed out that the wet well failure for ST5 occurred below the water level and, due to the loss of suppression pool water inventory, resulted in significantly less cesium iodide removal from the safety relief valve (SRV) flow to the suppression pool for ST5 than for the drywell failure case ST7 (PSEG 2010a). The differing release pathways resulted in the slightly different times for the initiation of release to the environment.

Based on the NRC staff's review of the Level 2 methodology, the applicant's responses to RAIs and the fact that the Level 2 model was reviewed in more detail as part of the 2008 BWROG peer review and found to be acceptable (except for two documentation related findings which would not impact the SAMA analysis), the NRC staff concludes that the Level 2 PRA provides an acceptable basis for evaluating the benefits associated with various SAMAs.

The NRC staff reviewed the process used by PSEG to extend the containment performance (Level 2) portion of the PRA to an assessment of offsite consequences (essentially a Level 3 PRA). This included consideration of the source terms used to characterize fission product releases for the applicable containment release categories and the major input assumptions used in the offsite consequence analyses. The MACCS2 code was utilized to estimate offsite consequences. Plant-specific input to the code includes the source terms for each category and the reactor core radionuclide inventory (both discussed above), site-specific meteorological data, projected population distribution within an 80-kilometer (50-mile) radius for the year 2046, emergency evacuation modeling, and economic data. This information is provided in Section E.3 of Appendix E to the ER (PSEG 2009).

PSEG used the MACCS2 code and a core inventory from a plant specific calculation at end of cycle to determine the offsite consequences of activity release. In response to an NRC staff RAI, PSEG stated that the MACCS2 analysis was based on the core inventory used in the NRC-approved Alternate Source Term for HCGS (PSEG 2010a).

All releases were modeled as being from the top of the reactor containment building and at low thermal content (ambient). Sensitivity studies were performed on these assumptions and indicated little or no change in population dose or offsite economic cost. Assuming a ground level release decreased dose risk and cost risk by 6 percent and 7 percent, respectively. Assuming a buoyant plume decreased dose risk and cost risk by 1 percent. Based on the information provided, the staff concludes that the release parameters utilized are acceptable for the purposes of the SAMA evaluation.

PSEG used site-specific meteorological data for the 2004 calendar year as input to the MACCS2 code. The development of the meteorological data is discussed in Section E.3.7 of Appendix E to the ER. The data were collected from onsite and local meteorological monitoring systems. Sensitivity analyses using MACCS2 and the meteorological data for the years 2005 through 2007 show that use of data for the year 2004 results in the largest dose and economic cost risk. Missing meteorological data was filled by (in order of preference): using data from the backup met pole instruments (10-meter), using corresponding data from another level of the main met tower, interpolation (if the data gap was less than 6 hours), or using data from the same hour and a nearby day (substitution technique). The 10-meter wind speed and direction were combined with precipitation and atmospheric stability (derived from the vertical temperature gradient) to create the hourly data file for use by MACCS2. The NRC staff notes that previous SAMA analyses results have shown little sensitivity to year-to-year differences in meteorological data and concludes that the use of the 2004 meteorological data in the SAMA analysis is reasonable.

The population distribution the licensee used as input to the MACCS2 analysis was estimated for the year 2046 using year 1990 and year 2000 census data as accessed by SECPOP2000 (NRC 2003) as a starting point. In response to an NRC staff RAI, PSEG stated that the transient population was included in the 10-mile EPZ, and included prior to the population projection (PSEG 2010a). A ten year population growth rate was estimated using the year 1990 to year 2000 SECPOP2000 data and applied to obtain the distribution in 2046. The baseline population was determined for each of 160 sectors, consisting of sixteen directions for each of ten concentric distance rings to a radius of 50 miles surrounding the site. The SECPOP2000 census data from 1990 and 2000 were used to determine a ten year population growth factor for each of the concentric rings. The population growth was averaged over each ring and applied uniformly to all sectors within each ring. The NRC staff requested PSEG provide an assessment of the impact on the SAMA analysis if a wind-direction weighted population estimate for each sector were used (NRC 2010a). In response to the RAI, PSEG stated that the impacts associated with angular population growth rates on PDR and OECR are minimal and bounded by the 30% population sensitivity case (PSEG 2010a). This is based on the relatively even wind distribution profile surrounding the site, the tendency for lateral dispersion between sectors, and the use of mean values in the analysis. A sensitivity study was performed for the population growth at year 2040. A 30 percent increase in population resulted in a 29 percent increase in dose risk and a 30 percent increase in cost risk. In response to an NRC staff RAI, PSEG stated that the radial growth rates used in the MACCS2 analysis provides a more conservative population growth estimate than using ‘whole county’ data for averaging (PSEG 2010a). PSEG also identified that the population sensitivity case of 30 percent growth was approximately equivalent to adding 5.9 percent to the 10-year growth rate. The NRC staff considers the methods and assumptions for estimating population reasonable and acceptable for purposes of the SAMA evaluation.

The emergency evacuation model was modeled as a single evacuation zone extending out 16 kilometers (10 miles) from the plant (the emergency planning zone – EPZ). PSEG assumed that 95 percent of the population would evacuate. This assumption is conservative relative to the NUREG-1150 study (NRC 1990), which assumed evacuation of 99.5 percent of the population within the emergency planning zone. The evacuated population was assumed to move at an average radial speed of approximately 2.8 meters per second (6.3 miles per hour) with a delayed start time of 65 minutes after declaration of a general emergency (KLD 2004). A general emergency declaration was assumed to occur at the onset of core damage. The evacuation speed is a time-weighted average value accounting for season, day of week, time of day, and weather conditions. It is noted that the longest evacuation time presented in the study (i.e., full 10 mile EPZ, winter snow conditions, 99th percentile evacuation) is 4 hours (from the issuance of the advisory to evacuate). Sensitivity studies on these assumptions indicate that there is minor impact to the population dose or offsite economic cost by the assumed variations. The sensitivity study reduced the evacuation speed by 50 percent to 1.4 m/s. This change resulted in a 2 percent increase in population dose risk and no change in offsite economic cost risk. The NRC staff concludes that the evacuation assumptions and analysis are reasonable and acceptable for the purposes of the SAMA evaluation.

Site specific agriculture and economic parameters were developed manually using data in the 2002 National Census of Agriculture (USDA 2004) and from the Bureau of Economic Analysis (BEA 2008) for each of the 23 counties surrounding HCGS, to a distance of 50 miles. Therefore, recently discovered problems in SECPOP2000 do not impact the HCGS analysis. The values used for each of the 160 sectors were the data from each of the surrounding counties multiplied by the fraction of that county's area that lies within that sector. Region-wide wealth data (i.e., farm wealth and non-farm wealth) were based on county-weighted averages for the region within 50-miles of the site using data in the 2002 National Census of Agriculture (USDA 2004) and the Bureau of Economic Analysis (BEA 2008). Food ingestion was modeled using the new MACCS2 ingestion pathway model COMIDA2 (NRC 1998a). For HCGS, less than one percent of the total population dose risk is due to food ingestion.

In addition, generic economic data that is applied to the region as a whole were revised from the MACCS2 sample problem input in order to account for cost escalation since 1986, the year that input was first specified. A factor of 1.96, representing cost escalation from 1986 to April 2008 was applied to parameters describing cost of evacuating and relocating people, land decontamination, and property condemnation.

The NRC staff concludes that the methodology used by PSEG to estimate the offsite consequences for HCGS provides an acceptable basis from which to proceed with an assessment of risk reduction potential for candidate SAMAs. Accordingly, the NRC staff based its assessment of offsite risk on the CDF and offsite doses reported by PSEG.

G.3 Potential Plant Improvements

The process for identifying potential plant improvements, an evaluation of that process, and the improvements evaluated in detail by PSEG are discussed in this section.

G.3.1 Process for Identifying Potential Plant Improvements

PSEG's process for identifying potential plant improvements (SAMAs) consisted of the following elements:

- Review of the most significant basic events from the current, plant-specific PRA and insights from the HCGS PRA Group,
- Review of potential plant improvements identified in, and original results of, the HCGS IPE and IPEEE,
- Review of SAMA candidates identified for license renewal applications for six other U.S. nuclear sites, and
- Review of generic SAMA candidates from NEI 05-01 (NEI 2005) to identify SAMAs that might address areas of concern identified in the HCGS PRA.

Based on this process, an initial set of 23 candidate SAMAs, referred to as Phase I SAMAs, was identified. In this Phase I evaluation, PSEG performed a qualitative screening of the initial list of SAMAs and eliminated SAMAs from further consideration using the following criteria:

- The SAMA is not applicable at HCGS due to design differences,
- The SAMA has already been implemented at HCGS,
- The SAMA would achieve results that have already been achieved at HCGS by other means, or
- The SAMA has estimated implementation costs that would exceed the dollar value associated with completely eliminating all severe accident risk at HCGS.

Based on this screening, one SAMA was eliminated, and one additional SAMA was eliminated by subsuming it into another SAMA. Therefore, 21 SAMAs required further evaluation. The results of the Phase I screening analysis is given in Table E.5-3 of Appendix E to the ER. The remaining SAMAs, referred to as Phase II SAMAs, are listed in Table E.6-1 of Appendix E to the ER. In Phase II a detailed evaluation was performed for each of the 21 remaining SAMA candidates, as discussed in Sections G.4 and G.6 below. To account for the potential impact of external events, the estimated benefits based on internal events were multiplied by a factor of 6.3, as previously discussed.

G.3.2 Review of PSEG's Process

PSEG's efforts to identify potential SAMAs focused primarily on areas associated with internal initiating events, but also included explicit consideration of potential SAMAs for important fire and seismic initiated core damage sequences. The initial list of SAMAs generally addressed the accident sequences considered to be important to CDF from risk reduction worth (RRW) perspectives at HCGS, and included selected SAMAs from prior SAMA analyses for other plants.

PSEG provided a tabular listing of the Level 1 PRA basic events sorted according to their RRW (PSEG 2009). SAMAs impacting these basic events would have the greatest potential for reducing risk. PSEG used a RRW cutoff of 1.006, which corresponds to about a 0.6 percent change in CDF given 100-percent reliability of the SAMA.[2] This equates to a benefit of approximately $100,000 (after the benefits have been multiplied by a factor of 6.3 to account for external events), which is the minimum implementation cost associated with a procedure change.[3] As a result of this review, 11 SAMAs were identified.

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[2] Subsequently, PSEG extended the review down to a RRW of 1.005 to account for a revised external events multiplier of 6.8, as discussed in Section G.2.2.

[3] NUREG/BR-0184 provides calculational techniques by which reductions in risk can be equated to monetary values. The reverse calculation can convert monetary values, such as the cost of a procedure, to a risk reduction for the specific plant under consideration. In this way, the $100,000 cost of a site-wide procedure change equates to a RRW of 1.006, representing the potential to reduce risk by 0.6%. The subsequent use of a RRW of 1.005 represents the potential to reduce risk by 0.5% (NRC 1997a).

In the level 1 importance review, PSEG stated for the important initiating events that "this initiator event is a compilation of industry and plant specific data. (No specific SAMA identified)." The NRC staff requested that PSEG provide assurance that for each of these initiating events there is not a dominant contributor for which a potential SAMA to reduce the initiating event frequency or mitigate the impact of the initiator would be viable. In response to this RAI, PSEG discussed each of the initiators and the previously identified SAMAs that would reduce the importance of the initiator by mitigating other failures in the core damage sequences associated with these initiators (PSEG 2010a). In response to a request for clarification PSEG indicated that HCGS specific failures that are contributors to the initiating event frequencies that pose a unique vulnerability are typically captured and corrected within existing procedures, e.g., the corrective action program, and can result in procedure changes, plant modifications and training enhancements aimed at reducing further recurrence (PSEG 2010b). Based on this discussion and a review of the latest ten years of HCGS Licensee Event Reports, the NRC staff concludes that it is unlikely that further HCGS data review will identify any additional cost beneficial SAMAs beyond those already identified.

The PSEG response to the NRC staff request for clarification provided additional information on initiators modeled utilizing a fault tree approach rather then being based on initiating event data. For the loss of station auxiliaries cooling system initiating event (%IE-SACS), PSEG identified and evaluated SAMA 42, "Installation of SACS Standby Diesel-Powered Pump" (PSEG 2010b).

For an event involving the station service water system (NR-IE-SWS, "Nonrecovery of %IE-SWS"), the importance review identified two SAMAs as potentially mitigating this event: SAMA 3, "Install Back-up Air Compressor to Supply Air-Operated Valves (AOVs)," and SAMA 4, "Provide Procedural Guidance to Cross-Tie Residual Heat Removal (RHR) Trains." In response to an NRC staff RAI to clarify the source and applicability of these SAMAs to this event, PSEG discussed the modeling involving the NR-IE-SWS event and the applicability of the SAMAs in terms of the more general loss of decay heat removal function of which the event is associated and other SAMAs that would mitigate this event (PSEG 2010a). Based on this discussion, the NRC staff concludes that this event is adequately addressed in the SAMA analysis.

For a significant number of the Level 1 events reviewed no SAMAs were identified with the reason stated to be that "…based on low contribution to L[evel] 1 risk and engineering judgment, the anticipated implementation costs of hardware mods associated with mitigating this event would likely exceed the expected cost-risk benefit" (PSEG 2009). In response to an NRC staff RAI, PSEG provided a revised assessment of each of these events that showed that each was either already addressed by an existing SAMA or that no effective SAMAs could be identified (PSEG 2010a).

The NRC staff also requested PSEG to specifically consider the following proposed SAMAs to address basic events on the Level 1 importance list for which no SAMA was identified (NRC 2010a):

- Install a diverse redundant temperature controller to address basic event SAC-XHE-MC-DF01, "dependent failure of miscalibration of temperature controller HV-2457S." In response to the RAI, PSEG explained that this SAMA is not warranted since 1) procedures are already in place to manually control the affected system which, if credited using a failure probability of 0.1, would reduce the RRW for this basic event to

1.005, the revised review threshold (discussed below), and 2) controller miscalibration would be observed during normal operation (PSEG 2010a).

- Install flood barriers to address basic event %FL-FPS-5302, "internal flood outside lower relay room." In response to the RAI, PSEG clarified that the ER incorrectly did not identify SAMA 8, "Convert Selected Fire Protection Piping from Wet Pipe to Dry Pipe System," to address this event and further explained that the proposed SAMA is not necessary because the conversion to a dry pipe system was considered preferable to developing flood barriers considering the multiple doors that exist in the corridor outside the relay room (PSEG 2010a).

- Install a spray shield to address basic event SWS-MOV-VF-SPRAY, "flood – spray causes motor-operated valve (MOV) failure in reactor auxiliaries cooling system (RACS) compartment." In response to the RAI, PSEG explained that the proposed SAMA is not required because the PRA conservatively assumes that all relevant spray events cause failure of the MOVs and that an assumption of 1 in 10 events causing failure would reduce the RRW for this basic event to below the 1.005 revised review threshold (PSEG 2010a).

- Installation of a passive containment vent to address basic event NR-RHRVENT-INT, "fail to initiate vent given failure to initiate residual heat removal (RHR) in suppression pool cooling (SPC)." This proposed SAMA would also be an alternative to SAMA 4, "Provide Procedural Guidance to Cross-tie RHR Trains." In response to the RAI, PSEG indicated that changing the existing hard pipe venting system to a passive vent design is not considered feasible due to the loss in response flexibility provided by the existing hard pipe venting system and the potential for premature opening of the rupture disks in the passive design (PSEG 2010a). In response to a request for clarification PSEG identified and evaluated SAMA 41, "Installation of Passive Hardened Containment Ventilation Pathway" (PSEG 2010b).

In summary, as a result of PSEG's reconsideration of basic events for which no SAMA had been identified in the ER, two new SAMAs were identified: SAMA 41, "Installation of Passive Hardened Containment Ventilation Pathway," and SAMA 42, "Installation of SACS Standby Diesel-Powered Pump." A Phase II cost-benefit evaluation was performed for each of these additional SAMAs, which is discussed in Section G.6.2.

In response to an NRC staff RAI, PSEG extended the review down to a RRW of 1.005 to account for a revised external events multiplier of 6.8, which was discussed in Section G.2.2. This extended review identified one additional SAMA as follows: SAMA RAI 5.j-IE1, "Install a Key Lock Switch for Bypass of the MSIV Low Level Isolation Logic" (PSEG 2010a, PSEG 2010b). The Phase II cost-benefit evaluation of this SAMA is discussed in Section G.6.2.

PSEG also provided and reviewed the Level 2 PRA basic events, down to a RRW of 1.006, for cutsets stated to contribute to large early release. This review did not identify any additional SAMAs. In response to an NRC staff RAI, PSEG revisited this review using only the cutsets from the high and moderate release categories, which contribute over 99 percent of the population dose-risk and offsite economic cost risk (PSEG 2010a). The Level 2 basic events for the remainder of the release categories were not included in the review so as to prevent high frequency-low consequence events from biasing the importance listing. In addition the review was extended down to a RRW of 1.005 to account for a revised external events multiplier of 6.8. The revisited review identified one additional SAMA, not identified in the extended Level 1 review discussed above, as follows: SAMA RAI 5p-1, “Install an Independent Boron Injection System." The Phase II cost-benefit evaluation of this SAMA is discussed in Section G.6.2.

The NRC staff also requested PSEG to specifically consider the following proposed SAMAs (NRC 2010a):

1. Installation of a curb or barrier inside the drywell to prevent early failure of the drywell shell due to shell melt-through. This proposed SAMA addresses basic event CNT-DWV-FF-MLTFL, “drywell (DW) shell melt-through failure due to containment failure,” for which no SAMA was identified. In response to the RAI, PSEG explained that this proposed SAMA would not be effective in reducing risk because 1) injection is not available and, without cooling, the core debris would degrade the barrier to the point of failure, and 2) an early unscrubbed release pathway is already available as a result of pre-existing containment failures resulting from loss of decay heat removal (PSEG 2010a).

2. Replacement of the normally open floor and equipment drain MOVs with fail-closed air-operated valves (AOVs). While this proposed SAMA is stated in the ER to be a more costly alternative to SAMA 5, “restore AC power with onsite gas turbine generator,” the NRC staff noted in the RAI that it might also be more effective and therefore have a larger benefit. In response to the RAI, PSEG provided a Phase II cost-benefit evaluation of this proposed SAMA, which is discussed in Section G.6.2.

One additional SAMA, SAMA 18, “replace a return fan with a different design in service water pump room,” was identified in the ER based on a review of PRA insights from the HCGS PRA Group and was identified to address two basic events on the Level 1 basic events importance list.

PSEG reviewed the cost-beneficial Phase II SAMAs from prior SAMA analyses for five General Electric BWR and one Westinghouse PWR sites. PSEG’s review determined that all but two of the Phase II SAMAs reviewed were either already represented by an existing SAMA, are already implemented at HCGS, have low potential for risk reduction at HCGS, or were not applicable to the HCGS design. This review resulted in two SAMAs being identified by PSEG for HCGS.

PSEG’s disposition of industry SAMA “auto align 480V AC portable station generator” is stated to be addressed by SAMA 5, “restore AC power with onsite gas turbine generator.” The NRC staff noted that the industry SAMA could mitigate events other than those addressed by SAMA 5 and requested PSEG to evaluate the industry SAMA (NRC 2010a). In response to an NRC staff RAI PSEG identified and evaluated an additional SAMA to automate the alignment of the portable 480V AC generator (PSEG 2010a, PSEG 2010b). The cost-benefit evaluation of this additional SAMA is discussed in Section G.6.2.

The ER states that an industry SAMA to "develop a procedure to open the door of the EDG buildings upon the higher temperature alarm" was included in the HCGS SAMA analysis. The NRC staff noted that no such SAMA was evaluated and asked PSEG to clarify this discrepancy (NRC 2010a). In response to the RAI, PSEG explained that this SAMA would not reduce HCGS risk since EDG room cooling issues are small contributors to risk at HCGS and that the statement in the ER is incorrect (PSEG 2010a).

The NRC asked PSEG to address a SAMA to "increase boron concentration or enrichment in the SLC system," which was determined to be potentially cost-beneficial in the Duane Arnold SAMA analysis (NRC 2010a). In response to the RAI, PSEG explained that this SAMA would have a negligible benefit at HCGS because Standby Liquid Control (SLC) is automatically initiated at HCGS and the basic events the SAMA addresses (related to manual SLC initiation) are not on the importance lists (PSEG 2010a).

PSEG considered the potential plant improvements described in the IPE in the identification of plant-specific candidate SAMAs for internal events. Review of the IPE led to no additional SAMA candidates since the three improvements identified in the IPE have already been implemented at HCGS. (PSEG 2009)

Based on this information, the NRC staff concludes that the set of SAMAs evaluated in the ER, together with those identified in response to NRC staff RAIs, addresses the major contributors to internal event CDF.

Although the IPEEE did not identify any fundamental vulnerabilities or weaknesses related to external events, two improvements related to HFO events were identified. The two improvements have been implemented at HCGS (PSEG 2009). In the ER PSEG also identified three post IPEEE site changes to determine if they could impact the IPEEE results and possibly lead to a SAMA. From this review no additional SAMAs were identified.

In a further effort to identify external event SAMAs, PSEG identified the top 10 fire scenarios contributing to fire CDF based on the results of the updated HCGS fire PRA model and reviewed the top 8 fire scenarios for potential SAMAs. These 8 scenarios are the only HCGS fire scenarios having a benefit equal to or greater than approximately $100,000, which is the approximate value of implementing a procedure change at a single unit at HCGS.[4] The maximum benefit for a fire area is the dollar value associated with completely eliminating the fire risk in that fire area. SAMAs having an implementation cost of less than that of a procedure change, or $100,000, are unlikely. As a result of this review, PSEG identified six Phase I SAMAs to reduce fire risk. The SAMAs identified included both procedural and hardware alternatives (PSEG 2009). The NRC staff concludes that the opportunity for fire-related SAMAs has been adequately explored and that it is unlikely that there are additional potentially cost-beneficial, fire-related SAMA candidates.

[4] Salem, which is a dual-unit site, also assumes this $100,000 cost for a procedure change, but this is halved to $50,000 for each unit.

For seismic events, PSEG reviewed the top 10 seismic sequences contributing to seismic CDF based on the results of the 2003 HCGS seismic analysis and initially reviewed the top 2 seismic sequences for potential SAMAs. These two sequences are the only HCGS seismic sequences having a benefit equal to or greater than approximately $100,000, which is the approximate value of implementing a procedure change at a single unit at HCGS. The maximum benefit for a seismic sequence is the dollar value associated with completely eliminating the seismic risk for that sequence. SAMAs having an implementation cost of less than that of a procedure change, or $100,000, are unlikely. As a result of this review, PSEG identified three Phase I SAMAs to reduce seismic risk (PSEG 2009).

In response to an NRC staff RAI, PSEG revised the review of seismic sequences to account for the increased maximum benefit of each sequence resulting from the use of the LLNL seismic hazard curve instead of the EPRI curve used initially, as discussed in Section G.2.2. This resulted in two additional seismic sequences having a benefit equal to or greater than the $100,000 threshold. As a result of the review of these sequences three additional SAMAs were identified: 1) reinforce 1E 125V DC distribution panels 1A/B/C/D-D-417, 2) reinforce 1E 120V AC distribution panels 1A/B/C/DJ482, and 3) reinforce the 1E 120V AC 481 distribution panels to 1.0g Seismic Rating (PSEG 2010a, PSEG 2010b). The cost-benefit evaluation of these additional SAMAs is discussed in Section G.6.2.

The NRC staff concludes that the opportunity for seismic-related SAMAs has been adequately explored and that it is unlikely that there are additional potentially cost-beneficial, seismic-related SAMA candidates.

As stated earlier, other external hazards (high winds, external floods, transportation and nearby facility accidents, release of on-site chemicals, and detritus) are below the IPEEE threshold screening frequency, or met the 1975 SRP design criteria, and are not expected to represent vulnerabilities. Nevertheless, PSEG reviewed the IPEEE results and subsequent plant changes for each of these external hazards and determined that either 1) the maximum benefit from eliminating all associated risk was less than approximately $100,000, which is the approximate value of implementing a procedure change at a single unit at HCGS, or 2) only hardware enhancements that would significantly exceed the maximum value of any potential risk reduction were available. As a result of this review, PSEG identified no additional Phase I SAMAs to reduce HFO risk (PSEG 2009). Based on it being extremely unlikely that any hardware enhancement could be implemented for less than the cost of a procedural change ($100,000), the NRC staff concludes that the licensee’s rationale for eliminating other external hazards enhancements from further consideration is reasonable.

The NRC staff noted that, while the generic SAMA list from NEI 05-01 (NEI 2005) was stated to have been used in the identification of SAMAs for HCGS, it was not specifically reviewed to identify SAMAs that might be applicable to HCGS but rather was used to identify SAMAs that might address areas of concern identified in the HCGS PRA (NRC 2010a). The NRC staff asked PSEG to provide further information to justify that this approach produced a comprehensive set of SAMAs for consideration. In response to the RAI, PSEG explained that, based on the early SAMA reviews, both the industry and NRC came to realize that a review of the generic SAMA list was of limited benefit because they were consistently found to not be cost-beneficial and that the real benefit was considered to be in the development of SAMAs generated based on plant specific risk insights from the PRA models (PSEG 2010a).

Furthermore, while the generic list does include potential plant improvements for plants having a similar design to HCGS, plant designs are sufficiently different that the specific plant improvements identified in the generic list are generally not directly applicable to HCGS, and require alteration to specifically address the HCGS design and risk contributors or otherwise would be screened as not applicable to the HCGS design. The NRC staff considers PSEG's limited use of the NEI 05-01 generic SAMA list as only an idea source to generate SAMAs that address important contributors to SGS risk reasonable for this particular HCGS application. .

The NRC staff noted that the 23 Phase I SAMA numbers were not consecutive from 1 to 23, but rather were intermittently numbered between 1 and 40 and requested clarification on the process used to develop the Phase I SAMA list (NRC 2010a). In response to the RAI, PSEG clarified that the original SAMA list was generated from an importance list using the HC108A PRA model, and that review of the subsequent importance list developed using the HC108B PRA model determined that certain SAMAs were either no longer applicable or were subsumed into other existing SAMAs (PSEG 2010a). PSEG further clarified that the resulting set of Phase I SAMAs was not renumbered to be consecutive so as to avoid configuration management errors that could occur when working with other documentation and supplemental files. Also, SAMAs identified from the review of external events were given a starting number of 30 so as to avoid overlap with SAMAs developed for internal events.

As indicated above two Phase 1 SAMAs were screened out. SAMA 38, "Enhance Fire Water System (FWS) and Automatic Depressurization System (ADS) for Long-term Injection," was screened out on the basis that a procedure has been implemented to address the actions associated with this SAMA. However, as discussed in ER Section E.5.1.7.2.2, this SAMA requires enhancement to the FWS, including strengthening the fire water tanks. In response to an NRC staff RAI, PSEG provided an additional discussion regarding this SAMA and how enhancements to the FWS have been addressed as part of the implementation of the current procedure (PSEG 2010a). The additional discussion indicated that the seismic sequence from which this SAMA originated was a low magnitude earthquake for which there would be a relatively small chance for failure of the FWS. Consequently, strengthening the FWS would have little impact on the sequence and, upon reevaluation, is not needed as part of SAMA 38. PSEG therefore concluded that the procedure implements the remaining requirements of this SAMA.

SAMA 14, "Alternate Room Cooling for Service Water (SW) Rooms," was screened out on the basis that it was subsumed into SAMA 4, "cross-tie RHR pump trains." It is described as providing an alternate means of opening Torus Vent Valves, but no basic event in the importance lists is identified as being addressed by this SAMA. In response to an NRC staff RAI, PSEG provided a further discussion of this SAMA and its disposition (PSEG 2010a). SAMA 14 was originally developed to address important containment venting failure events. The importance of these events would be reduced if the need to vent containment is reduced by addressing failure of SW room cooling which leads to loss of containment heat removal. It was subsequently determined that SAMA 4 was the most viable SAMA to address the loss of containment heat removal and SAMA 14 was subsumed into SAMA 4. PSEG also indicated that a loss of SW room cooling could also be addressed by a new SAMA that provides an alternate room cooling strategy for the SW room using procedures and portable fans. A Phase II detailed evaluation was performed for this new SAMA, referred to as SAMA RAI 7.a-1, "enhance procedures and provide additional equipment to respond to loss of all service water pump room supply or return fans" (PSEG 2010a).

The NRC staff questioned PSEG about lower cost alternatives to some of the SAMAs evaluated (NRC 2010a), including:

- Establishing procedures for opening doors and/or using portable fans for sequences involving room cooling failures.

- Extending the procedure for using the B.5.b low pressure pump for non-security events to include all applicable scenarios, not just SBOs.

- Utilizing a portable independently powered pump to inject into containment.

In response to the RAIs, PSEG addressed the suggested lower cost alternatives (PSEG 2010a). A new SAMA, SAMA RAI 7.a-1 discussed above, was assessed in a Phase II detailed evaluation for the first item while the other two items are effectively covered by existing procedures. This is discussed further in Section G.6.2.

The NRC staff notes that the set of SAMAs submitted is not all-inclusive, since additional, possibly even less expensive, design alternatives can always be postulated. However, the NRC staff concludes that the benefits of any additional modifications are unlikely to exceed the benefits of the modifications evaluated and that the alternative improvements would not likely cost less than the least expensive alternatives evaluated, when the subsidiary costs associated with maintenance, procedures, and training are considered.

The NRC staff concludes that PSEG used a systematic and comprehensive process for identifying potential plant improvements for HCGS, and that the set of potential plant improvements identified by PSEG is reasonably comprehensive and, therefore, acceptable. This search included reviewing insights from the plant-specific risk studies, and reviewing plant improvements considered in previous SAMA analyses. While explicit treatment of external events in the SAMA identification process was limited, it is recognized that the prior implementation of plant modifications for fire and seismic risks and the absence of external event vulnerabilities reasonably justifies examining primarily the internal events risk results for this purpose.

G.4 Risk Reduction Potential of Plant Improvements

PSEG evaluated the risk-reduction potential of the 21 remaining SAMAs that were applicable to HCGS, and additional SAMAs identified in response to NRC staff RAIs. The SAMA evaluations were performed using realistic assumptions with some conservatism. On balance, such calculations overestimate the benefit and are, therefore, conservative.

PSEG used model re-quantification to determine the potential benefits. The CDF, population dose reductions, and offsite economic cost reductions were estimated using the HCGS PRA model. The changes made to the model to quantify the impact of SAMAs are detailed in Section E.6 of Appendix E to the ER (PSEG 2009). Table G-6 lists the assumptions considered to estimate the risk reduction for each of the evaluated SAMAs, the estimated risk reduction in terms of percent reduction in CDF and population dose, and the estimated total benefit (present value) of the averted risk. The estimated benefits reported in Table G-6 reflect the combined benefit in both internal and external events. The determination of the benefits for the various SAMAs is further discussed in Section G.6.

The NRC staff questioned the assumptions used in evaluating the benefit or risk reduction estimate of SAMA 5, "Restore AC Power with Onsite Gas Turbine Generator." The assessment of this SAMA assumed this was equivalent to reducing the probability of failure to cross tie the HCGS emergency diesel generators. This assumption does not provide credit for the gas turbine generator (GTG) in the situation where all the emergency generators are unavailable (NRC 20010a). In response to the RAIs, PSEG provided the results of a sensitivity study which the NRC staff subsequently noted did not appear to include credit for the hardware changes included in the cost estimate (NRC 2010b). In response to the request for clarification, PSEG provided the results of a re-evaluation of SAMA 5 that incorporated the additional capability for mitigating a more complete set of loss of offsite power initiators consistent with the hardware changes proposed (PSEG 2010b). The revised results are provided in Table G-6.

For SAMAs that specifically addressed fire events (i.e., SAMA 30, "Provide Procedural Guidance for Partial Transfer of Control Functions from Control Room to the Remote Shutdown Panel," SAMA 31, "Install Improved Fire Barriers in the Main Control Room (MCR) Control Cabinets Containing the Primary Main Steam Isolation Valve (MSIV) Control Circuits," SAMA 32, "Install Additional Physical Barriers to Limit Dispersion of Fuel Oil from Diesel Generator (DG) Rooms," SAMA 33, "Install Division II 480V AC Bus Cross-ties," SAMA 34, "Install Division I 480V AC Bus Cross-ties," and SAMA 35, "Relocate, Minimize and/or Eliminate Electrical Heaters in Electrical Access Room"), the reduction in fire CDF and population dose was not directly calculated (in Table G-6 this is noted as "Not Estimated"). For these SAMAs, an estimate of the impact was made based on general assumptions regarding: the approximate contribution to total risk from external events relative to that from internal events; the fraction of the external event risk attributable to fire events; the fraction of the fire risk affected by the SAMA (based on information from the 2003 HCGS External Events Update); and the assumption that the SAMA eliminates 90 percent (SAMAs 30, 32, 33, and 34), 99 percent (SAMA 35), or all (SAMA 31) of the fire risk affected by the SAMA. Specifically, it is assumed that the contribution to risk from external events is approximately 5.3 times that from internal events, and that internal fires contribute 74 percent of this external events risk. The fire basic events impacted by the SAMA are identified and the portion of the total fire risk contributed by each of these fire basic events determined. For SAMA 31, the benefit or averted cost risk from reducing the fire risk affected by the SAMA is then calculated by multiplying the ratio of the fire risk affected by the SAMA to the internal events CDF by the total present dollar value equivalent associated with completely eliminating severe accidents from internal events at HCGS. For the other fire SAMAs, the benefit or averted cost risk from reducing the fire risk affected by the

SAMA is then calculated by multiplying the ratio of 90 percent, or 99 percent (SAMA 35), of the fire risk affected by the SAMA to the internal events CDF by the total present dollar value equivalent associated with completely eliminating severe accidents from internal events at HCGS. These SAMAs were assumed to have no additional benefits in internal events.

The NRC staff questioned the calculated impact for SAMA 35 which assumed that 90 percent of the fire risk affected by the SAMA was eliminated rather than the 99 percent stated in the ER (NRC 2010a). In response to the RAI, PSEG provided a revised evaluation using 99 percent (PSEG 2010a). The revised results are provided in Table G-6.

For SAMAs that specifically addressed seismic events (i.e., SAMA 36, "Provide Procedural Guidance for Loss of All 1E 120V AC Power," and SAMA 37, "Reinforce 1E 120V AC Distribution Panels") the reduction in seismic CDF and population dose also was not directly calculated. As was done for fire SAMAs, an estimate of the impact of seismic SAMAs was made based on general assumptions regarding: the approximate contribution to total risk from external events relative to that from internal events; the fraction of the external event risk attributable to seismic events; the fraction of the seismic risk affected by the SAMA (based on information from the 2003 HCGS External Events Update); and the assumption that the SAMA eliminates 50 percent (SAMA 36) or 90 percent (SAMA 37) of the seismic risk affected by the SAMA. Specifically, it is assumed that the contribution to risk from external events is approximately 5.3 times that from internal events, and that seismic events contribute 5 percent of this external events risk. The seismic basic events impacted by the SAMA are identified and the portion of the total seismic risk contributed by each of these seismic basic events determined. The benefit or averted cost risk from reducing the seismic risk affected by the SAMA is then calculated by multiplying the ratio of 50 percent (SAMA 36), or 90 percent (SAMA 37), of the seismic risk affected by the SAMA to the internal events CDF by the total present dollar value equivalent associated with completely eliminating severe accidents from internal events at HCGS. These SAMAs were assumed to have no additional benefits in internal events.

The NRC staff has reviewed PSEG's bases for calculating the risk reduction for the various plant improvements and concludes, with the above clarifications, that the rationale and assumptions for estimating risk reduction are reasonable and generally conservative (i.e., the estimated risk reduction is higher than what would actually be realized). Accordingly, the NRC staff based its estimates of averted risk for the various SAMAs on PSEG's risk reduction estimates.

Table G-6. SAMA Cost/Benefit Screening Analysis for HCGS[a] (PSEG 2009)

SAMA	Assumptions	% Risk Reduction		Total Benefit ($)		Cost ($)
		CDF	Population Dose	Baseline (Internal + External)	Baseline With Uncertainty[e]	
1 – Remove Automatic Depressurization System (ADS) Inhibit from Non-ATWS Emergency Operating Procedures	**The probability that operators fail to inhibit ADS was reduced to 0.1 from 1.0.**	**26**	**29**	**5.3M**	**14.9M**	**200K**
3 – Install Back-up Air Compressor to Supply AOVs	**The probability that operators fail to restore service water was reduced to 0.5 from 1.0.**	**16**	**16**	**3.3M**	**9.4M**	**700K**
4 – Provide Procedural Guidance to Cross-Tie RHR Trains	**The probability that operators fail to recover RHR was reduced to 0.1 from 0.35.**	**12**	**21**	**4.4M**	**12.4M**	**100K**
5[b] – Restore AC Power with Onsite Gas Turbine Generator	**The probability that operators fail to cross-tie the emergency diesel generators (EDGs) was reduced to 0.1 from 1.0. In response to an NRC staff RAI, the GTG failure probability, maintenance unavailability, and human error probability were set to 0.**	**9**	**11**	**2.2M**	**6.3M**	**2.05M**
7 – Install Better Flood Protection Instrumentation for Reactor Auxiliaries Cooling System (RACS) Compartment	The probability that operators fail to isolate locally a service water rupture in the RACS compartment was reduced to 0.1 from 1.0.	4	2	330K	930K	3.07M
8 – Convert Selected Fire Protection Piping from Wet to Dry Pipe System	**The probability that operators fail to isolate a fire protection header leak was reduced to 0.1 from 1.0.**	**4**	**1**	**300K**	**860K**	**600K**

Table G-6. SAMA Cost/Benefit Screening Analysis for HCGS[(a)] (PSEG 2009)

SAMA	Assumptions	% Risk Reduction		Total Benefit ($)		Cost ($)
		CDF	Population Dose	Baseline (Internal + External)	Baseline With Uncertainty[(e)]	
10 – Provide Procedural Guidance to use B.5.b Low Pressure Pump for Non-Security Events	**The probability that operators fail to align residual heat removal service water (RHRSW) for injection into the reactor pressure vessel (RPV) was reduced to 1.0E-02 from 1.0E-01.**	**1**	**1**	**200K**	**570K**	**100K**
15 – Alternate Design of Core Spray System (CSS) Suction Strainer to Mitigate Plugging	The probability that operators fail to locally open each of the service water valves was reduced to 8.36E-04 from 8.36E-03.	2	1	130K	360K	1.0M
16 – Use of Different Designs for Switchgear Room Cooling Fans	The probability that FANS AVH401 through DVH400 fail-to-start and fail-to-run was set to 0.	2	1	130K	370K	400K
17 – Replace a Supply Fan with a Different Design in Service Water Pump Room	**The probability that FANS AV503 through DV503 fail-to-start and fail-to-run was set to 0.**	**5**	**5**	**960K**	**2.7M**	**600K**
18 – Replace a Return Fan with a Different Design in Service Water Pump Room	**The probability that FANS AV504 through DV504 fail-to-start and fail-to-run was set to 0.**	**5**	**5**	**960K**	**2.7M**	**600K**
30 – Provide Procedural Guidance for Partial Transfer of Control Functions from Control Room to the Remote Shutdown Panel	**Reduce the fire CDF contribution from Fire Basic Events %IE-FIRE03, %IE-FIRE02, and %IE-FIRE01 by 90 percent.**	**NOT ESTIMATED**		**8.6M**	**24M**	**100K**
31 – Install Improved Fire Barriers in the Main Control Room (MCR) Control Cabinets Containing the Primary Main Steam Isolation Valve (MSIV) Control Circuits	Eliminate the fire CDF contribution from Fire Basic Event %IE-FIRE06.	NOT ESTIMATED		360K	1.0M	1.2M

Table G-6. SAMA Cost/Benefit Screening Analysis for HCGS[a] (PSEG 2009)

SAMA	Assumptions	% Risk Reduction		Total Benefit ($)		Cost ($)
		CDF	Population Dose	Baseline (Internal + External)	Baseline With Uncertainty[e]	
32 – Install Additional Physical Barriers to Limit Dispersion of Fuel Oil from Diesel Generator (DG) Rooms	**Reduce the fire CDF contribution from Fire Basic Event %IE-FIRE28 by 90 percent.**	**NOT ESTIMATED**		**480K**	**1.4M**	**800K**
33 – Install Division II 480V AC Bus Cross-ties	Reduce the fire CDF contribution from Fire Basic Event %IE-FIRE37 by 90 percent.	NOT ESTIMATED		450K	1.3M	1.32M
34 – Install Division I 480V AC Bus Cross-ties	Reduce the fire CDF contribution from Fire Basic Event %IE-FIRE20 by 90 percent.	NOT ESTIMATED		430K	1.2M	1.32M
35 – Relocate, Minimize and/or Eliminate Electrical Heaters in Electrical Access Room	**Reduce the fire CDF contribution from Fire Basic Event %IE-FIRE38 by 99 percent.**	**NOT ESTIMATED**		**410K[c]**	**1.2M[c]**	**270K**
36 – Provide Procedural Guidance for Loss of All 1E 120V AC Power	**Reduce the seismic CDF contribution from Seismic Basic Event %IE-SET36 by 50 percent.**	**NOT ESTIMATED**		**240K**	**680K**	**270K**
37 – Reinforce 1E 120V AC Distribution Panels	**Reduce the seismic CDF contribution from Seismic Basic Event %IE-SET36 by 90 percent.**	**NOT ESTIMATED**		**430K**	**1.2M**	**500K**
39 – Provide Procedural Guidance to Bypass Reactor Core Isolation Cooling (RCIC) Turbine Exhaust Pressure Trip	**As provided in response to an NRC staff RAI, modify fault tree to include a new operator action, having a failure probability of 1.0E-02, representing failure of the operator to defeat the HPCI/RCIC back pressure permissive .**	**10**	**<1**	**130K**	**380K**	**120K**

Table G-6. SAMA Cost/Benefit Screening Analysis for HCGS[(a)] (PSEG 2009)

SAMA	Assumptions	% Risk Reduction		Total Benefit ($)		Cost ($)
		CDF	**Population Dose**	**Baseline (Internal + External)**	**Baseline With Uncertainty[(e)]**	
40 – Increase Reliability/Install Manual Bypass of Low Pressure (LP) Permissive	As provided in response to an NRC staff RAI, the probability of common cause mis-calibration of all ECCS pressure transmitters was reduced to 8.0E-06 from 8.0E-05.	1	1	210K	610K	620K
41[(d)] – Installation of Passive Hardened Containment Ventilation Pathway	A completely passive containment vent system requiring no operator actions is assumed.	15	30	6.2M	18M	>25M
42[(d)] – Installation of SACS Standby Diesel-Powered Pump	Reduce the probability of initiating event %IE-SACS to 1.16E-05 per year from 1.16E-04 per year.	2	1	270K	760K	6.2M

(a) SAMAs in bold are potentially cost-beneficial.

(b) SAMA 5A added as a sensitivity case to SAMA 5 to provide a comprehensive, long term mitigation strategy for SBO scenarios.

(c) SAMAs 30, 31, and 32 were identified and evaluated in response to an NRC staff RAI (PSEG 2010a). The RAI response stated that the percent risk reduction was developed using SGS PRA Model Version 4.3 and that the implementation costs for SAMAs 30 and 31 are expected to be significantly greater than the $100K assumed in the SAMA evaluation.

(d) Value estimated by NRC staff using information provided in the ER.

(e) Using a factor of 2.5.

G.5 Cost Impacts of Candidate Plant Improvements

PSEG estimated the costs of implementing the 21 candidate SAMAs through the development of site-specific cost estimates. The cost estimates conservatively did not include the cost of replacement power during extended outages required to implement the modifications, nor did they include contingency costs for unforeseen difficulties (PSEG 2010a). The cost estimates provided in the ER did not account for inflation, which is considered another conservatism.

The NRC staff reviewed the bases for the applicant's cost estimates (presented in Table E.5-3 of Attachment E to the ER). For certain improvements, the NRC staff also compared the cost estimates to estimates developed elsewhere for similar improvements, including estimates developed as part of other licensees' analyses of SAMAs for operating reactors.

The ER stated that plant personnel developed HCGS-specific costs to implement each of the SAMAs. The NRC staff requested more information on the process PSEG used to develop the SAMA cost estimates (NRC 2010a). PSEG responded to the RAI by explaining that the cost estimates were developed in a series of meetings involving personnel responsible for development of the SAMA analysis and the two PSEG license renewal site leads who are engineering managers each having over 25 years of plant experience, including project management, operations, plant engineering, design engineering, procedure support, simulators, and training (PSEG 2010a). During these meetings, each SAMA was validated against the plant configuration, a budget-level estimate of its implementation cost was developed, and, in some instances, lower cost approaches that would achieve the same objective were developed. The SAMA implementation costs were then reviewed by the Design Engineering Manager for both technical and cost perspectives and revised accordingly. PSEG further explained that seven general cost categories were used in development of the budget-level cost estimates: engineering, material, installation, licensing, critical path impact, simulator modification, and procedures and training. Based on the use of personnel having significant nuclear plant engineering and operating experience, the NRC staff considers the process PSEG used to develop budget-level cost estimates reasonable.

The NRC staff requested additional clarification on the estimated cost of $2.05M for implementation of SAMA 5, "Restore AC Power with Onsite Gas Turbine Generator," and on the implementation cost of $270K for implementation of SAMA 36, "Provide Procedural Guidance for Loss of All 1E 120V AC Power," which are high for what are described as procedure changes and operator training (NRC 2010a). In response to an RAI, PSEG further described the SAMA 5 modification as providing the necessary equipment to connect a dedicated transformer at Salem Unit 3 to HCGS, which is significantly more costly than, and is in addition to, the procedure changes (PSEG 2010a). It was also explained that the SAMA 5 modification assumes that Salem Generating Station (SGS) SAMA 2 to install the dedicated transformer is already implemented and that SAMA 5 is a safety-related permanent plant modification. In response to a different RAI, PSEG explained that the SAMA 36 modification involves the development of a group of procedures, not just the revision of existing procedures or the development of a single procedure. In addition, there is a significant effort involved with determining a success path to achieve safe shutdown, to update the simulator to include all necessary components to implement the success path, to test the success path, and to implement the new procedures. Based on this additional information, the NRC staff considers the estimated cost to be reasonable and acceptable for purposes of the SAMA evaluation.

The NRC staff asked PSEG to justify the estimated cost of $100K for SAMA 10, "Provide Procedural Guidance to use B.5.b Low Pressure Pump for Non-Security Events," for what is described as including a new pump when $100K is the estimated cost of a procedure change used in the SAMA analysis (NRC 2010a). PSEG responded that the cost estimate for SAMA 10 assumes that an existing pump already installed at HCGS will be made available to implement this SAMA (PSEG 2010a). Based on this additional information, the NRC staff considers the estimated cost to be reasonable and acceptable for purposes of the SAMA evaluation.

In response to an RAI requesting a more detailed description of the changes associated with SAMA 16, "Use of Different Designs for Switchgear Room Cooling Fans," PSEG provided additional information detailing the cost estimate of this improvement (PSEG 2010a). The staff reviewed the cost estimate and found it to be reasonable, and generally consistent with estimates provided in support of other plants' analyses.

The NRC staff noted that SAMA 31, "Install Improved Fire Barriers in the Main Control Room (MCR) Control Cabinets Containing the Primary Main Steam Isolation Valve (MSIV) Control Circuits," is similar to SGS SAMAs 21 and 22 in that each involves installing fire barriers to prevent the propagation of a fire between cabinets and requested an explanation for why the estimated cost of $1.2M for SAMA 31 to modify one cabinet is similar to the estimated cost of $1.6M for SGS SAMA 22 to modify three Control Room consoles and is more than one-third of the $3.23M cost for SGS SAMA 21 to modify 48 Relay Room cabinets (NRC 2010a). PSEG responded that making the modifications to the SAMA 31 Control Room console, which is estimated to be $400K for materials and installation, is more complicated than making modifications to the SGS SAMA 21 Relay Room cabinets, which is estimated to be $35K to $70K for materials and maintenance (PSEG 2010a). Specifically, SAMA 31 requires making ventilation modifications due to the significant heat loads in addition to adding fire barrier materials. PSEG also explained that both SAMA 31 and SGS SAMA 22 assumed the same material and installation cost per console ($400K) and the same engineering cost ($800K) but that the engineering cost was evenly divided between the two units at SGS to arrive at a cost per unit. The NRC staff considers the basis for the differences in cost estimates reasonable.

The NRC staff noted that the estimated cost of $620K for SAMA 40, "Increase Reliability/Install Manual Bypass of Low Pressure (LP) Permissive," is significantly higher than the estimated cost of $250K for a similar improvement evaluated for the Duane Arnold nuclear power plant license renewal application (NRC 2010a). In response to the RAI, PSEG clarified that SAMA 40 involves the installation of six key-lock switches to bypass various low pressure submissives (PSEG 2010a). Key-lock switches are used rather than jumpers, as was assumed in the Duane Arnold application, because the benefit of this SAMA cannot be obtained otherwise due to the effort required to install six jumpers, which is a more time intensive action than the time required to operate key-lock switches. Based on this additional information, the NRC staff considers the estimated cost for HCGS to be reasonable and acceptable for purposes of the SAMA evaluation.

The NRC staff also noted that the estimated cost of $1.32M each for SAMA 33, "Install Division II 480V AC Bus Cross-ties," and SAMA 34, "Install Division I 480V AC Bus Cross-ties," is significantly higher than the estimated cost of $328K to $656K for a similar improvement evaluated for other nuclear power plant license renewal applications, i.e., Wolf Creek and Susquehanna (NRC 2010a). In response to the RAI, PSEG described these modifications as involving the installation of new tie-breakers and cables for the 480V AC bus cross-ties, having a material and installation cost of $400K (PSEG 2010a). The most significant cost was for engineering, which was estimated to be $800K due to the electrical load analysis required to support the cross-ties. Based on this additional information, the NRC staff considers the basis for the estimated cost to be reasonable.

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

G.6 Cost-Benefit Comparison

PSEG's cost-benefit analysis and the NRC staff's review are described in the following sections.

G.6.1 PSEG's Evaluation

The methodology used by PSEG was based primarily on NRC's guidance for performing cost-benefit analysis, i.e., NUREG/BR-0184, *Regulatory Analysis Technical Evaluation Handbook* (NRC 1997a). The guidance involves determining the net value for each SAMA according to the following formula:

Net Value = (APE + AOC + AOE + AOSC) – COE
where
APE = present value of averted public exposure ($)
AOC = present value of averted offsite property damage costs ($)
AOE = present value of averted occupational exposure costs ($)
AOSC = present value of averted onsite costs ($)
COE = cost of enhancement ($)

If the net value of a SAMA is negative, the cost of implementing the SAMA is larger than the benefit associated with the SAMA and it is not considered cost-beneficial. PSEG's derivation of each of the associated costs is summarized below.

NUREG/BR-0058 has recently been revised to reflect the agency's policy on discount rates. Revision 4 of NUREG/BR-0058 states that two sets of estimates should be developed, one at 3 percent and one at 7 percent (NRC 2004). PSEG performed the SAMA analysis using the 3 percent discount rate and a sensitivity study using the 7 percent discount rate (PSEG 2009).

Averted Public Exposure (APE) Costs

The APE costs were calculated using the following formula:

APE = Annual reduction in public exposure (Δperson-rem/year)
× monetary equivalent of unit dose ($2,000 per person-rem)
× present value conversion factor (15.04 based on a 20-year period with a 3-percent discount rate)

As stated in NUREG/BR-0184 (NRC 1997a), it is important to note that the monetary value of the public health risk after discounting does not represent the expected reduction in public health risk due to a single accident. Rather, it is the present value of a stream of potential losses extending over the remaining lifetime (in this case, the renewal period) of the facility. Thus, it reflects the expected annual loss due to a single accident, the possibility that such an accident could occur at any time over the renewal period, and the effect of discounting these potential future losses to present value. For the purposes of initial screening, which assumes elimination of all severe accidents, PSEG calculated an APE of approximately $688,000 for the 20-year license renewal period.

Averted Offsite Property Damage Costs (AOC)

The AOCs were calculated using the following formula:

AOC = Annual CDF reduction
x offsite economic costs associated with a severe accident (on a per-event basis)
x present value conversion factor.

This term represents the sum of the frequency-weighted offsite economic costs for each release category, as obtained for the Level 3 risk analysis. For the purposes of initial screening, which assumes elimination of all severe accidents caused by internal events, PSEG calculated an AOC of about $155,000 based on the Level 3 risk analysis. This results in a discounted value of approximately $2,332,000 for the 20-year license renewal period.

Averted Occupational Exposure (AOE) Costs

The AOE costs were calculated using the following formula:

AOE = Annual CDF reduction
× occupational exposure per core damage event
× monetary equivalent of unit dose
× present value conversion factor

PSEG derived the values for averted occupational exposure from information provided in Section 5.7.3 of the regulatory analysis handbook (NRC 1997a). Best estimate values provided for immediate occupational dose (3,300 person-rem) and long-term occupational dose (20,000 person-rem over a 10-year cleanup period) were used. The present value of these doses was calculated using the equations provided in the handbook in conjunction with a monetary equivalent of unit dose of $2,000 per person-rem, a real discount rate of 3 percent, and a time period of 20 years to represent the license renewal period. For the purposes of initial screening, which assumes elimination of all severe accidents caused by internal events, PSEG calculated an AOE of approximately $2,700 for the 20-year license renewal period (PSEG 2009).

<u>Averted Onsite Costs</u>

Averted onsite costs (AOSC) include averted cleanup and decontamination costs and averted power replacement costs. Repair and refurbishment costs are considered for recoverable accidents only and not for severe accidents. PSEG derived the values for AOSC based on information provided in Section 5.7.6 of NUREG/BR-0184, the regulatory analysis handbook (NRC 1997a).

PSEG divided this cost element into two parts – the onsite cleanup and decontamination cost, also commonly referred to as averted cleanup and decontamination costs (ACC), and the replacement power cost (RPC).

ACCs were calculated using the following formula:

ACC = Annual CDF reduction
x present value of cleanup costs per core damage event
× present value conversion factor

The total cost of cleanup and decontamination subsequent to a severe accident is estimated in NUREG/BR-0184 to be $\$1.5 \times 10^9$ (undiscounted). This value was converted to present costs over a 10-year cleanup period and integrated over the term of the proposed license extension. For the purposes of initial screening, which assumes elimination of all severe accidents caused by internal events, PSEG calculated an ACC of approximately $87,000 for the 20-year license renewal period.

Long-term RPCs were calculated using the following formula:

RPC = Annual CDF reduction
x present value of replacement power for a single event
× factor to account for remaining service years for which replacement power is required
× reactor power scaling factor

PSEG based its calculations on a HCGS net output of 1287 megawatt electric (MWe) and scaled up from the 910 MWe reference plant in NUREG/BR-0184 (NRC 1997a). Therefore PSEG applied a power scaling factor of 1287/910 to determine the replacement power costs. For the purposes of initial screening, which assumes elimination of all severe accidents caused by internal events, PSEG calculated an RPC of approximately $35,000 and an AOSC of approximately $122,000 for the 20-year license renewal period.

Using the above equations, PSEG estimated the total present dollar value equivalent associated with completely eliminating severe accidents from internal events at HCGS to be about $3.14M. Use of a multiplier of 6.3 to account for external events increases the value to $19.8M and represents the dollar value associated with completely eliminating all internal and external event severe accident risk for a single unit at HCGS, also referred to as the Maximum Averted Cost Risk (MACR).

PSEG's Results

If the implementation costs for a candidate SAMA exceeded the calculated benefit, the SAMA was considered not to be cost-beneficial. In the baseline analysis contained in the ER (using a 3 percent discount rate, and considering the impact of external events), PSEG identified nine potentially cost-beneficial SAMAs. PSEG performed additional analyses to evaluate the impact of parameter choices (alternative discount rates and variations in MACCS2 input parameters) and uncertainties on the results of the SAMA assessment and, as a result of this analysis, identified four additional potentially cost-beneficial SAMAs.

The potentially cost-beneficial SAMAs are:

- SAMA 1 – remove ADS Inhibit from Non-ATWS Emergency Operating Procedures
- SAMA 3 – Install Back-Up Air Compressor to Supply AOVs
- SAMA 4 – Provide Procedural Guidance to Cross-Tie RHR Trains
- SAMA 8 – Convert Selected Fire Protection Piping from Wet to Dry Pipe System
- SAMA 10 – Provide Procedural Guidance to Use B.5.b Low Pressure Pump for Non-Security Events
- SAMA 17 – Replace a Supply Fan with a Different Design in Service Water Pump Room
- SAMA 18 – Replace a Return Fan with a Different Design in Service Water Pump Room
- SAMA 30 – Provide Procedural Guidance for Partial Transfer of Control Functions from the Control Room to the Remote Shutdown Panel
- SAMA 32 – Install Additional Physical Barriers to Limit Dispersion of Fuel Oil from DG Rooms

- SAMA 35 – Relocate, Minimize, and/or Eliminate Electrical Heaters in Electrical Access Room

- SAMA 36 – Provide Procedural Guidance for Loss of All 1E 120V AC Power

- SAMA 37 – Reinforce 1E 120V AC Distribution Panels

- SAMA 39 – Provide Procedural Guidance to Bypass RCIC Turbine Exhaust Pressure Trip

PSEG indicated that they plan to further evaluate these SAMAs for possible implementation using existing HCGS Plant Heal Committee processes (PSEG 2009).

The potentially cost-beneficial SAMAs, and PSEG's plans for further evaluation of these SAMAs, are discussed in detail in Section G.6.2.

G.6.2 Review of PSEG's Cost-Benefit Evaluation

The cost-benefit analysis performed by PSEG was based primarily on NUREG/BR-0184 (NRC 1997a) and discount rate guidelines in NUREG/BR-0058 (NRC 2004) and was executed consistent with this guidance.

SAMAs identified primarily on the basis of the internal events analysis could provide benefits in certain external events, in addition to their benefits in internal events. To account for the additional benefits in external events, PSEG multiplied the internal event benefits for each internal event SAMA by a factor of 6.3, which is the ratio of the total CDF from internal and external events to the internal event CDF. As discussed in Section G.2.2, this factor was based on a seismic CDF of 1.1×10^{-6} per year, plus a fire CDF of 1.7×10^{-5} per year, plus the screening values for high winds, external flooding, transportation, detritus, and chemical release events (1×10^{-6} per year for each). The external event CDF of 2.3×10^{-5} per year is thus 5.3 times the internal events release frequency CDF of 4.4×10^{-6} per year. The total CDF is thus 6.3 $[(2.3 \times 10^{-5} + 4.4 \times 10^{-6}) / 4.4 \times 10^{-6}]$ times the internal events release frequency CDF (PSEG 2009). Seven SAMAs were determined to be cost-beneficial in PSEG's analysis (SAMAs 1, 3, 4, 10, 17, 18, and 39 as described above).

PSEG did not multiply the internal event benefits by the factor of 6.3 for eight SAMAs that specifically address fire and seismic risk (SAMAs 30, 31, 32, 33, 34, 35, 36, and 37). Multiplying the internal event benefits by 6.3 for these SAMAs would not be appropriate because these SAMAs are specific to fire or seismic risks and would not have a corresponding benefit on the risk from internal events. Two of these SAMAs were found to be cost-beneficial in PSEG's analysis (SAMAs 30 and 35, as described above).

PSEG considered the impact that possible increases in benefits from analysis uncertainties would have on the results of the SAMA assessment. In the ER, PSEG presents the results of an uncertainty analysis of the internal events CDF which indicates that the 95th percentile value is a factor of 2.84 times the point estimate CDF for HCGS. Since the two Phase I SAMAs that were screened based on qualitative criteria were screened due to one being subsumed into another SAMA or one having already been implemented at HCGS, a re-examination of the Phase I SAMAs based on the upper bound benefits was not necessary. PSEG considered the impact on the Phase II analysis if the estimated benefits were increased by a factor of 2.84 (in addition to the multiplier of 6.3 for external events). Four additional SAMAs became cost-beneficial in PSEG's analysis (SAMAs 8, 32, 36, and 37 as described above).

PSEG provided the results of additional sensitivity analyses in the ER, including use of a 7 percent discount rate and variations in MACCS2 input parameters. These analyses did not identify any additional potentially cost-beneficial SAMAs (PSEG 2009).

PSEG indicated that the 13 potentially cost-beneficial SAMAs (SAMAs 1, 3, 4, 8, 10, 17, 18, 30, 32, 35, 36, 37, and 39) will be considered for implementation through the established HCGS Plant Health Committee process (PSEG 2009).

As indicated in Section G.3.2, in response to NRC staff RAIs, PSEG considered additional plant improvements to address basic events for which no SAMAs had been identified in the ER. PSEG determined that of the plant improvements considered, two additional SAMAs warrant further consideration: 1) SAMA 41, "Installation of Passive Hardened Containment Ventilation Pathway," and 2) SAMA 42, "Installation of SACS Standby Diesel-Powered Pump." Each of these new SAMAs is included in Table G-6 and were evaluated as described above. PSEG's analysis determined that neither of these SAMA candidates was cost-beneficial in either the baseline analysis or the uncertainty analysis.

As indicated in Section G.2.2, PSEG determined that the external events multiplier would be 6.8 if the higher seismic CDF obtained using the LLNL hazard curves were used rather than the EPRI hazard curves. As discussed in Section G.3.2, PSEG then reviewed the Level 1 and Level 2 basic events down to an RRW of 1.005 to account for the revised external events multiplier of 6.8. In addition, since the maximum benefit of each seismic sequence increased as a result of using the LLNL hazard curves, PSEG reviewed two additional seismic sequences having a benefit equal to or greater than $100,000, the minimum expected SAMA implementation cost at HCGS. These reviews resulted in the identification and evaluation of five additional SAMAs, as summarized below:

- SAMA RAI 5.j-IE1, "Install a Key Lock Switch for Bypass of the Main Steam Isolation Valve (MSIV) Low Level Isolation Logic." PSEG estimated the implementation cost for this SAMA to be the same as SAMA 40, "Increase Reliability/Install Manual Bypass of Low Pressure (LP) Permissive," or $620K, which also involved installation of key lock bypass switches (PSEG 2010a). The maximum benefit was estimated to be $110K in the baseline analysis, and $300K after accounting for uncertainties, which assumed that the risk of the basic event addressed by this SAMA was completely eliminated. Since the implementation cost was greater than the estimated benefit accounting for uncertainties, PSEG concluded that SAMA RAI 5.j-IE1 was not cost-beneficial.

- SAMA RAI 5p-1, "Install an Independent Boron Injection System." PSEG estimated the implementation cost of this SAMA to be $1.5M based on the estimate for a similar SAMA to install a redundant system evaluated in the Browns Ferry nuclear power plant license renewal application and the estimated cost to install an additional tank (PSEG 2010a). To estimate the risk reduction, PSEG modified the HCGS PRA model fault tree to include a new basic event, having a failure probability of 1.0E-03, representing failure of the redundant system. The benefit was estimated to be $390K in the baseline analysis, and $1.1M after accounting for uncertainties. Since the implementation cost was greater than the estimated benefit accounting for uncertainties, PSEG concluded that SAMA RAI 5p-1 was not cost-beneficial.

- Reinforce 1E 125V DC distribution panels 1A/B/C/D-D-417. PSEG estimated the minimum implementation cost for this SAMA to be the same as SAMA 37, "Reinforce 1E 120V AC Distribution Panels," or $500K, but expects the cost to be higher because these panels have a much higher HCLPF value than the SAMA 37 120V AC panels (PSEG 2010a). To estimate the risk reduction, PSEG assumed that the contribution to risk from external events is approximately 5.8 times that from internal events (based on a revised seismic CDF of 3.58×10^{-6} per year using the LLNL hazard curves), that seismic events contribute 14 percent of this external events risk, and that 50 percent of the fire risk affected by the SAMA is eliminated. The benefit was estimated to be $155K in the baseline analysis, and $440K after accounting for uncertainties. Since the implementation cost was greater than the estimated benefit accounting for uncertainties, PSEG concluded that this SAMA was not cost-beneficial.

- Reinforce 1E 120V AC distribution panels 1A/B/C/DJ482. PSEG estimated the implementation cost for this SAMA to be the same as SAMA 37, or $500K, which also addresses 120V AC panels (PSEG 2010a). To estimate the risk reduction, PSEG assumed that the contribution to risk from external events is approximately 5.8 times that from internal events (based on a revised seismic CDF of 3.58×10^{-6} per year using the LLNL hazard curves), that seismic events contribute 14 percent of this external events risk, and that all of the seismic risk affected by the SAMA is eliminated. The benefit was estimated to be $110K in the baseline analysis, and $320K after accounting for uncertainties. Since the implementation cost was greater than the estimated benefit accounting for uncertainties, PSEG concluded that this SAMA was not cost-beneficial.

- Reinforce 1E 120V AC distribution panels to 1.0g Seismic Rating. This SAMA assumes that 1) SAMA 37 is implemented, 2) the HCLPF values for the 120V AC panels are further increased to 1 g as a result of the implementation, 3) the above SAMA to reinforce the 125V DC panels is implemented, and 4) the HCLPF values for the panels are increased from the current 0.57g to 1.0g as a result of the implementation (PSEG

2010b). SAMA 37 originally was assumed to reduce the risk of seismic basic event %IE-SET36, "seismic-induced equipment damage state SET-36 (impacts – 120V PNL481," by 90 percent while the proposed SAMA to reinforce the 125V DC panels, by itself was originally assumed to reduce the risk of seismic basic event %IE-SET37, seismic-induced equipment damage state (impacts – 125V)," by 50 percent. The synergistic benefit of this new proposed SAMA to reinforce the 120V AC panels to a HCLPF value of 1.0g is assumed to be the sum of the benefit to eliminate the remaining 10 percent of the risk of event %IE-SET36 ($176K) and the remaining 50 percent of the risk of event %IE-SET37 ($155K), for a total benefit of $330K in the baseline analysis, and $940K after accounting for uncertainties. PSEG estimated the implementation cost for this SAMA to be $900K, which assumes the panels can be modified and not have to be replaced. Since the estimated benefit is greater than the implementation cost, PSEG determined that this proposed SAMA was potentially cost-beneficial. PSEG stated that this proposed SAMA will be considered for implementation through the established HCGS Plant Health Committee process.

The NRC staff notes that SAMA 37 was determined to be cost-beneficial and will be considered by PSEG for implementation through the established HCGS Plant Health Committee process. PSEG concluded, however, that the above originally proposed SAMA to reinforce the 125V DC panels was, by itself, not cost-beneficial, yet it was assumed to be implemented in the evaluation of this new proposed combined SAMA. Because the risk reduction from this new proposed SAMA to reinforce the 120V AC panels to a HCLPF value of 1.0g cannot be obtained without implementation of the proposed SAMA to reinforce the 125V DC panels, the NRC staff concludes that both SAMAs (SAMA 37 and the combined SAMA of reinforcing both the 120 VAC and 125 VDC panels) should be considered for implementation.

As indicated in Section G.3.2, two plant improvements were identified in the ER but not included in the SAMA evaluation because they were higher cost than the SAMA selected for evaluation. The NRC staff noted however that the two improvements could have larger benefits than the SAMAs evaluated because they could be more effective or could mitigate additional events (PSEG 2010a). In response to the RAIs, PSEG evaluated the two improvements, as summarized below:

- Replace the normally open floor and equipment drain MOVs with fail-closed AOVs. PSEG estimated the implementation cost of this SAMA to be $2.05M, which is half the estimate for a similar SAMA to replace cooling water system MOVs, which are larger than drain MOVs, with fail-closed AOVs evaluated in the TMI-1 nuclear power plant license renewal application (PSEG 2010a). To estimate the risk reduction, PSEG assumed that the entire release frequency associated with basic event CIS-DRAN-L2-OPEN, "valves open automatically for drainage normally open," after adjustment to account for existing procedures that are not credited, was eliminated. The benefit, assuming an external multiplier of 6.8, was estimated to be $710K in the baseline analysis, and $2.0M after accounting for uncertainties. Since the implementation cost was greater than the estimated benefit accounting for uncertainties, PSEG concluded the proposed improvement was not cost-beneficial.

- Auto align 480V AC portable station generator. For HCGS, this improvement is described as requiring permanent installation of an existing portable generator and adding the logic to perform the auto start and load function. PSEG estimated the implementation cost of this SAMA to be at least $1.0M based on an estimate of $1.0M from the Shearon Harris nuclear power plant license renewal application to permanently install a 480V AC generator and pump and an estimate of $3.1M from the TMI-1 nuclear power plant license renewal application to automate the start and load of an existing, permanently installed 4KV AC generator (PSEG 2010a, PSEG 2010b). To estimate the risk reduction, PSEG set the failure probabilities of existing operator actions to align the portable generator, and associated joint human error probabilities, to zero. The benefit, assuming an external multiplier of 6.8, was estimated to be $210K in the baseline analysis, and $600K after accounting for uncertainties. Since the implementation cost was greater than the estimated benefit accounting for uncertainties, PSEG concluded the proposed improvement was not cost-beneficial.

As indicated in Section G.3.2, for certain SAMAs considered in the ER, there may be alternatives that could achieve much of the risk reduction at a lower cost. The NRC staff asked the applicant to evaluate additional lower cost alternatives to the SAMAs considered in the ER, as summarized below (NRC 2010a):

- Establishing procedures for opening doors and/or using portable fans for sequences involving room cooling failures. In response to the NRC staff RAI, PSEG stated that HCGS already has procedures to implement the suggested alternative on loss of normal Switchgear Room HVAC and that this event is credited in the PRA model (PSEG 2010a). However, PSEG did provide an evaluation to implement the suggested alternative in the Service Water Pump Room, which is considered a more practical and cost effective change than SAMA 17, “Replace a Supply Fan with a Different Design in Service Water Pump Room,” and SAMA 18, “Replace a Return Fan with a Different Design in Service Water Pump Room,” which involve permanent hardware modifications. The cost of implementing an alternate room cooling strategy for this room, identified as SAMA RAI 7.a-1, was estimated to be $150K. The baseline benefit was assumed to be the sum of the estimated benefits for SAMAs 17 and 18, or $1.9M. Accounting for the revised multiplier of 6.8 and uncertainties increases the benefit to $5.9M. Since the estimated benefit is greater than the implementation cost, PSEG determined that SAMA RAI 7.a-1 was potentially cost-beneficial. PSEG also stated that this SAMA will be further evaluated in parallel with cost-beneficial SAMAs 17 and 18 since there may be some benefit associated with the permanent hardware modifications considered in these SAMAs.

- Extending the procedure for using the B.5.b low pressure pump for non-security events to include all applicable scenarios, not just SBOs. In response to the NRC staff RAI, PSEG stated that the estimated benefit for SAMA 10, “Provide Procedural Guidance to use B.5.b Low Pressure Pump for Non-Security Events,” already includes the risk reduction for all applicable scenarios (PSEG 2010a). The NRC staff concludes that the suggested alternative has already been addressed.

- Utilizing a portable independently powered pump to inject into containment. In response to the NRC staff RAI, PSEG explained that the HCGS PRA model already credits use of the diesel fire pump to inject into the RPV and containment and that the addition of another independently powered pump to provide injection would have limited benefit (PSEG 2010a). PSEG further noted that SAMA 10 already evaluated aligning the B.5.b low pressure pump with RHRSW to provide al alternate source of injection. The NRC staff concludes that the suggested alternative has already been addressed.

As indicated in Section G.4, the NRC staff questioned PSEG on the risk reduction potential for certain SAMAs (NRC 2010a, NRC 2010b), as summarized below.

- For SAMA 5, “Restore AC Power with Onsite Gas Turbine Generator,” PSEG provided a revised estimate of the benefit that included credit for the additional capability for mitigating a more complete set of loss of offsite power initiators that is consistent with the hardware changes proposed (PSEG 2010a, PSEG 2010b). This SAMA was determined to be potentially cost-beneficial in PSEG’s revised analysis. PSEG stated that SAMA 5 will be considered for implementation through the established HCGS Plant Health Committee process.

- For SAMA 35, “Relocate, Minimize and/or Eliminate Electrical Heaters in Electrical Access Room”, PSEG provided a revised estimate of the benefit assuming 99 percent of the fire risk affected by the SAMA was eliminated (PSEG 2010a). This SAMA was determined to remain cost-beneficial in PSEG’s revised analysis.

The NRC staff notes that the 13 cost-beneficial SAMAs (SAMAs 1, 3, 4, 8, 10, 17, 18, 30, 32, 35, 36, 37, and 39) identified in PSEG’s original baseline and uncertainty analysis, and the three SAMAs and plant improvements determined to be cost-beneficial in response to NRC staff RAIs (“establishing procedures for opening doors and/or using portable fans for sequences involving Service Water Pump Room cooling failures,” SAMA 5, and “reinforce 1E 120V AC distribution panels to 1.0g Seismic Rating”), are included within the set of SAMAs that PSEG plans to further consider for implementation through the established Plant Health Committee (PHC) process. The NRC staff suggests that the proposed SAMA to “reinforce the 120V DC panels” also be considered for implementation since it must be implemented to obtain the risk reduction benefits of the SAMA to “reinforce 1E 120V AC distribution panels to 1.0g Seismic Rating.”

In response to an NRC staff RAI, PSEG described the PHC as being chaired by the Plant Manager and includes as members the Plant Engineering Manager and the Directors of Operations, Engineering, Maintenance, and Work Management (PSEG 2010a). The PHC is chartered with reviewing issues that require special plant management attention to ensure effective resolution and, with respect to each of the potentially cost-beneficial SAMAs, will decide on one of the following courses of actions: 1) approve for implementation, 2) conditionally approved for implementation pending the results of requested evaluations, 3) not approved for implementation, or 4) table until additional information needed to make a final decision is provided to the PHC. Additional information requested may include 1) making corrections to the original SAMA analysis, 2) examining an alternate solution, 3) performing sensitivity studies to determine the effect of implementing a sub-set of SAMAs, already approved SAMAs, or already approved non-SAMA design changes on the SAMA, or 4) coordinating the SAMA with related Mitigating System Performance Index (MSPI) margin recovery activities. If approved or conditionally approved for implementation, the SAMA will be ranked with respect to priority and assigned target years for implementation.

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

G.7 Conclusions

PSEG compiled a list of 23 SAMAs based on a review of: the most significant basic events from the plant-specific PRA and insights from the HCGS PRA group, insights from the plant-specific IPE and IPEEE, Phase II SAMAs from license renewal applications for other plants, and the generic SAMA candidates from NEI 05-01. A qualitative screening removed SAMA candidates that: (1) are not applicable to HCGS due to design differences, (2) have already been implemented at HCGS, (3) would achieve results that have already been achieved at HCGS by other means, and (4) have estimated implementation costs that would exceed the dollar value associated with completely eliminating all severe accident risk at HCGS. Based on this screening, 2 SAMAs were eliminated leaving 21 candidate SAMAs for evaluation. Nine additional SAMA candidates or plant improvements were identified and evaluated in response to NRC staff RAIs.

For the remaining 21 SAMA candidates, a more detailed design and cost estimate were developed as shown in Table G-6. The cost-benefit analyses in the ER and RAI response showed that 9 of the SAMA candidates were potentially cost-beneficial in the baseline analysis (Phase II SAMAs 1, 3, 4, 10, 17, 18, 30, 35, and 39). PSEG performed additional analyses to evaluate the impact of parameter choices and uncertainties on the results of the SAMA assessment. Four additional SAMA candidates (SAMAs 8, 32, 36, and 37) were identified as potentially cost-beneficial in the ER. In response to an NRC staff RAI regarding the assumptions used to estimate the risk reduction potential of certain SAMAs, PSEG identified one additional potentially cost-beneficial SAMA (SAMA 5). In response to NRC staff RAIs regarding the seismic CDF and potential lower cost alternatives, PSEG further identified “establishing procedures for opening doors and/or using portable fans for sequences involving

Service Water Pump Room cooling failures" and "reinforce 1E 120V AC distribution panels to 1.0g Seismic Rating" as being potentially cost-beneficial enhancements. PSEG has indicated that all 14 potentially cost-beneficial SAMAs, as well as the enhancements "establishing procedures for opening doors and/or using portable fans for sequences involving Service Water Pump Room cooling failures" and "reinforce 1E 120V AC distribution panels to 1.0g Seismic Rating," will be considered for implementation through the established HCGS Plant Health Committee process. In addition, it is suggested that the plant improvement to "reinforce the 120V DC panels" be included in the set of SAMAs to be considered for implementation since it must be implemented to obtain the risk reduction benefits of the plant improvement to "reinforce 1E 120V AC distribution panels to 1.0g Seismic Rating."

The NRC staff reviewed the PSEG analysis and concludes that the methods used and the implementation of those methods was sound. The treatment of SAMA benefits and costs support the general conclusion that the SAMA evaluations performed by PSEG are reasonable and sufficient for the license renewal submittal. Although the treatment of SAMAs for external events was somewhat limited, the likelihood of there being cost-beneficial enhancements in this area was minimized by improvements that have been realized as a result of the IPEEE process, and inclusion of a multiplier to account for external events.

The NRC staff concurs with PSEG's identification of areas in which risk can be further reduced in a cost-beneficial manner through the implementation of the identified, potentially cost-beneficial SAMAs. Given the potential for cost-beneficial risk reduction, the NRC staff agrees that further evaluation of these SAMAs by PSEG is warranted. However, these SAMAs do not relate to adequately managing the effects of aging during the period of extended operation. Therefore, they need not be implemented as part of license renewal pursuant to Title 10 of the *Code of Federal Regulations*, Part 54.

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Docket Nos. 50-272, 50-311, 50-354

11. ABSTRACT *(200 words or less)*

This draft supplemental environmental impact statement (SEIS) has been prepared in response to an application submitted by PSEG Nuclear, LLC (PSEG) to renew the operating licenses for Hope Creek Generating Station (HCGS) and Salem Nuclear Generating Station, Units 1 and 2 (Salem) for an additional 20 years. The SEIS includes the NRC staff's analysis that considers and weighs the environmental impacts of the proposed action, the environmental impacts of alternatives to the proposed action, and mitigation measures for reducing or avoiding adverse impacts. It also includes the staff's preliminary recommendation regarding the proposed action.

The NRC staff's preliminary recommendation is that the Commission determine that the adverse environmental impacts of license renewal for HCGS and Salem are not so great that preserving the option of license renewal for energy-planning decision makers would be unreasonable. The recommendation is based on (1) the analysis and findings in the GEIS; (2) the Environmental Reports submitted by PSEG; (3) consultation with Federal, State, and local agencies; (4) the staff's own independent review; and (5) the staff's consideration of public comments.

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