CHAPTER 5

ENVIRONMENTAL IMPACTS OF OPERATION

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ACRONYMS AND ABBREVIATIONS

Acronym	Definition
ABWR	Advanced Boiling Water Reactor
ac.	acre
ac-ft	acre-feet
AP1000	Advanced Passive 1000
BEIR	Biological Effects of Ionizing Radiation
BMP	best management practices
Bq	becquerel
Btu/hr	British thermal units per hour
BWR	boiling water reactor
CD-144	Card Deck 144
CDF	confined disposal facility
cfs	cubic feet per second
Ci	curie
Ci/yr	curies per year
CO	carbon monoxide
CORMIX	Cornell Mixing Zone Expert System
CWS	circulating water system
D/Q	ground deposition factor
DAW	dry active waste
°C	degrees Centigrade
°F	degrees Fahrenheit
dBA	A-weighted decibel
delta-T	temperature difference
DOE	U.S. Department of Energy
DRBC	Delaware River Basin Commission
DTM	Digital Terrain Model
EFH	essential fish habitat
EIF	equivalent impact factor
EMF	electromagnetic fields
EPRI	Electric Power Research Institute

ACRONYMS AND ABBREVIATIONS, CONTINUED

Acronym	Definition
ER	Environmental Report
ESPA	early site permit application
ft/sec	feet per second
ft.	foot
ft/ft	feet per foot
ft^3	cubic feet
ft^3/yr	cubic feet per year
GEIS	Generic Environmental Impact Statement
GI-LLI	gastrointestinal-lower lining of intestine
GIS	geographical information system
gpm	gallons per minute
gm	gram
H1H	High-1^{st}-High
H2H	High-2^{nd}-High
ha	hectare
HDA	heat dissipation area
HCGS	Hope Creek Generating Station
HIC	high integrity container
HLW	high-level waste
HPO	New Jersey Historic Preservation Office
hr.	hour
hr/yr	hours per year
HRCQ	highway route controlled quantity
IAEA	International Atomic Energy Agency
kg/ha/mo	kilogram per hectare per month
kg/m^3	kilograms per cubic meter
kg/s	kilogram per second
kV	kilovolt
lb.	pound
lb/ac/mo	pounds per acre per month

ACRONYMS AND ABBREVIATIONS, CONTINUED

Acronym	Definition
lb/gal	pound per gallons
LMDCT	linear mechanical draft cooling towers
LOS	level of service
LWR	light water reactor
m	meter
m^3	cubic meter
MBq	megabecquerel
MEI	maximally exposed individual
Mgd	million gallons per day
Mgm	million gallons per month
mg/L	milligrams per liter
Mgy	million gallons per year
$\mu g/m^3$	micrograms per cubic meter
mi.	mile
MMBtu/hr	million British thermal units per hour
mph	miles per hour
mrad	millirad
mrem	millirem
m/s	meter per second
mSv	millisieverts
MT	metric tonne
MTU	metric ton of uranium
MW	megawatt
MWd/MTU	megawattdays per metric ton of uranium
MWe	megawatt electric
MWt	megawatt thermal
NAAQS	National Ambient Air Quality Standards
NAVD	North American Vertical Datum 88
NCDC	National Climatic Data Center
NDCT	natural draft cooling towers

ACRONYMS AND ABBREVIATIONS, CONTINUED

Acronym	Definition
NESC	National Electrical Safety Code
NIEHS	National Institute of Environmental Health Sciences
NJAAQS	New Jersey Ambient Air Quality Standards
NJAC	New Jersey Administrative Code
NJDEP	New Jersey Department of Environmental Protection
NJPDES	New Jersey Pollutant Discharge Elimination System
NO_2	nitrogen dioxide
NO_x	nitrogen oxides
NPDES	National Pollutant Discharge Elimination System
NRC	U.S. Nuclear Regulatory Commission
NRHP	National Register of Historic Places
#/million m^3	individuals per million cubic meters
O_3	Ozone
OSHA	Occupational Health and Safety Administration
PHI	Pepco Holdings, Inc.
PM_{10}	particulate matter smaller than 10 microns in diameter
$PM_{2.5}$	particulate matter smaller than 2.5 microns in diameter
PPE	plant parameter envelope
ppm	parts per million
ppt	parts per thousand
PRM	Potomac-Raritan-Magothy
PSD	Prevention of Significant Deterioration
PSE&G	Public Service Electric and Gas Company
PSEG	PSEG Power, LLC and PSEG Nuclear, LLC
PWR	pressurized water reactor
RERR	Radioactive Effluent Release Report
RG	Regulatory Guide
RM	river mile
RTP	rated thermal power
SACTI	Seasonal/Annual Cooling Tower Impact

ACRONYMS AND ABBREVIATIONS, CONTINUED

Acronym	Definition
SGS	Salem Generating Station
SIL	significant impact levels
SO_2	sulfur dioxide
SO_x	sulfur oxides
sq. mi.	square mile
SSAR	Site Safety Analysis Report
SSC	structures, systems, and components
Sv	Sievert
SWS	service water system
SWU	separative work unit
TEDE	total effective dose equivalent
TDS	total dissolved solid
U-235	uranium-235
U_3O_8	yellow cake
UF_6	uranium hexafluoride
UHS	ultimate heat sink
UO_2	uranyl acetate
USACE	U.S. Army Corps of Engineers
US-APWR	U.S. Advanced Pressurized Water Reactor
USEPA	U.S. Environmental Protection Agency
U.S. EPR	U.S. Evolutionary Power Reactor
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
$W/m^2/^{\circ}C$	watts per square meter per degree Centigrade
WMA	Wildlife Management Area
χ/Q	atmospheric dispersion factor
yr	year

CHAPTER 5

ENVIRONMENTAL IMPACTS OF STATION OPERATIONS

5.0 INTRODUCTION

Chapter 5 presents the potential environmental impacts of operation of the new plant. In accordance with 10 CFR 51, *Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions*, impacts are analyzed and a single significance level of potential impact to each resource (i.e., SMALL, MODERATE, or LARGE) is assigned consistent with the criteria that the U.S. Nuclear Regulatory Commission (NRC or Commission) established in 10 CFR 51, Subpart A, Appendix B, Table B-1, Footnote 3 as follows:

- SMALL — Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource. For the purposes of assessing radiological impacts, the Commission has concluded that those impacts that do not exceed permissible levels in the Commission's regulations are considered small.
- 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.

This chapter is divided into 10 sections:

- Land Use Impacts (Section 5.1)
- Water Related Impacts (Section 5.2)
- Cooling System Impacts (Section 5.3)
- Radiological Impacts of Normal Operation (Section 5.4)
- Environmental Impacts of Waste (Section 5.5)
- Transmission System Impacts (Section 5.6)
- Uranium Fuel Cycle Impacts (Section 5.7)
- Socioeconomics Impacts (Section 5.8)
- Decommissioning Impacts (Section 5.9)
- Measures and Controls to Limit Adverse Impacts During Operations (Section 5.10)

5.1 LAND USE IMPACTS

5.1.1 THE SITE AND VICINITY

5.1.1.1 The Site

Land use impacts from construction are described in Subsection 4.1.1. Additional impacts to land use from operation of the new plant result from the deposition of solids from cooling tower operation. Cooling tower design is discussed in Subsection 3.4.2 and impacts of the heat dissipation system, including deposition, are discussed in Subsections 5.3.3.1 and 5.3.3.2. The bounding conditions used for the analysis of cooling tower impacts are two natural draft cooling towers (NDCT) (used for far-field impact analysis) and two mechanical draft units (used for near-field impact analysis) (Table 3.4-2) located north of the power block as shown on the Site Utilization Plan (Figure 3.1-2). Adjacent land uses north, west, and east of the proposed cooling tower location consist of a confined disposal facility (CDF), the Delaware River, and coastal marsh, respectively. As described in Section 2.2, no residences, farmland or other developed land uses are located within 2.8 miles (mi.) from the PSEG Site. No salt deposition impacts to off-site developed resources are expected to occur because these distances are large and greater than any zone of influence from cooling tower operation (Subsection 5.3.3). As discussed in Subsection 5.3.3.3.1, the predicted solids deposition is below the concentrations, which could damage the salt-tolerant species of the adjacent coastal salt marsh.

Periodic maintenance activities for the cooling water intake structure may be required. These include desilting of the intake bays and potentially, limited dredging of the intake area to maintain depth. The silt and dredge material is disposed of in approved upland areas.

Impacts to land use from the new plant operations, therefore, are SMALL.

5.1.1.2 The Vicinity

The assessment of potential operational effects on land use in the vicinity assumes that the residences of the employees associated with the new plant are distributed across the region in the same proportion as those of the current PSEG employees (Section 2.5). The operational work force for the new plant consists of 600 additional on-site employees (Site Safety Analysis Report [SSAR] Table 1.3-1, Item 17.5.1). Subsection 5.8.2 describes the impact of these new employees on the region's housing market and the increases in tax revenues. Increased tax revenues could introduce local land use changes and/or increased property taxes.

A total of 82.6 percent (496) of the new employees are expected to reside in the four-county socioeconomic Region of Influence (New Castle, Delaware [DE] and Salem, Cumberland, and Gloucester, New Jersey [NJ] counties) (Subsection 2.5.2). Most of the new employees from the three NJ counties are likely to come from the higher population communities such as Bridgeton, Glassboro, Millville, Pennsville Township, Penns Grove, Pitman, Quinton, Salem, and Vineland. New employees from New Castle County, DE are most likely to come from Bear, Brookside, Clayton, Edgemoor, Hockessin, New Castle, Newark, Pike Creek, and Wilmington. Based on the residential distribution of existing Hope Creek Generating Station (HCGS) and Salem Generating Station (SGS) employees, it is likely that most of the employees of the new plant will choose to settle in or commute from communities within the four-county area that are outside the 6-mi. vicinity of the PSEG Site. As indicated in Subsection 2.5.2, housing vacancy is adequate in these areas, and it is likely that those new employees that do relocate to the area will purchase existing homes. While some of the new employees may construct new houses, this is limited and dispersed over a large area within a number of political jurisdictions. Additionally, most new construction is likely to be within lots previously zoned for new residential development by local planning agencies. Consequently, the impact of associated secondary development and land use alteration in the vicinity is SMALL.

Extensive areas surrounding the PSEG Site consist of open water (Delaware River) and undeveloped coastal marsh. These lands are either owned by the federal government or NJ and portions are designated as state-owned wildlife management areas (WMAs) and licensed dredge material disposal areas (Section 2.2). Consequently, development within these areas is not expected. The impacts to land use in the vicinity are SMALL.

5.1.2 TRANSMISSION CORRIDORS AND OFF-SITE AREAS

Baseline information regarding land uses along potential off-site transmission line corridors and the proposed causeway are described in Subsections 2.2.3.3 and 2.2.3.4, respectively.

Land use impacts to any potential transmission corridors from operation of the new plant are similar to impacts resulting from the operation of existing transmission lines from HCGS and SGS. For any potential off-site transmission corridor, PSEG or Public Service Electric and Gas Company (PSE&G) will acquire transmission line rights-of-way (either by outright purchase of the land or easement) in a manner that provides access and control over how the land in the transmission corridor is managed. Land use in the corridors and underneath the high-voltage lines is compatible with the reliable transmission of electricity. Vegetation communities in these corridors will be kept at an early successional stage. PSE&G currently owns or controls the existing rights-of-way in NJ associated with HCGS and SGS. Allowable activities within the rights-of-way are variable, but may include farming for feed (hay, wheat, corn) for livestock or grazing. Maintenance of these rights-of-way is conducted in a manner to avoid impacts to potential threatened and/or endangered species as outlined in letters to and from the U.S. Fish and Wildlife Service (USFWS) (References 5.1-1 and 5.1-2). PSE&G's control and management of these rights-of-way preclude construction of residential and industrial features in the transmission corridors. Operational impacts to land use in transmission corridors are SMALL.

Land use impacts associated with the proposed causeway are limited to the construction phase alteration of land uses (Subsection 4.4.1.1.1.2.1). The proposed causeway is designed and constructed with a sufficient lifespan that is consistent with that of the operating life of the new plant. Periodic maintenance activities will be required for the proposed causeway to ensure that it is in a safe operational condition including storm drainage features. Such activities are expected to include repair and maintenance of the roadway surface and catch basins/drainage, lane striping, and periodic management, mowing, and cutting of adjacent vegetation. Maintenance of these rights-of-way is conducted in a similar manner to transmission corridors in order to avoid impacts to potential threatened and/or endangered species as outlined in letters to and from the USFWS (References 5.1-1 and 5.1-2). Additional land use alteration activities are not expected. Operational impacts to land use in access road corridors are SMALL.

The new plant generates low-level radioactive wastes that require disposal in permitted radioactive waste disposal facilities (Subsection 3.5.3) and nonradioactive wastes that require disposal in permitted landfills. Both types of waste are commonly generated. Because NJ is a member of the North East Low-Level Waste Compact (also commonly known as the Atlantic Compact) the repository for the low-level radioactive wastes from the PSEG Site is located in Barnwell, South Carolina. Nonradioactive wastes are disposed of in existing approved landfills. The disposal of these low-level radioactive and nonradioactive wastes from the new plant is not expected to result in the need to develop and permit a new off-site disposal area. The new plant generates spent fuel, which is stored on-site until such time as the U.S. Department of Energy (DOE) constructs and NRC licenses a high-level radioactive waste disposal facility. Impacts to off-site land use due to disposal of low-level radioactive, high-level radioactive and nonradioactive wastes generated at the new plant are SMALL.

5.1.3 HISTORIC PROPERTIES AND CULTURAL RESOURCES

Tables 2.5-45 and 2.5-46 list properties within 10-mi. of the PSEG Site that are either on or eligible for listing on the National Register of Historic Places (NRHP). No historic properties are located on the PSEG Site. As described in Subsection 2.5.3, the historic properties investigation identified the John Mason house as a historic structure that is located adjacent to the proposed causeway. The lands surrounding the John Mason house are also part of a potential historic district associated with rural salt hay farming practices. Additionally, previously unrecorded archaeological sites were identified along the proposed causeway as part of a Phase I field investigation. All of these sites are potentially eligible for inclusion on the NRHP.

Direct impacts to historic or cultural resources during operations are less than the impacts of construction described in Subsection 4.1.4. No cultural resource management guidelines are needed for on-going operational and maintenance activities at the site, because no historic properties are located within the PSEG Site. Maintenance activities in off-site areas (potential transmission line and proposed causeway) that may require permitting (e.g., land disturbance activities by PSEG) would be regulated. Permit conditions prescribe actions needed to address archaeological or paleontological resources. The precise route of a potential transmission line has not been determined. The potential for additional operational activities that may disturb lands adjacent to the proposed causeway and any transmission corridors is low, as the known sites will be avoided. The potential for effects on historic or cultural resources from new plant operations is SMALL.

After consultation with the New Jersey Historic Preservation Office (HPO) and the Delaware State Historic Preservation Office, a geographical information system (GIS)-based visual impact analysis was performed to evaluate the potential visibility of the new plant from historic sites listed on the NRHP.

A Digital Terrain Model (DTM) was developed in GIS using U.S. Geological Survey (USGS) topographic information. The cooling tower bounding elevation was then analyzed in GIS to identify listed NRHP properties from which the cooling towers may be visible. Two NDCTs are assumed to be located north of the power block. The model included a base terrain elevation of 10 feet (ft.) above existing grade, cooling tower height of 590 ft., and a tree canopy height of 50 feet.

A total of 91 NRHP properties are located within the 10-mi. radius (80 located in DE and 11 in NJ). Based on the GIS analysis, 65 of the 91 NRHP-listed sites (71 percent) considered in this analysis are potentially in settings where the new plant cooling tower is visible.

Using information from the DTM, selected areas and historic properties within the 10-mi. radius were visited to validate the DTM predictions. All listed sites in NJ were visited because NJ contained a relatively small number of properties. A representative number of sites were investigated in DE. Forty-six properties in NJ and DE were visited as part of this survey, including individual structures, historic districts, and one archaeological site. In addition to the 11 listed properties in NJ, an additional three properties were visited that were not included on the NRHP list but were of similar age and design as the included properties. Thirty-seven properties were visited in DE. Based on the results of field surveys, the visibility of the existing and similarly sized HCGS cooling tower is variable depending on local topography and vegetation near each property. The cooling tower is visible to a greater number of the sites in DE because they are located on elevated positions within a more rolling topography. The terrain in the vicinity of the PSEG Site in NJ is comparatively flat. As a result, relatively small obstructions cause the cooling tower to be out of view. Only twelve of the above listed properties visited as part of the field survey had either partial or whole views of the cooling tower.

Thirty-four of the 46 sites located in the field were predicted to be in settings in which the cooling tower is visible. However, a number of these sites (e.g., Alloways Creek Meetinghouse, Hancock House, and Broadway Historic District in NJ; Achmeister, Monterey, Misty Vale in DE, etc.) have a view in which the cooling tower is not visible. This is due to obstructions (buildings or trees) that were not accounted for by the GIS terrain model. Based on GIS analysis, the cooling tower of the new plant is predicted to be visible at 71 percent of the sites visited. Based on the results of field surveys however, the cooling tower is visible at only 26 percent of the sites. The impact of the view of the new cooling towers on the viewshed of historic properties is SMALL, because of the large distance of the new plant from known historic sites, and the physical similarity of the new plant cooling towers with the existing HCGS cooling tower.

Transmission towers and supporting lines can impact the viewscape for some members of the public. However, these towers and lines are generally located in sparsely populated areas such as agricultural and wooded areas. Colocation with existing transmission lines in more populated areas minimizes visual impacts. Therefore, the visual impact of new transmission towers and supporting lines is SMALL

5.1.4 REFERENCES

5.1-1 PSEG, Letter to Wendy Walsh of USFWS Regarding Endangered Species Compliance during Electric Transmission Rights-of-Way Vegetation Maintenance Activities, October 13, 2009.

5.1-2 U.S. Fish and Wildlife Service, Letter to Edward Keating of PSEG Regarding Federally Listed Threatened and Endangered Species in the Vicinity of Salem and Hope Creek Generating Stations, September 9, 2009.

5.2 WATER RELATED IMPACTS

This section identifies impacts to surface water and groundwater resources associated with operation of the new plant. As described in Section 3.3, the new plant requires water for cooling and other operational uses. The sources of this water are the Delaware River and groundwater.

5.2.1 HYDROLOGIC ALTERATIONS AND PLANT WATER SUPPLY

Subsection 2.3.1 provides a description of the surface water and groundwater systems in the vicinity of the PSEG Site. This subsection provides a description of how the new plant operation impacts those water resources.

The new plant at the PSEG Site uses a closed-cycle cooling system requiring makeup water to replace that lost due to cooling tower evaporation, drift (entrained water droplets), and blowdown (water released to maintain water chemistry). As discussed in Section 3.3, makeup water for the cooling towers is pumped from the Delaware River. The expected rate of withdrawal of Delaware River water during normal operation for the circulating water system (CWS) is 75,792 gallons per minute (gpm) (Subsection 3.3.1 and Figure 3.3-1) and 2404 gpm for the service water system (SWS).

Groundwater withdrawal during normal operation supports makeup to the demineralizer system, fire protection system, sanitary and potable systems, and other miscellaneous uses. The average groundwater withdrawal rate is 210 gpm with a maximum rate of 953 gpm (Table 3.3-1).

Water withdrawn for cooling tower makeup is returned to the river as blowdown or lost as evaporation and drift. Water returned to the river as blowdown is available to aquatic communities. Alternatively, evaporative losses and drift are not replaced and are considered consumptive use. Drift losses are estimated to be 12 gpm.

This section assesses potential impacts of consumptive water use, water withdrawal, and chemical/thermal discharges. For groundwater, water withdrawals are evaluated. No discharge streams are reintroduced into the site aquifers.

5.2.1.1 Regional Water Use

As presented in Section 2.3, surface water in the Delaware River and immediately surrounding tidal marshes and streams is brackish at a level of up to 18 parts per thousand (ppt) salinity and is not fit for potable water supply or normal irrigation uses. Consequently, surface water uses in the vicinity of the PSEG Site are limited. As described in Subsection 2.3.2, HCGS and SGS are the primary water users in the vicinity of the PSEG Site. Groundwater in the region is used for both potable and industrial needs, with the closest non-PSEG well located 3.5 mi. away.

CWS and SWS cooling are the primary surface water uses at the new plant. The normal diversion rate for CWS and SWS use is 78,196 gpm (174 cubic feet per second [cfs]) (Figure 3.3-1). The discharge rate to the river is 51,946 gpm (116 cfs). Consumptive surface water use is 26,420 gpm (59 cfs), consisting primarily of evaporation and drift from the CWS and SWS/UHS cooling towers. Groundwater supplies the remaining water needs including sanitary and potable water, fire suppression, demineralized water treatment supply, and water for other miscellaneous uses.

5.2.1.2 Surface Water

Freshwater flow rates in the upper Delaware River are monitored and managed to control salinity intrusion into areas with established water supply intakes. Consequently, consumptive water use is regulated within the basin. Several reservoirs have been constructed in the Delaware River watershed to maintain minimum flows in the river. The Delaware River Basin Commission (DRBC) applies an equivalent impact factor (EIF) to account for this difference, because consumptive water use at locations with brackish water has a lesser impact on salinity intrusion than an equal consumptive use of fresh water. At the PSEG Site, the EIF is 0.18. Therefore, the 26,420 gpm consumptive use from the Delaware River is estimated to be equivalent to a freshwater consumptive use of 4756 gpm.

As discussed in Section 4.2, near-shore dredging in the Delaware River is necessary to provide barge access to the site and facilitate flow to the new plant intake structure. The dredging impacts an area of up to 92 acres (ac.) with an average dredging depth of 4.5 feet. The dredging will not modify the bathymetry of the Delaware River such that either currents or water levels are noticeably altered. Localized alteration of flow patterns occurs as ebb and flood tides flow over a modified subsurface terrain. The existing bathymetry is assumed to be at near equilibrium. While sedimentation in the dredged area may increase, based on experience at HCGS, only limited maintenance dredging during plant operation is anticipated to maintain the appropriate intake depth.

Based on the new plant Site Utilization Plan (Figure 3.1-2) the western shoreline of PSEG Site is modified due to the development of shoreline plant features including the water intake structure, heavy haul road, and barge facility. In total, 9.5 ac. of nearshore water and riparian shoreline is impacted below the coastal wetland boundary, also known as the NJ upper wetland boundary. Based on the Site Utilization Plan, and as described in Section 4.2, the shoreline will be constructed as a stabilized shoreline (using riprap or other appropriate treatment). Therefore, shorelines are expected to be stable during the operational phase.

A total of 65 ac. of existing coastal marsh is filled for construction of the new plant (Table 4.3-3). The marsh area impacted is at the surface water divide, or headwater of the small marsh creek channels within the coastal wetland systems that convey flood and ebb tide flows through the marsh and are maintained in an open condition by the cyclical pulsing of tidal flow. Channels within the Site Utilization Plan boundary are filled and lost as conveyance areas. During new plant operation, channel segments immediately adjacent to the new plant fill area (Figure 4.2-1) convey less water during tidal cycles. Consequently, the upper end segments of these channels are hydrologically altered (reduced velocities and tidal exchange). As a result, the upper reaches will accrete limited sediment and may become vegetated.

The location and detailed design of retention and holding areas have not been determined. Stormwater runoff controls at the new plant are required to be designed, constructed, and operated in accordance with New Jersey Pollutant Discharge Elimination System (NJPDES) storm water discharge requirements (Section 6.6). Impacts from increased stormwater runoff will be SMALL.

The water discharge from the new plant to the Delaware River, including cooling tower blowdown and other water and wastewater discharges, is through a 48-inch diameter outfall located 100 ft. from the existing shoreline and 2500 ft. north of the HCGS outfall. This location is also 4200 ft. north of the HCGS intake structure. Potential impacts of the operation of the discharge are described in Subsection 5.2.2. The impacts of the hydrological alterations, the additional intake of surface water from the Delaware River, and discharge are SMALL.

5.2.1.3 Groundwater

Groundwater is used to support the demineralized makeup water and the sanitary and potable water systems at the new plant. Groundwater withdrawals are from the Potomac-Raritan-Magothy (PRM) aquifer. Based on the needs of the new plant, discussed in Subsection 3.3.1 and Figure 3.3-1, the average total rate of water withdrawal to support operations is 210 gpm with a maximum rate of 953 gpm. Two additional wells are included in conceptual designs to supply the new plant.

The current SGS and HCGS groundwater withdrawal permits allow for a maximum withdrawal rate of 2900 gpm, and total diversion limits of 43.2 million gallons per month (Mgm) and 300 million gallons per year (Mgy) (Subsection 2.3.2). The additional average groundwater withdrawal for construction is within the permitted amounts. The groundwater withdrawal for the new plant is 210 gpm, which equals 110.4 Mgy. The cumulative maximum withdrawal for operations, including SGS and HCGS average historic withdrawals (Table 2.3-24) is 309 Mgy which is 3 percent above the current SGS and HCGS site permitted annual water withdrawal. The highest SGS and HCGS historic groundwater withdrawal is 232.5 Mgy (1995). PSEG will continue to manage water use to further reduce the impact of the new plant on groundwater resources.

When the reactor technology is selected and a final site water balance is developed, PSEG will reevaluate total site (SGS, HCGS, and new plant) water use against the site water allocation permit limits. The current permits and authorizations will be modified as necessary to include the new plant, or new permit(s) for water withdrawal will be obtained.

The groundwater use for the new plant combined with long-term average SGS and HCGS groundwater use is only slightly above the current authorization for the site, therefore, the impacts of additional water use locally and regionally are SMALL.

5.2.2 WATER USE IMPACTS

5.2.2.1 Surface Water

Surface water used to support the operation of the new plant is withdrawn from the Delaware River. Monthly and annual average flows are described in Subsection 2.3.1.

A CWS intake will be constructed at the shoreline. To ensure adequate depth for maximum intake flow rate required during low tide, ice accumulation, and other relevant conditions, an intake approach area will be dredged and maintained. The intake is designed to meet the 0.5 foot per second through screen velocity requirement under the Clean Water Act Section 316(b) new facility requirements specified in 40 CFR 125.84. A similar intake configuration and hydrodynamic condition at HCGS intake requires limited dredging to maintain the design intake depths.

During times of normal and average freshwater inflow to the estuary upstream of the new plant, the consumptive water use is a small fraction of the freshwater flow (the EIF adjusted flow of 4756 gpm). The freshwater portion of the consumptive losses is equal to 0.7 percent of the annual median Delaware River flow at Trenton, NJ, whereas the total consumptive losses are 0.01 percent of the tidal flows at the PSEG Site.

Various programs are in place to assure that sufficient water is available during times of drought to prevent salinity intrusion upstream in the Delaware River. These programs include government agency-controlled flow management through reservoir storage systems, voluntary conservation programs, and regional regulatory programs. PSEG has an allocation of 6695 acre-feet (ac-ft) of storage in the Merrill Creek Reservoir available to offset consumptive use during periods of declared drought. The DRBC is responsible for the declaration of drought. DRBC has approved the operating plan for the Merrill Creek Reservoir and its ability to provide an appropriate level of mitigation for current PSEG plant consumptive uses. The PSEG allocation is applicable to HCGS, SGS, and Mercer Generating Station Units 1 and 2 in Hamilton Township, NJ.

PSEG will submit an application to the DRBC to include the new unit(s) in the PSEG allocation. Water use for the new plant is within the current allocation for the single unit reactor technologies under consideration. The dual unit plant (Advanced Passive 1000 [AP1000]) configuration may require an additional 6.9 percent (465 ac-ft) beyond the current allocation. At the time a reactor technology decision is made, additional analysis of the PSEG allocation of the Merrill Creek capacity will be performed to support New Jersey Department of Environmental Protection (NJDEP) permitting and DRBC docketing of the new unit(s). PSEG will acquire any needed additional water allocation from the existing rights/capacity of other Merrill Creek co-owners or revise consumptive use allocations among the other PSEG plants.

Based on the above, the potential impacts of operation on both the local and regional surface water hydrology are SMALL.

5.2.2.2 Groundwater

Groundwater is used to supply makeup to the demineralizer system, fire protection system, sanitary and potable systems, and for other miscellaneous uses. The increased use of groundwater for the new plant is 210 gpm with a maximum rate of 953 gpm. The total average of the three stations is 589 gpm (HCGS and SGS at 379 gpm, new plant at 210 gpm). These rates are within the production capacity of the existing wells. PSEG intends to permit and install an additional two groundwater withdrawal wells at the new plant location.

As described In Subsection 2.3.2, there are currently four pumping wells and two backup wells providing groundwater to HCGS and SGS. These include pumping wells PW-5 (maximum limit 800 gpm), HC-1 (maximum limit 750 gpm), HC-2 (maximum limit 750 gpm), PW-6 (maximum limit 600 gpm) that extract groundwater from the PRM aquifer, and backup wells PW-2 (maximum limit 300 gpm) and PW-3 (maximum limit 600 gpm) that extract groundwater from the Mount Laurel/Wenonah aquifer.

The demand is within the daily and monthly allocation and on an annual basis, this 210 gpm rate only slightly exceeds the current permit allocation limit of 300 Mgy (Subsection 2.3.2).

To support the initial HCGS/SGS groundwater use permit, groundwater modeling was conducted to evaluate aquifer properties. This modeling was conducted by Dames & Moore in 1988 (Reference 5.2-1). Dames & Moore used the Princeton Transport Code model to run simulations at different rates to evaluate potential aquifer responses to changes in withdrawal rates, as well as to understand the potential impacts of saline intrusion on the Mount Laurel-Wenonah and PRM aquifers.

Dames and Moore simulated continued water withdrawals (at the 1987 rates [i.e., a total of 736 gpm average]) for the period of 1987 to 2007. The Dames & Moore model results are pertinent to the evaluation of future use of potential groundwater supplies and the risk of salt-water intrusion into the aquifers. In additional simulations, the withdrawals from the Mount Laurel-Wenonah wells and from PW-6 in the Middle PRM were discontinued and a hypothetical well, PW-7 in the Magothy Sand, was added in conjunction with increases at wells HC-1 and HC-2, for a total increase in flow rate to 875 gpm. The final simulation held the same withdrawal rate with a different well configuration. The final simulation configuration (PW-5 at 200 gpm, HC-1 and HC-2 at 268 gpm each, and hypothetical PW-7 at 139 gpm) provided adequate supply with appropriately limited drawdown and without any significant increases in chloride level at the production wells. Note that the total withdrawal simulated in the increased demand scenario (875 gpm) is considerably more than the current total of 379 gpm, although the distribution of rates among wells is different than currently used. Pumping rates in this simulation were greater than the total groundwater use projected during operation (589 gpm).

The results of the Dames & Moore analysis indicate that there are no significant impacts on the region and that the PRM can support volumes of withdrawal that exceed the current usage combined with the new plant usage. These model runs also indicate that additional withdrawals would not cause a significant increase in chloride concentrations in the Upper PRM, even at simulated flow rates of nearly twice those of current operation (Reference 5.2-1.)

The Dames & Moore model is applicable for this early site permit application (ESPA) and the groundwater withdrawal requirements at the new plant because the total volume of water withdrawn to support the new plant is within the values modeled by Dames & Moore

Two additional wells will be installed to support the new plant. The increase in volume does not negatively impact the PRM aquifer or off-site groundwater users, and impacts of operational water use on groundwater are SMALL, both for the local and regional groundwater setting.

5.2.3 WATER QUALITY IMPACTS

5.2.3.1 Surface Water

Operational impacts to surface waters are limited to the Delaware River, as this is the primary receiving water body affected by both plant discharges and stormwater runoff. Discharges to adjoining marsh creeks are not anticipated. Impacts from the discharge to the Delaware River have the potential to affect both the temperature and turbidity of the receiving water body.

5.2.3.1.1 Chemical Impacts

As is discussed in Subsection 3.6.3, nonradioactive liquid effluents released to the Delaware River are limited under the NJPDES permit. These permitted liquid effluents primarily include discharge of site storm drainage and treated power block discharges, such as oily waste, acid/caustic wastes, and normal waste systems. Existing site storm drainage outfalls may be modified and outfalls constructed to route stormwater to the Delaware River. Treated liquid effluents from the power block of the new plant are combined with the cooling tower blowdown and sanitary system effluent, and routed to the common plant outfall that discharges to the Delaware River.

Potable and sanitary wastewater treatment system effluent discharges are regulated under the provisions of the Clean Water Act (a program delegated to NJDEP through the NJPDES permit) and the requirements of the DRBC. The conditions of discharge include total suspended solids and 5-day biochemical oxygen demand. These limits are specified in the NJPDES permit (Subsection 3.6.2). The normal effluent flow rate from the potable and sanitary wastewater system is 93 gpm, as indicated on Figure 3.3-1.

Point discharges are monitored for parameters established by the NJPDES permit as discussed in Section 6.6. Wastewater constituents potentially include materials present in plant systems or permitted additives that may be present in water discharges. The design of the stormwater systems for a new plant complies with relevant federal, state, and local stormwater regulations. The overall plant blowdown constituents and concentrations are provided in SSAR Table 1.3-2.

Chemical treatment is used in the CWS for biological control and water quality. The chemicals used are in accordance with appropriate permits.

The CWS blowdown is similar to the HCGS discharge. NJPDES permit requirements (Reference 5.2-6) address chemical constituents of waste streams. Discharge monitoring of regulated chemical constituents is part of on-going operations of the new plant to ensure compliance with NJPDES permit limits. Based on the history of compliance with chemical effluent standards at HCGS and SGS, the incorporation of similar treatment systems for the new plant, and the need to comply with the state and federal regulations, potential impacts associated with chemical effluents are SMALL.

5.2.3.1.2 Thermal Impacts

Thermal discharges are allowed under the NJPDES permit regulating the discharge of pollutants into waters of the state. Waste heat is considered a pollutant that is permitted and monitored. To evaluate the potential impacts from the new plant discharge system, the Cornell Mixing Zone Expert System (CORMIX) (Reference 5.2-3) model was used to determine the temperature distribution in the Delaware River resulting from the discharge of blowdown water. Regulatory standards applicable to thermal discharges are the DRBC’s standards for Zone 5 of the Delaware Estuary (Reference 5.2-2). Discharge induced water temperature increases above ambient outside the permitted heat dissipation area (HDA) may not exceed 2.2°Centigrade (°C) (4°Fahrenheit [°F]) from September to May, 0.8°C (1.5°F) from June through August; and not exceed 30°C (86°F).

CORMIX is a widely used model developed with support from the U.S. Environmental Protection Agency (USEPA) beginning in the 1970s. The model is currently available as proprietary software from MixZon. CORMIX is an expert system model for analyzing discharge plumes. The model performs steady-state hydraulic analyses and can model both near-field and far-field plume regions. The expert system first determines a flow classification for each portion of the plume being analyzed. It then selects the appropriate hydraulic algorithm for each segment. The CORMIX model was used to analyze the extent of a cooling water system thermal plume discharged from the new plant. The model is consistent with CORMIX modeling and analyses recently performed for the HCGS (Reference 5.2-4).

For tidal waters, steady flow conditions (i.e., flow conditions that are not changing over time) do not exist in the ambient, or receiving water. The time scale associated with tidal cycles is relatively long, and conditions change slowly enough relative to the movement of the plume and mixing that occurs near the discharge point. As such, the CORMIX steady-state analysis is accurate for some travel distance from the discharge point and the associated time period. CORMIX uses input data including the tidal period and the point in time on the tidal cycle that is being analyzed to calculate the length, or extent, of the plume for which a steady-state analysis is reliable (Reference 5.2-5). Additionally, when analyzing a reversing current tidal condition, CORMIX uses the tidal input data to calculate the return flow, or reentrainment, of warm water discharged during the previous tidal cycle.

Existing Delaware River conditions with regard to water temperature in the vicinity of the new plant are affected by the presence of SGS and, to a lesser extent, HCGS. Water temperature influences of SGS, when both units are in service, are characterized by surface water temperatures measured on May 29, 1998 at the end of flood tide (Figure 5.2-1) and at the end of ebb tide (Figure 5.2-2). The HDA for HCGS is defined as a rectangle extending 2500 ft. upstream, 2500 ft. downstream, and 1500 ft. riverward from the HCGS discharge point. The HCGS HDA is completely enveloped by the elevated surface temperatures along the shoreline during the flood tide. Maximum temperatures within SGS's thermal plume measured on that day, in the vicinity of the HCGS outfall and the new plant outfall, were 2.0°C to 2.25°C (3.6°F to 4.05°F) above ambient waters along the west (riverward) side of the plume. Those maximum temperatures in the plume are also a few degrees less than the maximum temperatures at the SGS discharge point. NJDEP has issued a discharge permit for the SGS (Reference 5.2-7) and determined that the SGS's thermal plume, including the maximum temperature, does not impact the balanced indigenous community (Subsection 5.3.2.2).

For the conditions at the time (May 29, 1998, end of flood tide) presented in Figure 5.2-1, the apparent transition from near-ambient to plume-influenced temperature is 22.0 to 22.5˚C (71.6 to 72.5 F). The maximum, minimum, and mean river water temperatures at the USGS Reedy Island Jetty monitoring site on May 29, 1998 were 22.4˚C (72.3°F), 21.4˚C (70.5°F), and 21.9˚C (71.4°F), respectively (Reference 5.2-10). At a plume surface water temperature of 22.5°C (72.5°F) the outer edge of the thermal plume is indistinguishable from the background (ambient) temperature. At the end of flood tide (Figure 5.2-1) the SGS thermal plume extends northward along the shoreline well beyond the location of the new plant discharge. At the end of ebb tide (Figure 5.2-2) tidal currents transport the warmest regions of SGS's thermal plume downstream from the new plant discharge. Surface water temperatures in the vicinity of the new plant approach ambient conditions, indicating that residual temperature increases are small (less than 2.0°C (3.6°F).

Basic CORMIX inputs for the bounding analysis are summarized in Table 5.2-1. The intent of the analysis was to use a set of input data that collectively produce a conservative determination of thermal impacts. There are several parameters that are variable and contribute to the mixing and extent of the thermal plume, including ambient water level/depth, velocity, temperature, density, and rate of heat loss to the atmosphere and effluent temperature and density. As further discussed in Subsection 5.3.2.1, use of 90th percentile inputs for excess temperature (above ambient) and effluent density as well as other selected inputs makes the analysis conservative relative to average conditions.

In tidal situations, CORMIX is applied at a series of times during a tidal cycle, particularly during critical conditions around slack water when minimum mixing occurs and tidal flow reversal may cause re-entrainment of warm water discharged during the prior tidal cycle. For these applications, CORMIX requires information describing ambient water conditions, including tidal period and analysis time relative to slack water, velocity and water depth. Ambient velocity and water level data were taken from typical data at Reedy Point just upstream from the PSEG Site. Five analyses were performed identified at varying times in the tidal cycle and are indicated as 1 through 5 on Figure 5.2-3. These five analyses include times shortly before and after slack tide when mixing is typically most critical for a tidal system (Table 5.2-2 and Figure 5.2-3).

In addition to information describing ambient conditions, CORMIX requires information on the discharge. This information includes; temperature increase from the makeup water intake to the discharge (commonly referred to as the excess temperature or delta-T above ambient); density of the discharge; and the geometry of the discharge (e.g., pipe size, slope and orientation). An excess temperature of 9.6°C (17.3°F) was used based on extensive analysis of the HCGS discharge (Reference 5.2-4). This is similar to the discharge from the new plant, as both plants consist of closed-cycle cooling systems utilizing cooling towers. Najarian Associates found that June was the critical month for meeting regulatory temperature criteria, and an excess temperature of 9.6°C (17.3°F) is exceeded only 10 percent of the time (Reference 5.2-4). As an additional level of conservatism, heat loss to the atmosphere was assumed to be zero.

Finally, CORMIX uses the densities of the discharge and ambient (makeup) water. During June, the effluent density at HCGS was estimated by Najarian Associates to be more than 0.61 kilograms per cubic meter (kg/m^3) higher than the ambient density 10 percent of the time, and more than 0.88 kg/m^3 higher 5 percent of the time (Reference 5.2-4). The June analysis uses an effluent density of 0.81 kg/m^3 greater than the ambient density. The densities of the makeup water and blowdown are dependent on salinity and temperature. The salinity and temperature of the ambient water are dependent on natural processes. The salinity of the discharge depends on the cycles of concentration in the cooling tower and the salinity of the makeup water, while the discharge temperature depends on weather conditions and the performance of the cooling tower. Typically, the cooling water system blowdown is warmer and has a higher salinity than the makeup water. The density difference between ambient/intake water and blow-down is generally not large because these differences have opposite effects on the overall density. For this analysis, density was calculated using the following equation (Reference 5.2-9).

$$\text{Density} = 1 + \{0.001\ [(28.14 - 0.0735\ T - 0.00469\ T^2) + (0.802 - 0.002\ T)(S - 35)]\}$$

(Equation 5.2-1)

where:

Density = grams per cubic centimeter (1000 kg/m3)
S = salinity in ppt
T = temperature in °C

CORMIX does not use actual ambient water or effluent temperatures, only excess temperature, except indirectly through the densities assigned to the ambient water and effluent. The densities selected reflect typical June water temperatures.

Table 5.2-3 provides the results of the CORMIX analysis. The left column of the table provides the excess temperature at a point at the centerline along the plume. The columns to the right provide the distance from the outfall to the same point for each of the five scenarios. For Analyses 1 and 4, CORMIX, when run as a tidal/unsteady analysis, provides plume characteristics extending to 1°C and 1.5°C (1.8°F to 2.7°F) respectively. To determine temperatures beyond the area where the tidal unsteady analysis automatically terminates, a steady flow analysis was performed and the predicted temperature profile was compared to the tidal prediction. The steady flow prediction, which does not include the reentrainment of previous effluent that may occur in tidal reversing current situations, can provide a longer profile that can be used to determine an extended unsteady analysis profile.

The five analyses performed represent a range of conditions. In two of the conditions (slack tide, Analyses 1 and 4) the discharge momentum carries the plume nearly directly off-shore during conditions with low ambient velocity. The other three analyses represent conditions in which the plume is quickly turned by the ambient current with little movement transverse to the ambient flow (ebb and flood tide, Analyses 2, 3, and 5).

Results from the selected analyses indicate that mixing occurs rapidly. The plume generally becomes vertically mixed near the discharge outlet due to the relatively shallow depth of the discharge outfall. The negatively buoyant density and angle of the pipe (0.01 feet per foot [ft/ft] downward slope) contribute to a general condition of bottom attachment of the plume near the outlet. Under flood and ebb tide conditions (Analyses 2, 3, and 5) the excess temperature drops to 1.5°C (2.7°F) less than 100 ft. (70 to 75 ft., Table 5.2-3) from the discharge. The five analyses also define an area that extends up to 450 ft. upstream and downstream (279 ft. upstream – Analysis 4, 443 ft. downstream – Analysis 1) from the end of the outlet pipe before mixing reduces the excess temperature to 1.5°F (note that the distances in Table 5.2-3 are trajectory distances along the centerline of the plume and not distances upstream/downstream or perpendicular to the shoreline). The lateral width of the plume extends 500 ft. transverse to ambient flow (427 ft. – Analysis 1, 466 ft. – Analysis 4) before mixing reduces the excess temperature to 0.8°C (1.5°F).

The extent of the plume as defined by a 0.8°C (1.5°F) excess temperature in the results of the five analyses is illustrated on the end of flood phase and end of ebb phase surface temperature profiles from the SGS in Figures 5.2-4 and 5.2-5, respectively. This area extends 300 to 500 ft. upstream/downstream from the discharge point and 450 ft. laterally across the river from the end of the discharge. The tidal current reversal criterion, as described above, was exceeded on two of the five analyses before reaching the 0.8°C (1.5°F) residual excess temperature location. The program automatically terminated because the results further along the plume may not be reliable. Steady flow analyses are used to assist in estimating the distance to that temperature location. The 0.8°C (1.5°F) excess temperature value is generally equivalent to the regulatory HDA.

CORMIX modeling for the new plant suggests that, with the proposed representative CWS effluent characteristics, the new plant thermal plume is normally contained within 600 ft. of the shoreline (100 ft. offshore discharge and 0.8°C [1.5˚F] isotherm within 470 ft. riverward from the discharge point, Analysis 4). Consequently, the new plant plume is contained within SGS's thermal plume where the combined excess temperatures from the new plant, SGS and HCGS are less than the maximum temperature in SGS's thermal plume. The SGS excess temperature during the May 28, 1998 monitoring event ranged from 8.10 to 8.65°C (14.6 to 15.5°F).

As indicated in Figure 10-74, Appendix E, Exhibit E-I-3, 1998 Annual Monitoring Report, PSEG 1999 NJPDES Renewal Application for Salem Generating Station (Reference 5.2-8) and similar presentations of thermal plume at other times, the excess temperature in the vicinity of the new plant discharge is 2°C (3.6°F) during tidal flood phases when both units at SGS are operating at capacity. For example, if the true Delaware River ambient temperature of interest is 26.7°C (80.0°F) then the expected water temperature at a location where the excess temperature due to the new plant is 1.5°C (2.7°F) then the cumulative effect of all three PSEG discharges is 30.2°C (86.4°F). Based on the rapid mixing that occurs within the Delaware River, the relatively small volume of water released as part of the closed-cycle cooling system, and the demonstrated small size of the heat dissipation area, potential impacts of the thermal discharge are SMALL.

Additionally, as discussed in Subsection 5.3.2.2, the determination by NJDEP that the larger SGS thermal plume does not impact the balanced indigenous community of the Delaware River further substantiates the conclusion that due to its comparatively smaller discharge and thermal effects the new plant impact is SMALL.

5.2.3.1.3 Physical Impacts

Sediment transport within the overall Delaware River and Delaware Estuary is a complex process affected by sediment delivery from inflowing streams, shoreline erosion, and spatially and temporally varying hydrodynamic conditions within the estuary. The PSEG Site is located near the downstream end of a reach identified as the null zone in the estuary where sedimentation and turbidity are typically highest (Subsection 2.3.1).

The operation of the new plant does not create any significant change in sedimentation in the estuary. The PSEG Site shoreline is protected with riprap and timbers. Shoreline erosion is not significantly changed by operation of the new plant. The wave height impacting the shoreline may be slightly larger due to the deeper water column after dredging the offshore area. However, this increase is minor and does not result in increased shoreline instability or other discernable change in near-field currents. The potential effects of incremental sedimentation caused by the limited dredging of these areas is SMALL because the depth and area of dredging are limited in the context of the Delaware River and Delaware Estuary.

The CWS intake and discharge results in minor changes in velocities in the near-field region of the river above ambient conditions at those locations. Scour is not anticipated to occur at that location because ecological and other considerations limit the magnitude of the velocity at the intake (Subsection 5.3.2).

The CWS blowdown discharge has a relatively high velocity (9.21 feet per second [ft/sec]). The CWS blowdown is negatively buoyant, with density greater than the ambient water, causing the discharge to sink. The slightly downward angle from the discharge pipe (0.01 ft/ft anticipated) contributes to this. The conceptual design of the discharge considers local scour potential at the outlet and incorporates dredging of the existing bottom to accommodate the discharge without creating a scour area. Additionally, as indicated by the CORMIX modeling, rapid mixing is expected to occur and the exit velocity is rapidly reduced. The discharge flow is also deflected by the tidal currents upstream and downstream. Riprap or other engineered features are used at the end of the outlet pipe (Figure 3.4-4), which further reduce scour potential. Accordingly, the impact of potential scour in terms of both river bed area and volume of sediment scoured is SMALL.

During operation, the use of the barge facility is relatively infrequent. On those occasions when it is used, localized propeller-induced scour may occur. However, the area affected by this activity is limited relative to the size of the contiguous areas of the Delaware River. Additionally, as described in Subsection 2.3.3, this reach of the Delaware River is characterized as having relatively high ambient turbidities. Therefore, the potential impacts of barge facility operation on the Delaware River are SMALL.

5.2.3.2 Groundwater

Operations at the PSEG Site do not result in routine discharges to groundwater. Potential impacts on groundwater quality can occur via two pathways: (1) non-routine chemical releases (e.g., leaks or spills of heating oils, vehicle fuels, or lubricating oils) to the ground that may migrate though the soil to the shallow water-bearing zones; and (2) saline intrusion to the deep aquifers due to groundwater withdrawals. Both potential impacts are discussed below.

Best management practices (BMPs) are employed during operations to minimize potential impacts to groundwater quality from inadvertent discharges of chemical constituents. Discharge prevention, control and countermeasure plans will be prepared as required by state and federal regulations. Chemical discharges may impact the shallow soils and potentially the shallow water-bearing zones. The site grade will consist of engineered fill and other relatively impervious materials, further reducing the risk of groundwater contamination. NJDEP requires that chemical discharges to the soils and groundwater be reported and remediated to prevent groundwater impacts. Based on NJDEP requirements, spill planning, and BMPs, chemical impacts on groundwater are SMALL.

For the groundwater aquifers, surface discharges are not expected to migrate to the deeper aquifers due to the presence of the hydraulic fill and the Hornerstown, and Kirkwood aquitards. Most of the power block area is either paved or consists of engineered fill, which retards the infiltration of any potential discharges to the underlying soils and groundwater. Saline intrusion into the Mount Laurel-Wenonah and PRM aquifers from additional groundwater withdrawals is a potential impact. Based on the modeling completed by Dames & Moore, water withdrawals from the PRM are not expected to result in an increase in salinity. Therefore, the groundwater withdrawal impacts are SMALL.

5.2.4 REFERENCES

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5.2-3 Doneker, R.L. and G. H. Jirka, CORMIX Users Manual, "A Hydrodynamic Mixing Zone Model and Decision Support System for Pollutant Discharges into Surface Waters," December 2007, EPA-823-K-07-001.

5.2-4 Najarian Associates, Final Report, "Hydrothermal Modeling Analysis for the Hope Creek Generating Station Extended Power Uprate Project," Volume 1: Main Report plus Appendices A and B (supporting data), January 2004.

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5.2-6 New Jersey Department of Environmental Protection, Final Surface Water Renewal Permit Action, Hope Creek Generating Station, NJPDES Permit Number NJ0025411, December 31, 2002.

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5.2-9 Thomann, R.V. and J.A. Mueller, Principles of Surface Water Quality Modeling and Control, Harper & Row, Publishers, Inc., New York, 1987.

5.2-10 U.S. Geological Survey, "01482800 Delaware River at Reedy Island Jetty, DE" Website, http://waterdata.usgs.gov/de/nwis/current/?type=quality, accessed January 4, 2010.

Table 5.2-1
CORMIX Fixed Inputs for the PSEG Site ESP Application

Ambient Conditions	
Wind	2.24 mph (1 m/s)
Heat Loss Coefficient	0.0 $W/m^2/^{\circ}C$ (no heat loss assumed)
Width	Bounded at 16,060 ft/uniform section
Roughness (Manning)	0.025
Density (density at, for example, 24°C and salinity of 8.0 ppt)	1003.32 kg/m^3 /uniform – not stratified
Effluent	
Blowdown Discharge Rate	116 cfs
Blowdown Excess Temperature	17.3°F
Blowdown Density (density at, for example, 33.62°C and 13.0 ppt; salinity based on 1.63 cycles of concentration)	1004.13 kg/m^3
Discharge	
Circular Pipe Diameter	48 inches / 1.219 m
Outlet Distance from Bank	100 ft/perpendicular to shoreline
Outlet Relative to River Bottom	3.0 ft. above
Pipe Slope	-0.575 degrees (0.010 ft/ft)

Table 5.2-2
CORMIX Tidal Variable Inputs

Parameter	Analysis No. 1	2	3	4	5
Time Relative to Slackwater [(hrs before (-) or after (+))]	+0.25	+2.0	-1.5	+0.10	+1.0
Ambient Average Depth (m)	5.5	4.6	3.7	4.0	4.5
Depth at Outlet (m)	5.3	4.4	3.7	3.8	4.3
Tidal Velocity (m/s)	0.11	0.49	0.59	0.09	0.61
Maximum Velocity (m/s)	0.76	0.76	0.76	0.76	0.76

Analysis #	Tidal Condition
1	Ebb tide, after slackwater
2	Ebb tide, running tide
3	Low water, running tide
4	Flood tide, after slackwater
5	Flood tide, running tide

Table 5.2-3
Distance Along Plume Centerline to Selected Excess Temperature Values

	Trajectory Distance[b] [ft. (m)] to Excess Temperature for Given Tidal Phase				
	Analysis No.				
Temp Excess °F (°C)	Ebb Tide, After Slack 1	Ebb Tide, Running Tide 2	Low Water, Running Tide 3	Flood Tide, After Slack 4	Flood Tide, Running Tide 5
Initial Temperature Excess of 17.3°F					
7.2 (4.0)	54 (16.5)	34 (10.3)	31 (9.5)	54 (16.6)	30 (9.2)
4.0 (2.2)	105 (31.9)	55 (16.8)	51 (15.4)	100 (30.5)	49 (15.)
3.6 (2.0)	114 (34.6)	56 (17)	52 (16)	102 (31)	56 (17)
2.7 (1.5)	141 (43)	72 (22)	70 (21.5)	171 (52.2)	75 (23)
1.8 (1.0)	279 (85)	92 (28)	295 (90)	360 (110)[a]	102 (31)
1.5 (0.8)	492 (150)[a]	443 (135)	328 (100)	656 (200)[a]	295 (90)

a) Analysis by CORMIX terminated prior to reaching specified temperature; distance determined by comparison with steady flow analysis.

b) Trajectory distance is along a varying plume centerline and may be greater than the straight line distance

Analysis #	Tidal Condition
1	Ebb tide, after slackwater
2	Ebb tide, running tide
3	Low water, running tide
4	Flood tide, after slackwater
5	Flood tide, running tide

5.3 COOLING SYSTEM IMPACTS

This section describes the potential impacts of the proposed cooling system of the new plant on the physical and biological systems of the Delaware River, adjacent coastal marsh, and terrestrial ecosystems of the PSEG Site and nearby areas.

5.3.1 INTAKE SYSTEM

5.3.1.1 Hydrodynamic Descriptions and Physical Impacts

The new plant uses a closed-cycle, recirculating cooling system. Section 3.4 provides a detailed description of the cooling system. Compared with a once-through cooling system, a closed-cycle cooling system substantially reduces the volume of water diverted for cooling but increases consumptive water use as a result of evaporation loss in the cooling tower.

The makeup water for the cooling system is withdrawn from the Delaware River. The normal diversion rate for CWS and SWS is 78,196 gpm (174 cfs)(Figure 3.3-1). The discharge rate to the river is 51,946 gpm (116 cfs). Consumptive surface water use varies seasonally with a summer maximum of 26,420 gpm (59 cfs) consisting of cooling tower evaporation and drift losses.

Dredging in the vicinity of the proposed intake structure provides for flow conveyance to the new plant water intake structure. This area is perpendicular to the shoreline and expands outward from the shoreline (Figure 3.4-2). The flat bottom width at the intake structure is 210 feet. The channel will be dredged to a flat bottom with elevation –19.8 North American Vertical Datum 88 (NAVD) (elevation 70.0 on PSEG plant datum). As required by Section 316(b) rules for Phase I facilities, the intake structure of the new plant will be designed with a through-screen velocity that is less than 0.5 ft/sec (Subsection 3.4.2.1). Approach velocities outside the intake structure are lower, as trash racks are located more than 30 ft. from the traveling screens. Average approach velocities are low and hydrodynamic impacts from intake structure operation are SMALL.

Potential hydrodynamic effects of the new intake may also relate to changes in sedimentation and scour. No known data suggests that the bathymetry of the Delaware River near the new plant location deviates significantly from an equilibrium condition. Under such conditions, the long-term sediment surface is in balance with the range of normally occurring sediment transport capacity and load conditions. As an equilibrium condition exists, it is anticipated that dredging for the intake channel creates an area with some potential for sedimentation.

U.S. Army Corps of Engineers (USACE) Delaware River navigation channel maintenance dredging is not performed near the PSEG Site, as the channel is well offshore here. Most maintenance dredging occurs at locations upstream of river mile (RM) 52. At RM 70 to RM 85, where the river is narrower and the velocities are higher, sediments requiring dredging are reported to be primarily sands and gravels. Sediments transported near RM 52 are generally not an issue in the navigation channel, but can lead to accumulation in the area of the intake. Surficial sediments in the vicinity of the new plant intake are primarily composed of relatively uniform medium and fine sands (Subsection 2.3.1) which PSEG routinely removes from the interior bays of the SGS and HCGS intake structures.

Operation of the new plant under normal conditions likely creates a slight sedimentary environment in the immediate area of the intake and intake channel. Minor, localized scouring conditions are not anticipated. Potential hydrodynamic impacts of intake operation on sedimentation and scour are SMALL.

5.3.1.2 Aquatic Ecosystems

Impacts to aquatic ecosystems attributable to the operation of the new plant's intake system are related to the impingement and entrainment of aquatic biota. Impingement occurs when larger organisms become trapped against intake screens. Entrainment occurs when small organisms pass through the traveling screens and into the facility's condenser cooling system. The USEPA has promulgated regulations requiring that cooling water intakes of new facilities represent the best technology available to minimize adverse environmental impact (Reference 5.3-11). The design of the new plant's CWS uses closed-cycle cooling and has an intake structure with a through-screen design velocity of less than 0.5 ft/sec.

The normal makeup water intake flow is 78,196 gpm (Section 3.3). In comparison, tidal flow near the PSEG Site is 180,000,000 to 212,000,000 gpm (400,000 to 472,000 cfs). As discussed in Subsection 2.3.1.1.3, freshwater flow from the Delaware River and its tributaries averages 20,240cfs. Thus, the overall percentage of water from the Delaware River withdrawn for makeup water intake is less than 0.05 percent of its flow.

5.3.1.2.1 Impingement Effects

Impingement collections at the PSEG Site have been performed since 1977. Historical impingement rates for the important aquatic species (Subsection 2.4.2) and the overall aquatic community from SGS (2003 to 2007) and HCGS (1986 to 1987) were used to determine potential impingement losses associated with the operation of the new plant. Impingement data from SGS are used to develop an average impingement rate for the 5 yr between 2003 and 2007 (Table 2.4-17) that is used as an estimator of impingement for the new plant. Mean impingement rates are a conservative predictor of the impingement rate for the new plant because SGS has a once-through CWS and the intake structure has a through-screen velocity of nominally 0.9 ft/sec. The CWS of HCGS is closed-cycle and includes a water intake structure with a through-screen design velocity of less than 0.5 ft/sec. Data from SGS in 1986 to 1987 are compared to HCGS data from the same years to develop a correction factor to account for intake velocity-related density differences (References 5.3-14 and 5.3-15).

Data from SGS indicate that 50 to 60 fish species are impinged annually. Total density averages 3242 individuals per million cubic meters (#/million m^3) (1.0 m^3 equals 264.2 gallons) of water during the 5-yr period from 2003 through 2007 (Table 2.4-18). Total density over the 5-yr period is similar to both a larger 13-yr (1995 – 2007) SGS data set (Table 2.4-18) and a 2-yr HCGS data set (1986 and 1987) (Table 2.4-19) (References 5.3-14 and 5.3-15). Mean total impingement densities at SGS from 2003 to 2007 and from 1986 to 1987 were 3243/million m^3 and 3330/million m^3, respectively (Table 5.3-1). Because of their similarity, no correction factor to account for the 20-yr difference between the SGS data sets is considered necessary. Compositionally, white perch, Atlantic croaker, weakfish, hogchoker, bay anchovy, spotted hake, striped bass, blueback herring, gizzard shad, and Atlantic silverside numerically dominated recent impingement collections and those from the 1980s. These 10 species accounted for 93 to 94 percent of the total collection for all three data sets. With the exceptions of hogchoker, spotted hake, and gizzard shad (which are neither listed among the commercial and/or recreational species or as representative important species in the ongoing studies) the remaining are considered important species for this ESPA.

Table 5.3-1 lists recorded impingement densities of important species, whether abundant, common or uncommon in impingement collections. This table also includes their densities in impingement samples from 1986 and 1987 at HCGS (References 5.3-14 and 5.3-15). Recorded total fish density is moderately lower at HCGS (1986 to 1987 mean equals 2422/million m^3) relative to SGS using either 1986 to 1987 (mean equals 3330/million m^3) or 1995 to 2007 (3243/million m^3) data sets. Atlantic croaker and bay anchovy dominate the collections at HCGS, accounting for 65 percent of the total. Weakfish are also abundant in HCGS impingement samples. The important species are less frequently encountered at HCGS than at SGS (Table 5.3-1), with the exception of the American eel. The American eel is more abundant at HCGS than at SGS during the same time period, and in recent collections from SGS. The only commercially important invertebrate vulnerable to substantial impingement by the intake structure of the new plant is the blue crab. Blue crab densities for impingement samples are 727/million m^3 in 2003 to 2007, and 1743/million m^3 in 1986 to 1987 at SGS and 3008/million m^3 in 1986 to 1987 at HCGS. The general trend is in part attributable to the different physical locations of the intake structures of the two existing plants (i.e., southwest for the SGS cooling water intake structure versus west for the HCGS service water intake structure), and differences in intake screening technology.

Impingement rates of finfish at the new plant are calculated by multiplying the recent SGS impingement densities by 0.727 (73 percent). This correction factor is the ratio of the total impingement density at HCGS (1986 to 1987) to that of SGS for the same period. Historical HCGS impingement rates are used as a correction factor for the estimate because the new plant intake design velocity (less than 0.5 ft/sec) is more comparable to HCGS than to SGS (roughly 0.9 ft/sec). Table 5.3-2 presents these results with comparison to a conservative estimate, the unconverted impingement density at SGS from 2003 to 2007. Thus, the total impingement rate of finfish due to new plant operation is 2359/million m^3. White perch, Atlantic croaker, and weakfish are expected to comprise the majority of the impingement total.

The water volume withdrawn from the Delaware River by the closed cycle new plant is substantially lower. Maximum intake of the new plant based on the bounding value of 78,196 gpm is equivalent to 3.7 percent of the intake flow of SGS. Consequently the number of finfish and blue crab impinged, when using the 73 percent reduction in impingement (based on the above analysis) is 2.7 percent of that observed at SGS.

These estimates indicate comparable impingement rates at PSEG's existing plants and the new plant. Under Section 316(b) of the Clean Water Act [33 U.S.C. 1326(b)], the NJDEP must determine whether the location, design, construction, and capacity of a power plant's intake structure reflect Best Technology Available for minimizing Adverse Environmental Impact. The EPA's Phase I regulations for new sources [Federal Register: June 19, 2003 (Volume 68, Number 118, Pages 36749-36755)] require closed-cycle cooling, which the new plant will have. Therefore, impacts of the operation of the intake system are SMALL.

5.3.1.2.2 Entrainment Effects

Direct application of the entrainment rates from SGS are used to calculate entrainment rates of the new plant. The entrainment rates at SGS are applied to the new plant without a correction factor because organisms entrained are planktonic and entrainment rates are not influenced by through-screen velocities.

Total entrainment density at SGS averaged 146 ichthyoplankters (all life stages included) per 100 m^3 of water during the 5-yr period from 2003 to 2007 (Table 2.4-21). Bay anchovy comprised 61 percent of the total during that period. Other important species, striped bass (7.4 percent) and Atlantic croaker (4.0 percent) are also abundant. Naked goby accounted for 22 percent of the total density, on average. Seasonal vulnerability to entrainment is species-specific. Larvae and juveniles of bay anchovy are most numerous in entrainment samples in the summer (June 21 to September 20) and to a lesser extent the spring (March 21 to June 20) (Table 2.4-22). Striped bass larvae and juveniles are primarily collected in the spring, whereas Atlantic croaker young are most abundant in the fall (September 21 to December 20). In general, the densities of entrained individuals for most species are greatest in the spring and/or summer, corresponding to the spawning periods for these species. The entrainment rates of important species due to new plant operation are presented on an annualized basis in Table 5.3-3 and by season in Table 5.3-4. Based on the small volume of water withdrawn for the new plant's closed cycle cooling water system, the impacts of the operation of the intake system are SMALL.

5.3.1.2.3 Important Species

Impingement and entrainment of threatened or endangered species such as the shortnose and Atlantic sturgeons is unlikely. Threatened or endangered aquatic species are infrequently encountered near the PSEG Site at life stages where they are vulnerable to intake effects. Both the shortnose sturgeon and Atlantic sturgeon spawn in fresh waters (References 5.3-2 and 5.3-4) so their eggs and larvae are unlikely to be impinged or entrained by a low velocity intake at the new plant location. Of the five threatened or endangered turtle species, only the loggerhead and Kemp's ridley sea turtles have been encountered near the cooling water intake of SGS. Mitigation measures to reduce the incidental capture of sea turtles at SGS were implemented in 1992 and 1993. Since then, only six loggerhead sea turtles and no Kemp's ridley sea turtles have been encountered (Subsection 2.4.2.2). Based on the above, incidental capture of sea turtles is not expected at the new plant.

Historic impingment and entrainment studies commonly identified the following commercially or recreationally important species; weakfish, Atlantic croaker, white perch, striped bass, and blue crab. Data from Delaware River trawl and seine surveys (Subsection 2.4.2) are used in performing long-term abundance analyses for these species, and for the important forage fish, the bay anchovy (Reference 5.3-7).

Bottom trawl surveys show a significant decline in weakfish abundance between 1996 and 2004, but seine surveys do not exhibit a significant trend over the same period. In 2005, however, weakfish abundance was extremely high in bottom trawl collections. Abundance of juvenile Atlantic croaker increased significantly since 1980, but shows no statistically significant annual trend between 1995 and 2004. White perch abundance increased in seine and trawl surveys, but is statistically significant only in the seine collections. Similarly, seine surveys have indicated decreased abundance of bay anchovy but increased abundance of juvenile striped bass in the Delaware River. Trawl surveys also suggest increased abundance for these species, but not by significant margins.

Blue crab abundance exhibited a decline from 1995 to 2004. However, data from bottom trawl surveys from 2005 through 2007 indicate a subsequent increase in blue crab abundance (References 5.3-6, 5.3-8, and 5.3-9). Thus, the trend of declining numbers for this species appears to have been temporary. Data collected throughout this period generally indicate that the abundance of important species can vary over a wide range, but that the populations of these species are stable near the PSEG Site.

In summary, the new plant CWS is designed as a closed-cycle system and the intake structure withdraws a comparatively small volume of water from the Delaware River, at a through-screen velocity of less than 0.5 ft/sec. This is considered Best Technology Available under the Phase I Clean Water Act Section 316(b) regulations. Calculations of impingement mortality and entrainment rates indicate the loss of a small number of aquatic biota relative to the abundance of the standing stocks in the river and bay, and do not adversely affect the stability of the overall community or important species.

Species richness and diversity levels of the fish community in the vicinity of the existing power plants on the PSEG Site are documented in PSEG's NJPDES permit renewal filings generally as high as, or higher, than in the 1970s. Species lists from preoperational and current studies are similar, and with regard to the populations of individual species, most of the important species have either remained stable or varied due to regional or coast-wide environmental factors (Reference 5.3-7). Therefore, impacts of the intake system operation are SMALL.

5.3.2 DISCHARGE SYSTEMS

5.3.2.1 Thermal Discharges and Other Physical Impacts

Cooling tower blowdown from the new plant is discharged directly into the Delaware River through a new discharge structure located 8000 ft. north from the existing SGS discharge and 4000 ft. north from the existing HCGS discharge. The new discharge structure is located 1000 ft. north from the intake.

As illustrated in Figure 3.4-4, the discharge system consists of a 48-inch diameter pipe with its outlet end located 100 ft. from the shoreline. The depth of water at the outlet is 12 ft. below mean lower low water, and the bottom of the pipe elevated 3 ft. above the river bed.

The thermal discharge plume for the new plant is analyzed using CORMIX. CORMIX was developed for the USEPA for analysis of pollutant discharge plumes in water. Detailed discussion regarding the CORMIX analyses and results are presented in Subsection 5.2.3. CORMIX is used to analyze plume mixing in both the nearfield and farfield, assuming steady-state conditions. That is, the discharge, or effluent, characteristics and the ambient water characteristics are assumed steady, or fixed, over time. CORMIX can be applied to the inherently unsteady ambient conditions associated with tidal waters by adapting time scales. The time scale for a valid steady-state assumption is used that is shorter than the rate of change of ambient conditions due to the tidal cycle. The limiting time scale is directly related to

the distance downstream along the plume that the pollutant is conveyed before unsteady conditions prevail, causing a steady-state analysis to no longer be a valid assumption.
An excess temperature, or temperature rise from intake water temperature through the cooling tower to blowdown of 17.3°F is used, based on extensive analysis of the HCGS discharge as part of the extended power uprate application (Subsection 5.2.3) (Reference 5.3-5). The new plant thermal discharge is similar to the HCGS thermal discharge. Najarian and Associates (Reference 5.3-5) determined that a June discharge scenario is the critical time period with regard to thermal discharge impacts. This selected excess temperature is not a worst case condition, but is relatively conservative, with the excess temperature for June being a 90 percent non-exceedance frequency. Additionally, it was determined that statistically, the density difference in June with a 90 percent non-exceedance frequency has been -0.61 kg/m^3 (negatively buoyant with effluent density higher than ambient density). The density difference is input to CORMIX as -0.81 kg/m^3, which is consistent with a salinity of 8 ppt and the general range of assumed actual temperatures (CORMIX does not directly use temperature magnitudes, only temperature differences).

In addition to the unsteady tidal condition, another fundamental site characteristic is that the new plant discharge is located within the region influenced by the SGS and the HCGS thermal discharges. The SGS thermal discharge, while more distant from the new plant discharge than the HCGS discharge, is more dominant because it is a discharge from a once-through cooling system. As discussed in Subsection 5.2.3, the new plant discharge under normal conditions, results in a thermal plume with a delta-T of 1.5°F extending up to 750 ft. upstream and downstream of the discharge on flood tide and ebb tide, respectively. It also extends horizontally to a distance of up to 300 ft. under slack tide conditions. The physical effects of the thermal discharge are expected to be SMALL because the distribution of this 1.5°F plume is within the mixing zone limits established by DRBC (3500 ft. upstream and downstream).

Potential non-thermal physical effects of the cooling system blowdown discharge are similarly limited by the reduced flows resulting from a closed-cycle cooling system. The CWS blowdown discharge through a 48-inch diameter pipe has a relatively high velocity, 9.21 ft/sec. One of the reasons for the limited effect is the increase in initial mixing that occurs with a higher velocity. As with the intake channel, the design and construction of the discharge includes consideration of local scour potential at the outlet, with initial dredging of the existing bottom to accommodate the discharge without creating a scour area. As discussed above, the CWS blowdown, is at times negatively buoyant, with a density greater than the ambient water, causing the effluent to tend to sink in addition to the slightly downward angle from the discharge pipe (0.01 ft/ft). As indicated by the CORMIX modeling, rapid mixing is expected to occur and the exit plume velocity is expected to reduce rapidly. The exit plume is affected by the tidal currents, bending either upstream or downstream. While the bottom of the discharge pipe is 3.0 ft. above the surrounding river bed, rock riprap or other engineered feature is used around the end of the outlet pipe, which reduces scour potential. As design and construction provisions to avoid scour are included, the potential amount of scour in terms of both river bed area and volume of sediment potentially scoured is SMALL.

5.3.2.2 Aquatic Ecosystem

Nuclear power plant heat dissipation systems can impact aquatic communities in receiving waters in multiple ways. The three considered here are thermal, chemical, and physical effects.

5.3.2.2.1 Thermal Effects

Heated effluent from cooling systems can affect the distribution and abundance of aquatic organisms in receiving waters by direct mortality, reduction of growth or reproduction, or by causing avoidance of areas for periods of time. The CORMIX simulation discussed in Subsection 5.2.3 indicates that under most conditions (i.e., when tidal currents are present) the heated discharge is localized and contained in a narrow plume in the transverse axis. In periods of slack-water, the horizontal extent of the plume is 300 ft. before mixing reduces the excess temperature (delta-T) to 1.5°F. The longitudinal extent of the plume generally ranges from 750 ft. upstream and downstream of the end of the discharge pipe before mixing reduces the delta-T to 1.5°F. A small vertical plume is anticipated, as mixing occurs near the outlet due to the plume's negative buoyancy and the downward slope of the pipe. The majority of the water column of the Delaware River is unaffected by the blowdown, thus the thermal plume does not create a barrier to upstream or downstream movement of important migrating fish species.

With regard to fish and other vertebrate species, thermal impacts are limited to the area in the immediate proximity of the discharge. Avoidance of this localized area is expected to occur due to the high velocity of the outfall (9.21 ft/sec). Blue crab is the only important benthic species commonly encountered in the vicinity. Potential impacts to blue crab populations are expected to be SMALL because the thermal plume is localized and small in relation to the available habitat in the Delaware River.

A thermal demonstration study for SGS (Reference 5.3-1) concluded that the SGS thermal plume does not cause appreciable damage to a balanced, indigenous aquatic community. This conclusion is based on the following:

- There are no unique or rare habitats in the vicinity of the discharge, nor are there areas of special food production, nurseries, or critical spawning habitats necessary for the propagation and survival of a species.

- Of the six biological categories analyzed (phytoplankton, zooplankton, habitat formers, macroinvertebrates/shellfish, fish, and other vertebrate wildlife) none are significantly affected by the plume. The SGS thermal plume is too small to impair phytoplankton and zooplankton communities. Phytoplankton recover quickly from disturbance and, due to the high turbidity of the estuary, they contribute little to the primary production of the area. Similarly, zooplankton quickly recover from local perturbations due to their short generation time, prolific reproductive rate, and rapid transport and dispersal by currents. The two primary habitat formers, oyster beds and marsh grass, are not negatively affected. There are no active oyster beds in the vicinity, and the offshore location of the discharge minimizes contact of marsh plants with stressful water temperatures. With regard to shellfish and other macroinvertebrates, there are no listed threatened or endangered species of this category in the vicinity of the discharge, and there are no rare or unique habitats critical for their survival in the area. The spatial extent, nature, and intensity of the thermal plume are such that fish and other vertebrate wildlife are expected to avoid excessive temperatures and appreciable harm.

- Representative important species of macroinvertebrates (scud, opossum shrimp, and blue crab) and fish (American shad, alewife, blueback herring, striped bass, white perch, weakfish, spot, Atlantic croaker, and bay anchovy) were analyzed in terms of predicting the plume's potential effects on their populations, using highly conservative assumptions. This predictive assessment indicates that the species are expected to incur no negative effects on survival, growth or reproduction, primarily because of the small area of the plume in relation to the estuary and the ability of these species to avoid lethal temperatures.

- The retrospective assessment of no prior appreciable harm indicates that fish species richness has increased in the area since SGS operations began, and that abundance has increased for all but one of the representative important species considered. For the one exception, blueback herring, the population decline was not attributed to the plant, as the species spawns in freshwater tributaries far from the station. The authors note that this species was undergoing a large-scale and long-term decline in abundance, likely due to overfishing and habitat loss.

The more recent (2006) NJPDES renewal application indicates that SGS has not, and is not expected to, cause appreciable harm to aquatic communities in the Delaware Estuary. Species richness and diversity levels of the fish community in the vicinity of the existing power plants on the PSEG Site are as high as, or higher, than in the 1970s. Species lists from preoperational studies and current studies are similar, and with regard to the populations of individual species, most of the important species have either remained stable or varied due to local or coast-wide environmental changes (Reference 5.3-7). Potential effects of thermal effluents on aquatic communities are SMALL because the thermal discharge of the new plant is much smaller than that of SGS and the discharge is not expected to significantly increase thermal conditions within the SGS far-field (Subsection 5.2.3).

The thermal effluent of the new plant has the potential to affect some aspects of essential fish habitat (EFH) for four species identified by NMFS as having EFH in the Delaware River (Subsection 2.4.2.3.2). These species are summer flounder, butterfish, winter flounder, and windowpane. An NRC assessment of the potential effect of an extended power uprate for HCGS concluded that the potential effects to EFH for each of these species were SMALL (References 5.3-12, 5.3-13). Larval and juvenile life stages of winter flounder and windowpane are unlikely to use this segment of the river because it does not stratify and lacks the deep salinity wedge with a net upstream flow that these species use to move up or maintain their position in the river (Reference 5.3-12). The same conditions limit the use of the area by juvenile butterfish. The Delaware River adjacent to both HCGS and the new plant is relatively shallow and does not tend to stratify in terms of water temperature (Reference 5.3-12). Similarly, the closed-cycle configurations of both HCGS and the new plant limit the physical area and the magnitude of temperature increase associated with the thermal effluent. Thus, for each of the four species with EFH in the area near the PSEG Site, the potential impacts of thermal effluents from the new plant are SMALL.

5.3.2.2.2 Chemical Effects

Chemicals used in circulating water systems to control biofouling and corrosion can be harmful to aquatic organisms. As discussed in Subsection 5.2.3, operation of the new plant cooling towers is based on 1.5 cycles of concentration, meaning that solids and other constituents in makeup water are concentrated to 1.5 times the amount in raw intake water before being discharged (SSAR Table 1.3-1, Item 2.5.6). As a result, levels of solids and organics in cooling water blowdown are 1.5 times greater than ambient conditions. The blowdown stream is small relative to the flow of the Delaware River, and the turbulence near the end of the discharge pipe is high due to tidal exchange (Subsection 5.3.2.1). Therefore, concentrations of these solids and other constituents are mixed to ambient levels immediately downstream of the discharge pipe. Additionally, the discharge structure and concentrations of effluent parameters will meet NJPDES permit conditions established to provide protection for aquatic life. Therefore, impacts of effluents to aquatic communities are SMALL.

5.3.2.2.3 Physical Effects

High flows associated with circulating water systems can potentially scour substrates adjacent to the discharge, and transport sediments to other locations. These circumstances can potentially harm benthic organisms and damage fish spawning habitats. Based on the predicted discharge velocities (Subsection 5.3.2.1) some localized bottom scouring is expected in the immediate vicinity of the discharge pipe opening. As described in Subsection 5.3.2.1, the extent of bottom scouring associated with operation of the new plant discharge is controlled by energy dissipation structures at the outfall (Figure 3.4-4). Therefore, the physical effects of scour due to discharge are localized and small, particularly in relation to the available habitat in the Delaware River. Benthic organisms (potentially blue crab and other macrobenthos) in this area are likely to avoid the immediate outlet area of the discharge. This effect is localized and small, and does not adversely affect other important aquatic species. Thus, physical impacts to aquatic communities are SMALL.

5.3.3 HEAT DISSIPATION SYSTEMS

PSEG is evaluating three different closed-loop designs for the CWS of the new plant: mechanical draft, natural draft, and fan-assisted natural draft. However, for purposes of this impact assessment only the mechanical and natural draft designs are evaluated as they represent the bounding conditions with respect to fogging, icing, drift, shadowing, and plume heights and lengths. One design consists of two linear mechanical draft cooling towers (LMDCT) each with 34 cells. The other design consists of two large (408-ft. diameter) NDCT. Both cooling tower designs are wet towers. The cooling towers are located just north of the proposed reactor units and the source of cooling water for these towers is the Delaware River. This study is evaluating both types of CWS to determine the potential for impacts to the surrounding area.

The new plant uses four smaller essential service water system/ultimate heat sink (SWS/UHS) cooling towers that have a considerably smaller impact than the CWS. Normal heat loads to the SWS/UHS cooling towers are a small fraction of the heat load to the CWS cooling tower. The combined design water flow rate of the four SWS/UHS cooling towers is 3 percent of the design water flow rate for the CWS. Any impacts from the heat dissipation to the atmosphere by the SWS/UHS cooling towers are small by comparison. Therefore, the SWS/UHS cooling towers are not considered further in the analysis.

A visible mist or plume can be created when the evaporated water from the cooling tower undergoes partial recondensation under certain meteorological conditions. The plume is expected to have the potential to be visible and cause shadowing and, in some cases, ground level fogging and icing. In addition to evaporation, small water droplets drift out of the tops of the wet cooling towers. The dissolved solids (salts) in the drift can create a potential for salt deposition on vegetation or equipment in the nearby areas due to gravitational settling. This subsection provides an analysis of the likelihood and extent of such occurrences.

The effluent from wet cooling towers can be saturated with moisture at temperatures exceeding ambient temperature. When the effluent is exhausted to the atmosphere under such conditions, a plume is formed. As the temperature of the plume drops, its moisture-carrying capacity is reduced, resulting in the potential for condensation. However, this is offset by plume dispersion that entrains generally drier ambient air into the plume mass, thereby increasing moisture-carrying capacity. The overall potential for condensation is dependent upon the net balance of these two mutually offsetting phenomena. When ambient humidity is low, the potential for condensation is low; while under high ambient humidity conditions, the potential for condensation of plume moisture is high. During conditions that promote condensation, visible plumes can form, resulting in plume shadowing on the ground. Ground-level fogging occurs when a condensed cooling tower plume comes in contact with the ground surface. Furthermore, condensation that occurs during freezing temperatures (less than 32°F) results in icing when the plume makes contact with a nearby surface.

5.3.3.1 Modeling Methodology

The Seasonal/Annual Cooling Tower Impact (SACTI) (Reference 5.3-3) probabilistic model developed by the Electric Power Research Institute (EPRI) is used to analyze the plumes generated by the LMDCT and NDCT. The SACTI model specifically simulates the dispersion and transport of wet cooling tower plumes. SACTI is a probabilistic model capable of predicting the likelihood and extent of impacts from the wet plumes in the area surrounding the cooling towers. The model predicts seasonal and annual cooling tower impacts from mechanical or natural draft cooling towers based on representative meteorological data and cooling tower design data, including average plume length, drift deposition, fogging, icing, and shadowing. The model’s predictions have been validated with experimental data. The area surrounding the proposed plant is primarily rural, consisting of water surfaces and wetlands. Based on 2001 land use/land cover data from the USGS, 1 percent of the land within 3 mi. of the facility is designated medium and high intensity developed land (Subsection 4.3.1 regarding additional land use/land cover discussion). Surface water and wetlands comprise 90 percent of the area. Even with the addition of the new facility, the developed land use does not increase to the point where the area is considered urban. Therefore, the modeling analysis for the new plant is conducted in rural mode.

5.3.3.1.1 Plant Parameter Envelope Source Data

As discussed above, two types of cooling towers for the CWS are considered in this analysis: LMDCT and NDCT. Both designs are closed-loop, wet cooling systems equipped with high efficiency drift eliminators. Makeup water for the CWS is taken from the Delaware River at a rate of 75,792 gpm (37,896 gpm per tower) assuming 1.5 cycles of concentration.

The CWS is located within the 50-ac. cooling tower area immediately north of the power block. The nearest site boundary is west of the cooling towers, 1100 ft. from the center of the cooling tower area (Figure 3.1-2). The next closest site boundary is 1165 ft. to the east. Table 5.3-5 presents the model input data for the LMDCT, while Table 5.3-6 presents the data for the NDCT.

The above data for both types of towers represent maximum capacity operation resulting in the greatest potential for emissions. For modeling purposes, the conservative assumption is that the cooling towers operate year-round at maximum capacity (8760 hours [hr.] per yr).

There are two LMDCT, each with 34 cells. The SACTI model limits the number of cells that can be simulated in a single model run. Due to this limitation, each 34-cell LMDCT tower is modeled as a 12-cell tower. The diameter of each proposed mechanical draft tower is 31.6 feet. The diameter is adjusted for the 12 modeled cells, so that the total equivalent diameter, which represents the total exhaust area of all cells in a tower (an input to the model), is the same as that for the designed 34 cells. No changes are made to the other input parameters, including the heat dissipation rate, air flow rate, circulating water flow rate, drift rate and the cycles of concentration.

5.3.3.1.2 Meteorological Data

This analysis uses on-site surface meteorological data from 2006 through 2008. Ceiling heights and cloud cover data were obtained from nearby New Castle County Airport (Wilmington, DE). Given the proximity of this airport to the study area, these data are considered representative. The mixing height data from the Dulles Airport in Sterling, Virginia, which is the closest representative upper-air station, are used in the analysis. These data were obtained from the National Climatic Data Center (NCDC) and processed into model-ready format. The processed data consisted of surface weather observations in a specific format referred to by the NCDC as “Card Deck 144” (CD-144) and twice daily mixing heights required for model execution. Following standard modeling guidance, 3 yr of on-site data are used for the modeling analysis. Figure 5.3-1 presents a 3-yr composite wind rose of the data. The predominant wind direction is from the northwest and, therefore, the maximum frequency of impacts is expected to occur toward the southeast. The next most dominant wind direction is from the southeast, which results in impacts to the northwest. In general, there is a greater frequency of winds from the west and the northwest quadrants as compared to the east and southeast quadrants. Therefore, greater impacts are expected to the southeast and east of the cooling tower location as compared to the northwest and west.

The SACTI model has an inherent limitation in that it expects the meteorological data to be between the years of 1964 to 1999. To address this, the data from the 2006 to 2008 modeling period is input into the model as 1996 to 1998 by changing the 2-digit yr from 06, 07 and 08 to 96, 97 and 98, respectively. No other changes are made to the modeled meteorological data.

5.3.3.1.3 Receptor Data

The SACTI model is applied with its default receptor grid, which consists of a polar network centered at the midpoint between the two towers and receptors placed along each of the 16 cardinal wind directions. The network extends 6.2 mi. in all directions for performing plume length and salt deposition calculations, 5 mi. for plume shadowing calculations, and 5250 ft. for fogging and icing calculations. The extent of the grid is sufficient because the modeled impacts are located well within the grid and are found to reduce with distance near the edge of the grid.

5.3.3.2 SACTI Results

The SACTI model is used to analyze plume frequencies and elevations, the potential for icing, fogging and shadowing, and distribution and concentrations of drift. The results are summarized in the following subsections.

5.3.3.2.1 Length and Frequency of Elevated Plumes

The SACTI code was used to calculate the expected plume lengths annually, and for each season by direction, for the CWS cooling towers. The plumes are expected to occur in all compass directions. However, as indicated by the wind rose data presented in Figure 5.3-1, the largest frequencies of visible plumes are to the southeast and east.

The largest frequency of visible plume occurrence is on-site. For both tower designs, the LMDCT and NDCT, the most frequent occurrences are within 328 ft. from the towers for 831 hr/yr to the southeast and 795 hr/yr to the east. Of these occurrences, the most frequent occurrence is expected during winter, 302 hr/yr to the southeast and 269 hr/yr to the east (assuming 2160 hr for winter). The visible plume frequency is reduced with increasing distance from the towers. Depending on direction, the visible plume extends to a distance of 1640 ft. or 500 meters (m) an average of 278 hr/yr for LMDCT and 499 hr/yr for NDCT. Similarly, the visible plume extends to a distance of 3281 ft. (1000 m) from the tower an average of 179 hr/yr for LMDCT and 282 hr/yr for NDCT.

For the LMDCT, the visible plumes are expected to reach a height of at least 144 ft. (34 m) above ground level, whereas the plumes for the NDCT are expected to reach a height of at least 820 ft. (250 m) above ground level. The median plume height (based on moisture content rather than visibility) for the LMDCT is 702 ft. (214 m) above ground level, whereas the median plume height for the NDCT is 1574 ft. (480 m) above ground level. Given the greater release height of the plumes from the NDCT as compared to the LMDCT, the NDCT plumes achieve a greater height above ground level than the LMDCT plumes.

The visible plume frequencies discussed above include nighttime hours when plumes may not be discernable. During daytime, when the plumes are more likely to be visible, the frequency of occurrence is smaller than the frequencies presented above. Given the limited elevations and extent of the plumes from the LMDCT and NDCT, any associated impacts are SMALL.

5.3.3.2.2 Ground-Level Fogging and Icing

The potential for ground-level fogging and icing is greater with the LMDCT than with the NDCT. This is because the NDCT exhaust is released from a considerably greater height above ground (590 ft.) as compared to the exhaust release height of 46 ft. for the LMDCT (Tables 5.3-5 and 5.3-6). Ground-level fogging and icing is not a problem for the NDCT. As such, the SACTI model does not calculate the probability of ground-level fogging and icing from a NDCT and this subsection only addresses these impacts for the LMDCT.

Fogging from mechanical draft cooling towers occurs when the visible plume intersects with the ground, appearing as fog to an observer. Fogging is generally predicted to occur more frequently in the winter, spring, and fall seasons than in summer. Based on modeling results, the maximum fogging duration within the model grid is 2.7 hr. during the winter season. The grid location exposed to fogging is located northwest of the CWS cooling tower. Similarly, the location having the greatest exposure to fogging during the spring season (maximum of 5.5 hr.) is west-southwest. In the fall, the longest fogging events occur predominantly northwest (maximum of 3.0 hr.). No fogging is expected during the summer season. The total annual fogging in all directions is less than 136 hr., and a large majority is within the immediate vicinity of the cooling tower (i.e., within 984 ft. [300 m] of the tower). Although the wind rose data presented in Figure 5.3-1 show a greater frequency of winds from the west and northwest as compared to the east and southeast, fogging occurs more frequently toward the west. This is likely because the meteorological conditions conducive to ground-level fogging are more frequently associated with winds from the east and southeast. However, overall fogging events are infrequent and most fogging events occur on-site, and do not affect roadway conditions in the vicinity of the PSEG Site. Similarly, commercial traffic on the Delaware River are not affected by fogging from CWS emissions. Therefore, the potential effects of fogging are SMALL.

Icing from a mechanical draft cooling tower occurs when ambient temperatures are below freezing during a fogging event. The SACTI model predicts that there are no icing events due to CWS operation at any location in any season. This is an indication that fogging events do not occur during freezing conditions.

Given that no icing impacts are predicted and that fogging events occur for only small percentage of the time and most frequently on-site, the potential off-site effects of LMDCT-induced fogging or icing are SMALL.

5.3.3.2.3 Plume Shadowing

Although plumes are visible during some periods of operation, adverse effects attributable to plume shadowing are not significant. A majority of the plume shadowing occurs within 656 ft. (200 m) of the CWS. For LMDCT shadowing within this area occurs 2830 hr/yr, whereas shadowing occurs for 1658 hr/yr for NDCT. The frequency of occurrence decreases rapidly with distance. For example, the frequency of shadowing at a distance of 1312 ft. (400 m) from the towers decreases to 1098 hr/yr for LMDCT and 1117 hr/yr for NDCT. Similarly, at a distance of 3281 ft. (1000 m), the frequency further decreases to 345 hr/yr for LMDCT and 412 hr/yr for NDCT. Beyond 9843 ft. (3000 m), the shadowing frequency reduces to less than 150 hr/yr for both LMDCT and NDCT. Given that the vast majority of shadowing occurs on-site, off-site effects are SMALL.

5.3.3.2.4 Salt Deposition

Water droplets, or drift, blown from the cooling towers have the same concentration of total dissolved solids (TDS, or salts) as the water in the makeup water reservoir. As these water droplets evaporate, either in the air or on vegetation or equipment, these salts are deposited. As discussed in Section 3.3, the water source for the cooling towers is the Delaware River. As a conservative approach, the maximum TDS value of 12,900 milligrams per liter (mg/L) (Tables 5.3-5 and 5.3-6) is used in the analysis. The highest measured mean TDS value in the river water (6280 mg/L) is less than half this value.

The maximum predicted salt deposition rate from the cooling towers is provided in Table 5.3-7. To evaluate the effect of salt deposits on plants, an order-of magnitude approach is used because some plant species are more sensitive to salt deposits than others, and tolerance levels of most species are not well known. According to NUREG-1437, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*, March 2000, deposits of salt drift at rates of 1 to 2 kilograms per hectare per month (kg/ha/mo) (0.9 to 1.8 pounds per acre per month [lb/ac/mo]) are generally not damaging to plants, while deposition rates approaching or exceeding 10 kg/ha/mo, or 8.9 lb/ac/mo, in any month during the growing season causes leaf damage in many species. For LMDCT, the maximum salt deposition rate is predicted to be 0.89 kg/ha/mo (0.80 lb/ac/mo) in any direction from the towers. On a seasonal basis, for LMDCT, the maximum predicted salt deposition rate is 1.31 kg/ha/mo (1.17 lb/ac/mo) in winter and summer is shown to have the smallest deposition rate of 0.56 kg/ha/mo (0.50 lb/ac/mo). For NDCT, the maximum predicted salt deposition rate is 0.023 kg/ha/mo (0.021 lb/ac/mo) with winter and summer months having the highest and the smallest deposition rates, respectively. Figure 5.3-2 shows the isopleths of the annual salt deposition rates for the bounding condition represented by the LMDCT. Figure 5.3-3 shows the isopleths of the annual salt deposition rates from the NDCT. As shown in the figures, as well as the low depositional rates contained in Table 5.3-7, the impacts to vegetation due to salt deposition from either the LMDCT or the NDCT for both on-site and off-site locations are SMALL.

5.3.3.3 Terrestrial Ecosystems

Heat dissipation systems have the potential to impact terrestrial ecosystems through salt drift, vapor plumes, icing, precipitation modifications, noise, and avian collisions with structures (e.g., cooling towers).

5.3.3.3.1 Salt Drift

Based on the analyses summarized in Table 5.3-7, the LMDCT has the greater potential for salt drift. The LMDCT releases drift capable of depositing as much as 0.80 lb/ac/mo of dissolved solutes, primarily salt originating from the brackish makeup water, on terrestrial ecosystems surrounding the PSEG Site. Analyses have shown that the cooling tower drift over terrestrial habitats is primarily to the east (within coastal wetlands) and southeast (on the PSEG Site) (Figure 5.3-2). Terrestrial fauna are not impacted by salt deposition from cooling tower drift. Rather, soil and vegetation, whose foliage lies directly beneath the water droplets and particulates of the drift, comprise the most likely terrestrial ecosystems to be impacted (NUREG-1437).

Potential effects to vegetation from salt drift may include acute damage (e.g. necrotic tissue and other deformities) and/or less visible chronic effects (e.g. reduced growth and increased susceptibility to disease). Based on its study of salt drift at a number of sites, the NRC concluded, that salt deposition from drift from natural draft cooling towers is typically small and below the rates that affect even sensitive vegetation. Damage from operation of mechanical-draft towers at Palisades was noted by NRC to be more extensive than for the other nuclear plants, but was limited to 8 ha (20 ac.) on the site. The damage resulted from Palisades' unique location, the addition of sulfuric acid to cooling water, and possibly from a cooling tower malfunction combined with unusual weather conditions. The use of sulfuric acid was discontinued, significantly reducing the impact. The effect on soil salinization is even less significant, usually with undetectable measurement levels (NUREG-1437).

The majority of plant communities within the salt drift zone exposed to drift from the cooling towers consist of salt marsh or brackish marsh ecosystems dominated by medium- to high-salinity tolerant species. Most of the salt marsh and brackish marsh ecosystems surrounding the PSEG Site are dominated by *Phragmites australis* and *Spartina alterniflora*, which are high-salinity tolerant plant species (Subsection 2.4.1). Prior surveys conducted at the PSEG Site (NUREG-1437) have shown no impact from salt deposition due to drift from the existing HCGS natural draft cooling tower on any specific plant species.

Based on the results of SACTI modeling conducted for the new plant, as presented in Subsection 5.3.3.2.4, the relatively low rate of salt deposition expected (0.80 lb/ac/mo for the LMDCT, and 0.021 lb/ac/mo for the NDCT) in comparison to the deposition levels at which leaf damage can be expected (8.9 lb/ac/mo according to NUREG-1437) and the character of the local plant communities (i.e., salt marsh) the potential effects of new plant cooling tower operation on surrounding plant communities are SMALL.

5.3.3.3.2 Potential Overall Effects on Terrestrial Ecosystems

The surrounding terrestrial ecosystems at the PSEG Site are mainly salt marsh or brackish marsh ecosystems, dominated by *Phragmites australis* and *Spartina alterniflora*, so any salt deposition due to drift is expected to have little to no impact. Surveys conducted at the PSEG Site (NUREG-1437) show no impact from salt deposition due to drift from the existing HCGS cooling tower on terrestrial ecosystems. Other areas of the PSEG Site that are exposed to potential salt drift from the LMDCT are low quality upland old field habitats. Consequently, the potential for impacts associated with cooling tower drift from the new plant are SMALL.

5.3.3.3.3 Fogging, Humidity, and Precipitation

Evaluations of increased fogging, icing, humidity, and/or precipitation due to cooling tower drift have previously been conducted for nuclear power plants with cooling towers (natural draft and mechanical draft). No significant impacts were reported (NUREG-1437). Additionally, based on the analysis for the new plant (Subsection 5.3.3.2.2) the duration of any fogging and other cooling tower induced precipitation events is low. Therefore, the impacts of any additional impacts of fogging, humidity and precipitation from the new plant cooling towers are SMALL.

5.3.3.3.4 Noise

The bounding noise level for operational noise emissions is associated with the fan-assisted natural draft cooling towers, as presented in SSAR Table 1.3-1, Item 2.6.10. The estimated A-weighted noise emission for this type of cooling tower is 60 decibels (dBA) at 1000 feet. Noise measurements recorded on-site demonstrate that existing noise levels attenuate to a maximum of 51.6 dBA (a value typical of ambient low noise environments) near the site boundary (Table 2.5-54).

Noise from on-site sources associated with the new plant attenuate with distance. For example, a source with a noise level of 50 dBA at 1000 ft. has a noise level of 44 dBA at 2000 ft. from the source, and a source with a noise level of 60 dBA at 1000 ft. has a dBA of 54 at 2000 feet. A 2009 baseline ambient noise survey indicates that the noise from sources at the existing plant attenuate to levels that generally represent background noise values in natural environments (Table 2.5-54). This noise level is similar to that measured near the PSEG Site boundary. Noise sources within the adjacent marsh environment include wind, rustling of reeds and grasses

(*Phragmites*), and periodic animal noises (breeding frogs, bird song, etc.). Thus, the impacts of noise from operation of new plant cooling towers are SMALL.

5.3.3.3.5 Avian Collisions

The cooling tower at the PSEG Site should not cause significant bird mortality from bird collisions. Surveys conducted over several years at the existing HCGS NDCT show few instances of bird collisions (Reference 5.3-10). Though infrequent bird collisions with NDCT resulting in mortality can occur, they are a small percentage of the total avian mortality and have minimal impacts on bird populations (NUREG-1437). Therefore, the impacts to bird species and populations are SMALL.

5.3.3.4 Impacts to Members of the Public

This subsection describes the potential health impacts associated with the cooling systems for the new plant. Specifically, impacts to human health from thermophilic microorganisms and from noise resulting from operation of the cooling system are addressed.

5.3.3.4.1 Thermophilic Microorganism Impacts

Consideration of the impacts of thermophilic microorganisms on public health are important for facilities using cooling ponds, lakes, canals, or small rivers, because use of such water bodies has the potential to increase the presence and numbers of thermophilic microorganisms.

Some microorganisms associated with cooling towers and thermal discharges can have deleterious impacts on human health. Their presence can be enhanced by thermal additions. These microorganisms include the enteric pathogens *Salmonella* sp. and *Shigella* sp. as well as *Pseudomonas aeruginosa* and the thermophilic fungi. Tests for these pathogens are well established, and factors germane to their presence in aquatic environs are known, and in some cases controllable. Other aquatic microorganisms normally present in surface waters have more recently been recognized as pathogenic for humans. Among these are Legionnaires' disease bacteria (*Legionella* sp.) and free-living amoebae of the genera *Naegleria* and *Acanthamoeba*, the causative agents of various, although rare, human infections. Factors affecting the distribution of *Legionella* sp. and pathogenic free-living amoebae are not well understood. Simple, rapid tests for their detection and procedures for their control are not yet available.

The impacts of large power plant cooling towers and thermal discharges are considered of small human health significance if they do not enhance the presence of microorganisms detrimental to water and public health (NUREG-1437).

PSEG is aware of the potential concerns regarding thermophilic microorganisms and has performed monitoring of the water systems associated with the HCGS. No *Naegleria* has been observed in sampling at HCGS. However, low levels of *Legionella* sp. had been observed in samples from the Delaware River and the HCGS cooling tower. Densities found in all samples were lower than the limiting guideline.

Additionally, the Salem County Department of Health was contacted to obtain information regarding the incidence of thermophilic organisms within the county. There are no health advisories or reported cases of thermophilic organisms in the project area.

According to the NRC, thermophilic organisms may or may not be influenced by the operation of nuclear power plants. The NRC recognizes a potential health impact stemming from heated effluents. Occupational health questions are currently resolved using proven industrial hygiene principles to minimize worker exposures to these organisms in mists of cooling towers. NRC anticipates that all plants continue to employ proven industrial hygiene principles so that adverse occupational health effects associated with microorganisms are SMALL, and no mitigation measures beyond those already implemented are warranted (NUREG-1437). Based on the NRC position in NUREG-1437, the monitoring provided at HCGS and the information provided by Salem County Department of Health, occupational health impacts resulting from the operation of the new cooling towers are SMALL.

5.3.3.4.2 Noise Impacts

The new plant produces noise from the operation of pumps, cooling towers, transformers, turbines, generators, switchyard equipment, alarms, and loudspeakers. NUREG-1555, *Standard Review Plans for Environmental Review of Nuclear Power Plants: Environmental Standard Review Plan,* notes that the principal sources of noise include NDCTs and pumps that supply the cooling water.

Most equipment is located inside structures, reducing the outdoor noise level. Intake structure equipment (pumps and ventilation fans) introduce some noise at the edge of the Delaware River. The public use of the river, primarily by fishermen, crabbers, and watercraft is limited. Noise is further attenuated by distance from the site boundary. The bounding noise level for operational noise emissions is generally associated with the fan assisted NDCTs. As presented in SSAR Table 1.3-1, Item 2.6.10, the estimated noise emission for this type of cooling tower is 60 dBA at 1000 ft., whereas the estimated noise emission for a NDCT is 50 dBA at 1000 feet.

As stated in Subsection 4.4.1.2, New Jersey regulates continuous noise levels at the residential property line from industrial, commercial, public service, or community service facilities (Section 7.29 of the New Jersey Administrative Code [NJAC])). For continuous noise sources, the protective level is 65 dBA during the day and 50 dBA during the night at the residential property line. The similar DE limits (Part VII, Title 7, Chapter 71 of the Delaware Code) provide for a protective level of 65 dBA during the day and 55 dBA during the night for residential receptors. As described in Section 2.1, the nearest residences are located 2.8 mi. west-northwest, and 3.4 mi. east-northeast of the PSEG Site. Given these distances, the noise from on-site sources attenuate to levels that meet the NJ nighttime noise level standard. For example, a source with a dBA reading of 50 at 1000 ft. has a dBA of 44 at 2000 ft. from the source, and a source with a dBA value of 60 at 1000 ft. has a dBA of 54 at 2000 feet. Noise levels below 60 to 65 dBA are considered by the NRC to be of small significance (NUREG-1437). Thus, the impacts of noise from operation of the new plant on nearby residences and recreational areas are SMALL.

5.3.4 REFERENCES

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Table 5.3-1
Recorded Impingement Rate (Total and Important Species) at SGS and HCGS

		Impingement Rate (#/10^6 m^3)		
Scientific Name	**Common Name**	**SGS (2003 – 2007)**	**SGS (1986 – 1987)**	**HCGS (1986 – 1987)**
Acipenser brevirostrum	Shortnose sturgeon	--	--	--
Acipenser oxyrhynchus	Atlantic sturgeon	0.1	0.0	--
Anguila rostrata	American eel	4.3	10.9	19.7
Conger oceanicus	Conger eel	0.1	0.3	1.0
Alosa aestivalis	Blueback herring	48.5	56.1	5.3
Alosa pseudoharengus	Alewife	9.8	8.4	1.1
Alosa sapidissima	American shad	16.2	6.3	0.2
Brevoortia tyrannus	Atlantic menhaden	21.0	34.3	4.9
Anchoa mitchilli	Bay anchovy	113.6	830.6	521.5
Ictalurus punctatus	Channel catfish	11.2	0.7	2.1
Merluccius bilinearis	Silver hake	0.1	0.4	0.3
Menidia menidia	Atlantic silverside	35.4	21.2	17.3
Prionotus carolinus	Northern sea robin	6.8	2.4	2.9
Morone americana	White perch	1143.5	472.7	25.3
Morone saxatilus	Striped bass	71.7	8.0	0.7
Centropristis striata	Black sea bass	0.3	4.4	2.4
Pomatomus saltatrix	Bluefish	6.5	4.1	1.0
Stenotomus chrysops	Scup	2.0	--	--
Cynoscion regalis	Weakfish	582.2	556.3	169.2
Leiostomus xanthurus	Spot	14.0	15.2	4.2
Menticirrhus saxatilis	Northern kingfish	11.6	0.1	--
Micropogonias undulatus	Atlantic croaker	786.0	230.1	1063.9
Pogonias cromis	Black drum	3.0	3.9	0.6
Peprilus triacanthus	Butterfish	1.1	1.1	--
Paralichthys dentatus	Summer flounder	3.9	15.4	5.5
Scophthalmus aquosus	Windowpane flounder	3.5	7.0	2.3
Pseudopleuronectes americanus	Winter flounder	1.1	0.3	0.3
	All other species	346.0	1039.9	569.9
Total density		3243.3	3329.9	2421.6
Callinectes sapidus	Blue crab	727.2	1742.9	3007.6

References 5.3-6 through 5.3-9, 5.3-14, and 5.3-15

Table 5.3-2
Estimated Rate of Impingement (Total and Important Species) for the New Plant

Scientific Name	Common Name	Impingement Rate (#/10^6 m^3) Estimate[(a)]	Impingement Rate (#/10^6 m^3) Conservative Estimate[(b)]
Acipenser brevirostrum	Shortnose sturgeon	--	--
Acipenser oxyrhynchus	Atlantic sturgeon	0.0	0.1
Anguila rostrata	American eel	3.1	4.3
Conger oceanicus	Conger eel	0.1	0.1
Alosa aestivalis	Blueback herring	35.3	48.5
Alosa pseudoharengus	Alewife	7.1	9.8
Alosa sapidissima	American shad	11.7	16.2
Brevoortia tyrannus	Atlantic menhaden	15.2	21.0
Anchoa mitchilli	Bay anchovy	82.6	113.6
Ictalurus punctatus	Channel catfish	8.2	11.2
Merluccius bilinearis	Silver hake	0.1	0.1
Menidia menidia	Atlantic silverside	25.7	35.4
Prionotus carolinus	Northern sea robin	4.9	6.8
Morone americana	White perch	831.6	1143.5
Morone saxatilus	Striped bass	52.2	71.7
Centropristis striata	Black sea bass	0.2	0.3
Pomatomus saltatrix	Bluefish	4.7	6.5
Stenotomus chrysops	Scup	1.5	2.0
Cynoscion regalis	Weakfish	423.4	582.2
Leiostomus xanthurus	Spot	10.2	14.0
Menticirrhus saxatilis	Northern kingfish	8.4	11.6
Micropogonias undulatus	Atlantic croaker	571.6	786.0
Pogonias cromis	Black drum	2.2	3.0
Peprilus triacanthus	Butterfish	0.8	1.1
Paralichthys dentatus	Summer flounder	2.8	3.9
Scophthalmus aquosus	Windowpane flounder	2.5	3.5
Pseudopleuronectes americanus	Winter flounder	0.8	1.1
	Other species	251.6	346.0
Total Finfish Density		2358.6	3243.3
Callinectes sapidus	Blue crab	528.7	727.2

a) Velocity-based correction factor applied to data from References 5.3-6 through 5.3-9

b) No correction factor applied to data from References 5.3-6 through 5.3-9

Table 5.3-3
Estimated Entrainment Rates
(Total Density and Density of Important Species) at the New Plant

Scientific Name	Common Name	Entrainment Rate (#/100 m^3) Annual Mean
Anguila rostrata	American eel	0.14
Alosa aestivalis	Blueback herring	0.01
Alosa pseudoharengus	Alewife	0.05
Brevoortia tyrannus	Atlantic menhaden	1.64
Anchoa mitchilli	Bay anchovy	88.70
Ictalurus punctatus	Channel catfish	0.01
Menidia menidia	Atlantic silverside	0.31
Prionotus carolinus	Northern sea robin	0.01
Morone americana	White perch	0.62
Morone saxatilus	Striped bass	10.76
Cynoscion regalis	Weakfish	1.15
Leiostomus xanthurus	Spot	0.08
Menticirrhus saxatilis	Northern kingfish	0.01
Micropogonias undulatus	Atlantic croaker	5.93
Pogonias cromis	Black drum	0.01
Paralichthys dentatus	Summer flounder	0.08
Scophthalmus aquosus	Windowpane flounder	0.01
Pseudopleuronectes americanus	Winter flounder	0.02
	Other species	36.81
Total Density		146.35

Estimates derived from References 5.3-6 through 5.3-9.

Table 5.3-4
Estimated Mean Entrainment Rate of Important Species at the New Plant by Season (Larvae and Juveniles)

		Entrainment Rate[a] (#/100 m^3)			
Scientific Name	**Common Name**	**Winter Mean**	**Spring Mean**	**Summer Mean**	**Fall Mean**
Anguila rostrata	American eel	0.081	0.035	0.003	0.001
Alosa aestivalis	Blueback herring	0.001	0.001	0.005	0.005
Alosa pseudoharengus	Alewife	0.001	0.013	0.025	--
Brevoortia tyrannus	Atlantic menhaden	0.491	0.577	0.059	0.115
Anchoa mitchilli	Bay anchovy	0.039	4.245	9.234	0.423
Ictalurus punctatus	Channel catfish	--	--	0.000	--
Menidia menidia	Atlantic silverside	0.001	0.089	0.068	0.000
Prionotus carolinus	Northern sea robin	--	--	0.000	--
Morone americana	White perch	0.007	0.220	0.098	0.014
Morone saxatilus	Striped bass	--	5.117	0.391	0.001
Cynoscion regalis	Weakfish	--	0.162	0.507	0.004
Leiostomus xanthurus	Spot	--	0.021	0.007	0.000
Menticirrhus saxatilis	Northern kingfish	--	--	0.001	--
Micropogonias undulatus	Atlantic croaker	0.902	0.097	0.364	5.922
Pogonias cromis	Black drum	--	0.001	0.001	0.000
Paralichthys dentatus	Summer flounder	0.037	0.004	--	0.052
Scophthalmus aquosus	Windowpane flounder	--	0.001	0.000	--
Pseudopleuronectes americanus	Winter flounder	--	0.003	--	--

a) Estimates derived from References 5.3-6 through 5.3-9.

Values of 0.00 indicate species were encountered at a mean density < 0.005; dashed lines indicate species that were not encountered in samples from that season.

Table 5.3-5
Modeled Source Data for LMDCT

	Parameter	Value
Tower Physical Parameters	No. of Towers	2
	Tower Orientation	85 degrees east of north
	Tower Height	46 feet
	Tower Length	817 feet
	Tower Width	100 feet
	No. of Cells per Tower	34
	Cell Diameter	31.6 feet
Tower Operating Parameters	Total Heat Dissipation Rate	4417 MW
		(15,080) (MMBtu/hr)
	Total Input Airflow Rate	45,900 kg/sec
		(675) (kg/sec per cell)
	Drift Rate	0.001 Percent
	Cycles of Concentration	1.5
Cooling Water Data	Water Circulation Flow Rate	1,200,000 gal/min
		(600,000) (gal/min per tower)
	Circulating Water Density	8.05 lb/gal
	Total Dissolved Solids (Salt) Concentration	0.0134 gm salt/gm solution
		(12,900) (Mg/L maximum)
	Salt Density	2.17 gm/cc
		(0.0784) (lb/cubic inches)

Table 5.3-6
Modeled Source Data for NDCT

	Parameter	Value
Tower Physical Parameters	No. of Towers	2
	Tower Height	590 feet
	Tower Diameter	242 feet
Tower Operating Parameters	Total Heat Dissipation Rate	4417 MW (15,080)(MMBtu/hr)
	Total Input Airflow Rate	46,192 kg/sec (23,096) (kg/sec per tower)
	Drift Rate	0.001 percent
	Cycles of Concentration	1.5
Cooling Water Data	Water Circulation Flow Rate	1,200,000 gal/min (600,000) (gal/min per tower)
	Circulating Water Density	8.05 lb/gal
	Total Dissolved Solids (Salt) Concentration	0.0134 gm salt/gm solution (12,900) (mg/liter maximum)
	Salt Density	2.17 gm/cc (0.0784) (lb/cubic inches)

Table 5.3-7
Maximum Predicted Salt Deposition Rate

Parameter	LMDCT	NDCT
Maximum predicted deposition rate	0.89 kg/ha. per month (0.80 lb/ac. per month)	0.023 kg/ha. per month (0.021 lb/ac. per month)
Distance to maximum deposition	700 m (2297 ft.)	1300 m (4265 ft.)
Direction to maximum deposition	East	North

5.4 RADIOLOGICAL IMPACTS OF NORMAL OPERATION

This section describes the radiological effects of normal plant operation on members of the public and biota in the areas surrounding the PSEG Site. Subsection 5.4.1 describes the various exposure pathways through which organisms can come into contact with radioactive material. Subsection 5.4.2 describes the maximum dose that a member of the public may receive resulting from operation of new unit(s) at the PSEG Site. This section also describes the maximum doses to members of the public resulting from operation of two new AP1000 units at the PSEG Site as well as the operation of the existing SGS and HCGS units. Subsection 5.4.3 compares these doses to the applicable regulatory limits. Subsection 5.4.4 considers the radiological effects of normal operation on non-human biota. Subsection 5.4.5 evaluates occupational radiation doses to workers on-site.

Doses for a new unit are based on the bounding PPE set of composite average annual effluent releases given in SSAR Tables 1.3-7 and 1.3-8. This bounding set is the worst case composite of all four technologies under consideration. Releases from a new dual unit plant are taken as twice the bounding PPE effluent release set.

5.4.1 EXPOSURE PATHWAYS

During normal operation of a new plant at the PSEG Site, small amounts of radioactive liquids and gases are released into the environment. To analyze the effects of such releases on individuals, population groups, and non-human biota, a wide variety of potential pathways are considered. These pathways facilitate transport of the radioactive material from the release points to the receptors of interest. The significance of a given pathway is determined by the type and amount of radioactivity transported, the transport mechanism, and the consumption or usage factors of the receptor.

The maximally exposed individual (MEI) is the individual who is positioned to receive a maximum possible calculated dose. Consideration of the dose to the MEI is useful for conservative comparison to the regulations for doses to the public. The analytical methods and exposure pathways considered for calculating doses to the MEI and the collective population in the area surrounding the PSEG Site are based on NRC Regulatory Guide (RG) 1.109, *Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR 50*, and NRC RG 1.111, *Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors.*

5.4.1.1 Liquid Pathways

The new plant releases liquid effluents to the Delaware River which has a tidal flow rate ranging from 400,000 to 472,000 cfs. The NRC endorsed LADTAP II computer code is used to calculate the doses resulting from these effluents. This code uses radiological exposure models, as described in RG 1.109, to determine the radioactive releases in the liquid effluent. Exposure pathways considered are the ingestion of aquatic organisms as food and recreational activity on and near the Delaware River. The drinking water pathway is not considered because the Delaware River is composed of brackish water, and is not a potable source of water.

Liquid effluent activity releases are given in Table 5.4-2. Values for average annual liquid effluent releases from a new unit are taken from SSAR Table 1.3-8, and multiplied by two to account for the possibility of dual units.

5.4.1.2 Gaseous Pathways

The new plant releases gaseous effluents to the atmosphere. The NRC endorsed GASPAR II computer code is used to calculate the doses to off-site receptors due to postulated gaseous effluents released from the new plant. This code uses radiological exposure models, as described in RG 1.109 and RG 1.111, to determine the doses resulting from radioactive releases in gaseous effluent. The gaseous exposure pathways modeled in GASPAR II are:

- External exposure to airborne activity in the plume
- External exposure to deposited activity on the ground
- Inhalation of airborne activity in the plume
- Ingestion of contaminated agricultural products

MEI locations and corresponding atmospheric dispersion factors (χ/Q values) and ground deposition factors (D/Q values) are listed in Table 5.4-5. Annual agricultural product consumption rates are listed in Table 5.4-6. Total agricultural production, as shown in Table 5.4-7, is assumed to be the maximum consumption for each agricultural product multiplied by the projected population within 50 mi. of the PSEG Site. This population projection is given in Table 2.5-7 for the year 2081, along with the population distribution by distance from the PSEG Site. Based on population projections, the population (and the accompanying maximum agricultural consumption estimate) for 2081 is bounding.

Gaseous release source terms are given in Table 5.4-1. Values for average annual gaseous effluent releases from a new unit are taken from SSAR Table 1.3-7, and multiplied by two to account for the possibility of dual units.

5.4.1.3 Direct Radiation from the New Plant

Doses from SGS and HCGS due to direct radiation are measured using TLDs located around the site. The measured values are comparable to the preoperational background radiation data (Reference 5.4-2). This data indicates that the sources of direct radiation from SGS and HCGS are shielded and do not contribute significantly to the radiation levels at the site boundary.

Contained sources of radiation at the new plant are shielded. An evaluation of all operating plants by the NRC in NUREG 1437 states that:

> “…because the primary coolant of an LWR is contained in a heavily shielded area, dose rates in the vicinity of light water reactors are generally undetectable and are less than 1 mrem/year at the site boundary. Some plants [mostly boiling water reactors (BWRs)] do not have completely shielded secondary systems and may contribute some measurable off-site dose.”

The NRC concludes that the direct radiation from normal operation results in “small contributions at site boundaries” (NUREG-1437). The contribution to MEI doses from direct radiation from a new unit is listed in Table 5.4-10. The values are taken from SSAR Table 11.3-9.

5.4.2 RADIATION DOSES TO MEMBERS OF THE PUBLIC

5.4.2.1 Liquid Pathway Doses

The LADTAP II computer code is used to calculate doses to the MEI for the liquid pathway. The results of the calculation are shown in Table 5.4-4. These results are based on the inputs found in Tables 5.4-2 and 5.4-3. Note that the amount of near-field dilution between the radwaste system and the discharge point at the receiving water body (Delaware River) is based on the NUREG-0133, *Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants*, 1978, assumption that the blowdown rate (cfs) multiplied by the dilution factor is less than or equal to 1000 cfs. The minimum (most conservative) blowdown rate for the new plant is 45 cfs (20,000 gpm) and therefore the dilution is equal to 20.

5.4.2.2 Gaseous Pathway Doses

The GASPAR II computer code is used to calculate doses to the MEI for each pathway at various locations. The results of this calculation are shown in Table 5.4-8. These results are based on the inputs found in Table 5.4-1, Tables 5.4-5 to 5.4-7, and SSAR Figure 2.1-20.

5.4.3 IMPACTS TO MEMBERS OF THE PUBLIC

Radiological impacts to individuals and collective population groups are examined in this subsection and compared to federal limits. Doses from both gaseous and liquid effluent pathways are considered.

Compliance with the 10 CFR 50, Appendix I, dose limits is shown in Table 5.4-9. These dose limits are on a per unit basis. Gaseous effluent doses are calculated at the site boundary assuming continuous occupancy for the duration of a year.

Compliance with 40 CFR 190 is shown in Table 5.4-10. These dose limits are on a site-wide basis, and consider doses from SGS, HCGS, and the new plant. Dose values from SGS and HCGS are obtained from the 2008 RERR for SGS and HCGS (Reference 5.4-2). Releases from 2008 are considered to be representative because the releases do not vary significantly from 2006 and 2007 releases. In addition any small increase in power dependent radiation levels due to the implementation of Hope Creek's Extended Power Uprate is included in the 2008 data. Doses from direct radiation, inhalation, ground deposition, and plume exposure are considered at the nearest residence. As 40 CFR 190, *Environment Radiation Protection Standards for Nuclear Power Operations,* is more conservative than 10 CFR 20.1301, compliance with 40 CFR 190 demonstrates compliance with 10 CFR 20.1301.

Collective doses (per unit) from a new plant to the population within 50 mi. of the PSEG Site are shown in Table 5.4-11 and Table 5.4-12.

Doses from the new plant are higher than those from the existing SGS and HCGS units because doses from the existing units are based on actual site measurements, compared to the conservatively calculated, theoretical doses from the new plant.

5.4.4 IMPACTS TO BIOTA OTHER THAN MEMBERS OF THE PUBLIC

The technical basis for determining impacts to biota as discussed by the NRC in NUREG-1555 is given in this subsection.

Evaluation of the potential for significant radiological impact to biota requires the consideration of the exposure pathways to biota and the determination if any of these pathways could be expected to result in doses significantly greater than those given in 40 CFR 190. The regulations in 40 CFR 190 apply specifically to members of the public or other persons in unrestricted areas. These guidelines are, however, applied in this subsection to biota other than members of the public.

Depending on the pathway and the radiation source, terrestrial and aquatic biota receive doses approximately the same or somewhat higher than members of the public receive. Although guidelines have not been established for acceptance limits for radiation exposure to species other than members of the public, it is generally agreed that the limits established for humans are also conservative for other species.

Experience has shown that the maintenance of population stability is crucial to the survival of a species, and species in most ecosystems suffer rather high mortality rates from natural causes. The fate of individual organisms is generally not the major concern; rather, the response and maintenance of the endemic population is a major concern (Reference 5.4-3). Thus, higher dose limits could be permitted. Exceptions are threatened or endangered species where protection of the individual is required in the absence of an incidental take permit, specifically for dose-related effects. Although the existence of extremely radiosensitive biota is theoretically possible, and whereas increased radiosensitivity in organisms may result from environmental interactions with other stresses (e.g., heat, biocides), no biotas have been discovered that show any significant changes in morbidity or mortality due to radiation exposures from nuclear power plants.

At nuclear power plants for which an analysis of radiation exposure to biota, other than members of the public, has been made, there have been no cases of exposures that are considered significant in terms of harm to the species or that approach the exposure limits of 10 CFR 20 to members of the public (Reference 5.4-4). The Committee on the Biological Effects of Ionizing Radiation (BEIR) report (Reference 5.4-5) concludes that the evidence indicates that no other living organisms have been identified that are likely to be more radiosensitive than members of the public.

The International Atomic Energy Agency (IAEA) (Reference 5.4-6) concludes that there is no convincing evidence from scientific literature that chronic radiation dose rates below 100 millirads (mrad) per day harm animal or plant populations. Limiting exposure in humans to 100 mrem/day results in dose rates to plants and animals in the same area of less than 100 mrad/day. The National Council on Radiation Protection and Measurements also concludes that the 1977 International Commission on Radiological Protection statement “if man is adequately protected, then other living things are also likely to be sufficiently protected” (Reference 5.4-3) is appropriate.

Therefore, demonstrating compliance with the regulatory limits of 40 CFR 190 and dose guidelines given by the IAEA provides sufficient assurance that other biota are protected.

5.4.4.1 Liquid Pathway

Liquid pathway doses to biota are calculated using the LADTAP II computer code. This assessment uses species that provide representative information about the various dose pathways potentially affecting broader classes of living organisms (Table 5.4-13). Biota consumption rates and other input factors for LADTAP II are based on the code's default values.

5.4.4.2 Gaseous Pathway

Biota in the vicinity of the PSEG Site may receive doses from the gaseous pathway. Doses to biota are similar to those received by the MEI, as calculated using the GASPAR II computer code. Doses to biota are considered to be the sum of the MEI plume, inhalation, and twice the ground plane doses at the site boundary. The ground plane deposition is multiplied by two because animals are closer to the ground than humans.

5.4.4.3 Biota Doses

Doses to biota are given in Table 5.4-13. These doses were calculated at the site boundary. The total body dose is taken as the sum of the internal and external doses to biota. Total body doses are compared to 40 CFR 190. Doses to biota are well within 40 CFR 190 limits, and are well below the 100 mrad/day dose criteria evaluated by the IAEA. Thus, impacts to biota other than members of the public from exposure to sources of radiation are SMALL.

5.4.5 OCCUPATIONAL RADIATION DOSES

The maximum annual occupational dose from the new plant at the PSEG Site is expected to be less than that from SGS and HCGS. New plant designs and application of technology results in reduced occupational radiation exposure. For 2007, the collective total effective dose equivalent (TEDE) to workers was 118 person-rem at SGS and 191 person-rem at HCGS (Reference 5.4-1).

If two new AP1000 units are constructed at the PSEG Site, the total body dose to a construction worker at the second unit from operation of the first unit is small, as discussed in Subsection 4.5.3. Overall, the impacts to workers from occupational radiation doses are SMALL.

5.4.6 REFERENCES

5.4-1 U.S. Nuclear Regulatory Commission, "Occupational Radiation Exposure at Commercial Nuclear Power Reactors and Other Facilities 2007," Fortieth Annual Report, NUREG-0713, Vol. 29, Office of Nuclear Regulatory Research, Washington D.C., 2008.

5.4-2 Public Service Enterprise Group Nuclear LLC, "2008 Annual Radioactive Effluent Release Report (RERR) for the Salem and Hope Creek Generating Stations," 2009.

5.4-3 National Council on Radiation Protection and Measurements (NCRP), "Effects of Ionizing Radiation on Aquatic Organisms," Report No. 109, 1991.

5.4-4 U.S. Atomic Energy Commission (AEC), “Final Environmental Statement, Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion ‘As Low As Practicable’ for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents,” WASH-1258, USAEC, 1975.

5.4-5 National Academy of Sciences, Committee on the Biological Effects of Ionizing Radiation (BEIR), “The Effects on Populations of Exposure to Low Levels of Ionizing Radiation,” BEIR, National Research Council, 1972.

5.4-6 International Atomic Energy Agency (IAEA), “Effects of Ionizing Radiation on Plants and Animals at Levels Implied by Current Radiation protection Standards,” Technical Reports Series No. 332, 1992.

Table 5.4-1 (Sheet 1 of 4)
Gaseous Release Source Terms

	New Unit(s)	
	Single Unit[a]	Dual Unit
Isotope[b,c]	(Ci/yr)	(Ci/yr)
Ag-110m	2.00E-06	4.00E-06
Ar-41	3.40E+01	6.80E+01
Ba-140	2.70E-02	5.41E-02
C-14	1.89E+01	3.78E+01
Ce-141	9.19E-03	1.84E-02
Ce-144	1.89E-05	3.78E-05
Co-57	8.20E-06	1.64E-05
Co-58	2.30E-02	4.60E-02
Co-60	1.30E-02	2.59E-02
Cr-51	3.51E-02	7.03E-02
Cs-134	6.22E-03	1.24E-02
Cs-136	5.95E-04	1.19E-03
Cs-137	9.46E-03	1.89E-02
Cs-138	1.70E-04	3.41E-04
Cu-64	1.00E-02	2.00E-02
Fe-55	6.49E-03	1.30E-02
Fe-59	8.11E-04	1.62E-03
H-3	3.5E+02	7.0E+02
I-131	2.59E-01	5.19E-01
I-132	2.19E+00	4.38E+00

**Table 5.4-1 (Sheet 2 of 4)
Gaseous Release Source Terms**

Isotope[b,c]	New Unit(s)	
	Single Unit[a] (Ci/yr)	Dual Unit (Ci/yr)
I-133	1.70E+00	3.41E+00
I-134	3.78E+00	7.57E+00
I-135	2.41E+00	4.81E+00
Kr-83m	8.38E-04	1.68E-03
Kr-85	4.10E+03	8.20E+03
Kr-85m	1.50E+02	3.00E+02
Kr-87	5.30E+01	1.06E+02
Kr-88	1.80E+02	3.60E+02
Kr-89	2.41E+02	4.81E+02
La-140	1.81E-03	3.62E-03
Mn-54	5.41E-03	1.08E-02
Mn-56	3.51E-03	7.03E-03
Mo-99	5.95E-02	1.19E-01
Na-24	4.05E-03	8.11E-03
Nb-95	8.38E-03	1.68E-02
Ni-63	6.49E-06	1.30E-05
Np-239	1.19E-02	2.38E-02
P-32	9.19E-04	1.84E-03
Pr-144	1.89E-05	3.78E-05
Rb-89	4.32E-05	8.65E-05
Ru-103	3.51E-03	7.03E-03
Ru-106	7.80E-05	1.56E-04

Table 5.4-1 (Sheet 3 of 4)
Gaseous Release Source Terms

Isotope[b,c]	New Unit(s)	
	Single Unit[a]	Dual Unit
	(Ci/yr)	(Ci/yr)
Sb-124	1.81E-04	3.62E-04
Sb-125	6.10E-05	1.22E-04
Sr-89	5.68E-03	1.14E-02
Sr-90	1.20E-03	2.40E-03
Sr-91	1.00E-03	2.00E-03
Sr-92	7.84E-04	1.57E-03
Tc-99m	2.97E-04	5.95E-04
Te-129m	2.19E-04	4.38E-04
Te-131m	7.57E-05	1.51E-04
Te-132	1.89E-05	3.78E-05
W-187	1.89E-04	3.78E-04
Xe-131m	2.70E+03	5.40E+03
Xe-133	7.20E+03	1.44E+04
Xe-133m	1.70E+02	3.40E+02
Xe-135	1.20E+03	2.40E+03
Xe-135m	4.05E+02	8.11E+02
Xe-137	5.14E+02	1.03E+03
Xe-138	4.32E+02	8.65E+02
Y-90	4.59E-05	9.19E-05
Y-91	2.41E-04	4.81E-04
Y-92	6.22E-04	1.24E-03

Table 5.4-1 (Sheet 4 of 4)
Gaseous Release Source Terms

Isotope[b,c]	New Unit(s) Single Unit[a] (Ci/yr)	New Unit(s) Dual Unit (Ci/yr)
Y-93	1.11E-03	2.22E-03
Zn-65	1.11E-02	2.22E-02
Zr-95	1.59E-03	3.19E-03
Total	1.78E+04	3.56E+04

a) Single unit is the PPE value from SSAR Table 1.3-7, and is included for single unit analysis throughout the section.
b) Radionuclides Kr-90 and Xe-139 are short lived and will decay prior to release to the environment and are therefore, not included in this table.
c) The emissions from Rh-103m, Rh-106, and Ba-137m are attributed to their parent radionuclides and therefore, are not included in this table.

Table 5.4-2 (Sheet 1 of 3)
Liquid Release Source Terms

Isotope[b]	New Unit(s) Single Unit[a] (Ci/yr)	New Unit(s) Dual Unit (Ci/yr)
Ag-110m	1.80E-03	3.60E-03
Ba-140	5.80E-03	1.16E-02
Br-84	2.00E-05	4.00E-05
Ce-141	2.97E-04	5.94E-04
Ce-143	6.10E-04	1.22E-03
Ce-144	5.60E-03	1.12E-02
Co-58	9.80E-03	1.96E-02
Co-60	1.54E-02	3.08E-02
Cr-51	1.70E-02	3.40E-02
Cs-134	1.20E-02	2.40E-02
Cs-136	2.20E-02	4.40E-02
Cs-137	1.80E-02	3.60E-02
Cs-138	8.00E-07	1.60E-06
Cu-64	1.26E-02	2.52E-02
Fe-55	9.46E-03	1.89E-02
Fe-59	2.30E-03	4.60E-03
H-3	1.66E+03	3.32E+03
I-131	3.40E-02	6.80E-02
I-132	1.93E-03	3.86E-03
I-133	3.73E-02	7.46E-02
I-134	8.10E-04	1.62E-03

Table 5.4-2 (Sheet 2 of 3)
Liquid Release Source Terms

Isotope[b]	New Unit(s)	
	Single Unit[a] (Ci/yr)	Dual Unit (Ci/yr)
I-135	1.50E-02	3.00E-02
La-140	8.00E-03	1.60E-02
Mn-54	4.50E-03	9.00E-03
Mn-56	2.04E-03	4.08E-03
Mo-99	2.61E-03	5.22E-03
Na-24	6.10E-03	1.22E-02
Nb-95	2.00E-03	4.00E-03
Nd-147	2.00E-06	4.00E-06
Ni-63	1.70E-03	3.40E-03
Np-239	9.49E-03	1.90E-02
P-32	5.68E-04	1.14E-03
Pr-143	1.30E-04	2.60E-04
Pr-144	3.16E-03	6.32E-03
Rb-88	2.80E-02	5.60E-02
Ru-103	4.93E-03	9.86E-03
Ru-106	7.35E-02	1.47E-01
Sb-124	4.30E-04	8.60E-04
Sr-89	3.14E-04	6.28E-04
Sr-90	2.68E-05	5.36E-05
Sr-91	1.25E-03	2.50E-03

Table 5.4-2 (Sheet 3 of 3)
Liquid Release Source Terms

Isotope[b]	New Unit(s)	
	Single Unit[a] (Ci/yr)	Dual Unit (Ci/yr)
Sr-92	4.43E-04	8.86E-04
Tc-99m	5.68E-03	1.14E-02
Te-129	3.10E-04	6.20E-04
Te-129m	1.20E-04	2.40E-04
Te-131	7.60E-05	1.52E-04
Te-131m	3.10E-04	6.20E-04
Te-132	4.80E-04	9.60E-04
W -187	4.60E-04	9.20E-04
Y-91	2.35E-04	4.70E-04
Y-91m	5.00E-05	1.00E-04
Y-92	1.69E-03	3.38E-03
Y-93	1.36E-03	2.72E-03
Zn-65	4.41E-04	8.82E-04
Zr-95	1.30E-03	2.60E-03
Total	1.66E+03	3.32E+03

a) Single unit is the PPE value from SSAR Table 1.3-8, and is included for single unit analysis throughout the section.
b) Radionuclides Ag-110, Ba-137m, Rh-103m, and Rh-106 are short lived and their emissions attributed to their parent radionuclides. Therefore, they are not included in this table.

Table 5.4-3
Liquid Pathway Parameters

Parameter	Value
Discharge Rate	20,000 gpm
Dilution Factor	20
Transit Time to Receptor	0 sec.
Impoundment Reconcentration Model	None
50 mi. Population	8,138,635 people
50 mi. Sport Fishing[a]	5.62E+07 kg/yr
50 mi. Invertebrate Ingestion[a]	8.14E+06 kg/yr
50 mi. Shoreline Usage[a]	3.83E+08 person-hr/yr
50 mi. Swimming Usage[a]	7.65E+07 person-hr/yr
50 mi. Boating Usage[a]	7.65E+07 person-hr/yr

a) Parameter is based on the LADTAP II default value.

Table 5.4-4
Liquid Pathway Doses for Maximally Exposed Individuals (per Unit)

Dose Pathway	Adult (mrem/yr)	Teen (mrem/yr)	Child (mrem/yr)	Infant (mrem/yr)
Total Body Dose				
Fish Ingestion	1.02E-02	8.73E-03	8.49E-03	0.00E+00
Invertebrate Ingestion	5.17E-03	5.02E-03	5.62E-03	0.00E+00
Shoreline	2.84E-04	1.59E-03	3.31E-04	0.00E+00
Swimming	1.66E-06	9.26E-06	1.94E-06	0.00E+00
Boating	8.29E-07	4.63E-06	9.68E-07	0.00E+00
Total	1.57E-02	1.54E-02	1.44E-02	0.00E+00
Limiting Organ Dose				
Fish Ingestion	6.55E-02	4.76E-02	1.19E-01	0.00E+00
Invertebrate Ingestion	1.11E-01	8.78E-02	3.81E-02	0.00E+00
Shoreline	2.84E-04	1.59E-03	3.31E-04	0.00E+00
Swimming	1.66E-06	9.26E-06	1.94E-06	0.00E+00
Boating	8.29E-07	4.63E-06	9.68E-07	0.00E+00
Total	1.77E-01	1.37E-01	1.57E-01	0.00E+00
Thyroid Dose				
Fish Ingestion	1.98E-02	1.82E-02	1.88E-02	0.00E+00
Invertebrate Ingestion	2.14E-02	2.00E-02	2.17E-02	0.00E+00
Shoreline	2.84E-04	1.59E-03	3.31E-04	0.00E+00
Swimming	1.66E-06	9.26E-06	1.94E-06	0.00E+00
Boating	8.29E-07	4.63E-06	9.68E-07	0.00E+00
Total	4.15E-02	3.98E-02	4.08E-02	0.00E+00

Table 5.4-5
Gaseous Release MEI Locations and Associated χ/Q and D/Q Values

			χ/Q			
MEI Location	**Sector**	**Distance (mi.)**	**No Decay / Undepleted (s/m^3)**	**2.26-Day Half-life / Undepleted (s/m^3)**	**8-Day Half-life / Depleted (s/m^3)**	**D/Q ($1/m^2$)**
Nearest Meat Animal[(a)]	NW	4.9	1.1E-07	1.1E-07	8.2E-08	3.5E-10
Nearest Milk-Producing Animals (Cow/Goat)[(a)(b)]	NW	4.9	1.1E-07	1.1E-07	8.2E-08	3.5E-10
Nearest Residence	NW	2.8	2.4E-07	2.4E-07	1.9E-07	9.6E-10
Nearest Vegetable Garden[(a)]	NW	4.9	1.1E-07	1.1E-07	8.2E-08	3.5E-10
Nearest Site Boundary	ENE	0.24	1.0E-05	1.0E-05	9.5E-06	4.1E-08

a) Meat animals, milk producing animals, and vegetable gardens are assumed to exist at the closest farm.

b) Goats are assumed to be the milk producing animals, since goat milk bioaccumulates more than cows milk, making the pathway more conservative.

Table 5.4-6
Annual Agricultural Consumption[(a)]

Parameter	Non-Leafy Vegetables (kg/yr)	Leafy Vegetables (kg/yr)	Milk (L/yr)	Meat (kg/yr)
Average Adult	190	30	110	95
Average Teen	240	20	200	59
Average Child	200	10	170	37
Maximum Adult	520	64	310	110
Maximum Teen	630	42	400	65
Maximum Child	520	26	330	41
Maximum Infant	0	0	330	0
Maximum[(b)]	630	64	400	110

a) Values are based on the GASPAR II default values.
b) Maximum refers to the maximum value from any age group in each consumption category.

Table 5.4-7
Total Annual Agricultural Production

	Total Vegetables[a] (kg/yr)	Milk (L/yr)	Meat (kg/yr)
Max Consumption (Individual)	6.94E+02	4.00E+02	1.10E+02
Production[b]	5.65E+09	3.26E+09	8.95E+08

a) Total vegetable consumption is the sum of non-leafy vegetable and leafy vegetable consumption from Table 5.4-6 (i.e., 630 kg/yr + 64 kg/yr = 694 kg/yr).

b) Annual production is the population within 50 miles of the PSEG Site (from Table 2.5-7) multiplied by the maximum food consumption.

Table 5.4-8 (Sheet 1 of 2)
Doses to MEIs from Gaseous Effluent Releases

MEI Location	Pathway	MEI	Dose per Unit (mrem/yr)			
			T. Body	GI-Tract	Bone	Liver
Nearest Meat Animal	Meat	Adult	4.90E-03	6.26E-03	2.26E-02	5.03E-03
		Teen	4.03E-03	4.78E-03	1.90E-02	4.17E-03
		Child	7.36E-03	7.69E-03	3.57E-02	7.56E-03
Nearest Milk-Producing animals (Goat)	Milk	Adult	9.93E-03	6.41E-03	2.92E-02	1.16E-02
		Teen	1.45E-02	1.10E-02	5.32E-02	2.02E-02
		Child	2.83E-02	2.47E-02	1.30E-01	4.08E-02
		Infant	5.44E-02	4.99E-02	2.47E-01	8.24E-02
Nearest Residence	Ground Plane		1.53E-02	1.53E-02	1.53E-02	1.53E-02
	Plume		9.52E-02	9.52E-02	9.52E-02	9.52E-02
	Inhalation	Adult	2.14E-03	2.35E-03	5.03E-04	2.44E-03
		Teen	2.20E-03	2.43E-03	6.52E-04	2.64E-03
		Child	2.00E-03	2.03E-03	8.35E-04	2.38E-03
		Infant	1.18E-03	1.15E-03	5.33E-04	1.58E-03
Nearest Vegetable Garden	Vegetable	Adult	1.55E-02	1.56E-02	7.30E-02	1.61E-02
		Teen	2.32E-02	2.35E-02	1.15E-01	2.50E-02
		Child	5.21E-02	5.11E-02	2.72E-01	5.56E-02
Nearest Site Boundary	Ground Plane		6.55E-01	6.55E-01	6.55E-01	6.55E-01
	Plume		3.97E+00	3.97E+00	3.97E+00	3.97E+00
	Inhalation	Adult	9.03E-02	1.01E-01	2.41E-02	1.04E-01
		Teen	9.31E-02	1.04E-01	3.11E-02	1.13E-01
		Child	8.44E-02	8.62E-02	3.97E-02	1.02E-01
		Infant	4.97E-02	4.85E-02	2.51E-02	6.83E-02

Table 5.4-8 (Sheet 2 of 2)
Doses to MEIs from Gaseous Effluent Releases

MEI Location	Pathway	MEI	Dose per Unit (mrem/yr)			
			Kidney	Thyroid	Lung	Skin
Nearest Meat Animal	Meat	Adult	4.87E-03	1.17E-02	4.69E-03	4.66E-03
		Teen	4.04E-03	9.04E-03	3.91E-03	3.88E-03
		Child	7.39E-03	1.50E-02	7.24E-03	7.20E-03
Nearest Milk-Producing animals (Goat)	Milk	Adult	8.93E-03	2.53E-01	6.45E-03	5.92E-03
		Teen	1.56E-02	4.02E-01	1.14E-02	1.03E-02
		Child	3.29E-02	8.05E-01	2.58E-02	2.42E-02
		Infant	6.35E-02	1.94E+00	5.21E-02	4.92E-02
Nearest Residence	Ground Plane		1.53E-02	1.53E-02	1.53E-02	1.80E-02
	Plume		9.52E-02	9.52E-02	9.79E-02	2.92E-01
	Inhalation	Adult	2.68E-03	5.78E-02	3.08E-03	1.91E-03
		Teen	2.98E-03	7.51E-02	3.71E-03	1.93E-03
		Child	2.67E-03	9.23E-02	3.19E-03	1.70E-03
		Infant	1.60E-03	8.36E-02	2.10E-03	9.80E-04
Nearest Vegetable Garden	Vegetable	Adult	1.51E-02	1.77E-01	1.37E-02	1.35E-02
		Teen	2.35E-02	2.25E-01	2.15E-02	2.11E-02
		Child	5.31E-02	4.29E-01	4.99E-02	4.94E-02
Nearest Site Boundary	Ground Plane		6.55E-01	6.55E-01	6.55E-01	7.69E-01
	Plume		3.97E+00	3.97E+00	4.08E+00	1.22E+01
	Inhalation	Adult	1.15E-01	2.61E+00	1.38E-01	7.97E-02
		Teen	1.28E-01	3.40E+00	1.69E-01	8.04E-02
		Child	1.15E-01	4.18E+00	1.45E-01	7.10E-02
		Infant	6.93E-02	3.79E+00	9.68E-02	4.09E-02

Table 5.4-9
Comparison of Annual Maximally Exposed Individual Doses with 10 CFR 50, Appendix I Criteria

Type of Dose	Annual Dose: Single New Unit[(a)]	Annual Dose: Limit
Liquid Effluent		
Total Body (mrem)	1.57E-02	3
Maximum Organ – GI-LLI (mrem)	1.77E-01	10
Gaseous Effluent		
Gamma Air (mrad)	6.10E+00	10
Beta Air (mrad)	1.10E+01	20
Total Body (mrem)	4.62E+00	5
Skin (mrem)	1.22E+01	15
Iodines and Particulates (Gaseous Effluents)		
Maximum Organ – Thyroid (mrem)	7.22E+00	15

GI-LLI = gastrointestinal-lining of lower intestine

a) Annual gaseous effluent doses are based on the member of the public that is situated on the nearest site boundary for the entire duration of a year.

Table 5.4-10 (Sheet 1 of 2)
Comparison of Maximally Exposed Individual Doses with 40 CFR 190 Criteria

	Type of Dose	Liquid	Gaseous	Direct Radiation[h]	Total	Limit
Dual New Units	Total Body (mrem/yr)	3.14E-02[a]	4.00E-01[d]	2.50E+00	2.93E+00	-
	Thyroid (mrem/yr)	8.30E-02[b]	4.26E+00[e]	2.50E+00	6.84E+00	-
	Other Organ (mrem/yr)	3.54E-01[c]	1.10E+00[f]	2.50E+00	3.95E+00	-
Existing Units	Total Body (mrem/yr)	6.69E-05	5.29E-03	-	5.36E-03	-
	Thyroid (mrem/yr)	NA	NA	-	2.04E-02	-
	Other Organ (mrem/yr)	NA	NA	-	2.04E-02	-
Site Total	Total Body (mrem/yr)	3.15E-02	4.05E-01	2.50E+00	2.94E+00	25
	Thyroid (mrem/yr)	NA	NA	2.50E+00	6.86E+00	75
	Other Organ (mrem/yr)	NA	NA	2.50E+00	3.97E+00	25

a) Liquid MEI for total body dose is an adult. Value is obtained from Table 5.4-4 and multiplied by two to account for dual units.
b) Liquid MEI for the thyroid dose is an adult. Value is obtained from Table 5.4-4 and multiplied by two to account for dual units.
c) Liquid MEI for the limiting organ gastrointestinal-lining of lower intestine (GI-LLI) dose is an adult. Value is obtained from Table 5.4-4 and multiplied by two to account for dual units.
d) Gaseous MEI for this case is a child. Value is the sum of child total body dose from meat, milk, vegetable, and inhalation exposure plus the ground plane and plume exposure, as given in Table 5.4-8.
e) Gaseous MEI for this case is an infant. Value is the sum of infant thyroid dose from milk and inhalation exposure plus the ground plane and plume exposure, as given in Table 5.4-8.

Table 5.4-10 (Sheet 2 of 2)
Comparison of Maximally Exposed Individual Doses with 40 CFR 190 Criteria

f) Gaseous MEI for this case is a child, and the limiting organ is the bone. Value is the sum of child bone dose from meat, milk, vegetable, and inhalation exposure plus the ground plane and plume exposure, as given in Table 5.4-8.
g) NA – Not Available. The RERR provides total liquid and gasous dose for SGS and HCGS but does not provide a breakdown into the separate liquid and gasous dose component for organ and thyroid dose.
h) The bounding direct radiation dose at the PSEG Site is from a single unit ABWR configuration. The direct doses from the other reactor technology configurations presented in Subsection 1.2.3 are less than the ABWR.

Table 5.4-11
Collective Doses from a New Unit to Population within 50 Miles, Liquid Pathway

	Dose (person-rem/yr)	
Pathway	**Total Body**	**Thyroid (Worst Case Organ)**
Fish Ingestion	2.72E+01	3.59E+01
Invertebrate Ingestion	9.22E+00	2.22E+01
Shoreline	9.05E+00	9.05E+00
Swimming	5.29E-02	5.29E-02
Boating	2.64E-02	2.64E-02
Total	4.55E+01	6.72E+01

Table 5.4-12
Collective Doses from a New Unit to Population within 50 Miles, Gaseous Pathway

	Dose (person-rem/yr)	
Pathway	**Total Body**	**Thyroid (Worst Case Organ)**
Meat	3.61E+00	6.86E+00
Milk (cow)	3.62E+00	6.06E+01
Ground Plane	1.04E+00	1.04E+00
Plume	3.89E+00	3.89E+00
Inhalation	4.57E-01	1.04E+01
Vegetable	7.76E+00	8.12E+00
Total	2.04E+01	9.10E+01

Table 5.4-13
Doses to Biota from Liquid and Gaseous Effluents (per New Unit)

	Liquid Effluents (mrad/yr)		Gaseous Effluents (mrem/yr)			
Biota	**Internal Dose**	**External Dose**	**Internal Dose**	**External Dose**	**Total (mrem/yr)**	**40 CFR 190 Limit (mrem/yr)**
Fish	6.17E-01	1.04E+00	0.00E+00	0.00E+00	1.66E+00	25
Invertebrate	3.80E+00	2.08E+00	0.00E+00	0.00E+00	5.88E+00	25
Algae	8.21E+00	6.05E-03	0.00E+00	0.00E+00	8.22E+00	25
Muskrat	1.20E+00	6.94E-01	9.31E-02	5.28E+00	7.27E+00	25
Raccoon	3.11E-01	5.19E-01	9.31E-02	5.28E+00	6.20E+00	25
Heron	1.33E+00	6.93E-01	9.31E-02	5.28E+00	7.40E+00	25
Duck	1.11E+00	1.04E+00	9.31E-02	5.28E+00	7.52E+00	25

5.5 ENVIRONMENTAL IMPACTS OF WASTE

The following subsections discuss the environmental impacts of nonradioactive waste and mixed waste (a matrix of low-level radioactive and hazardous waste) as they pertain to the operation of the new plant. Regulations for generating, managing, handling, storing, treating, protecting, and disposing of these wastes are contained in federal regulations issued and overseen by the NRC and USEPA, and in NJDEP regulations. These regulations include compliance with provisions of the Clean Air Act, Clean Water Act, Atomic Energy Act, and Resource Conservation and Recovery Act, among others.

5.5.1 NONRADIOACTIVE WASTE SYSTEM IMPACTS

The new plant systems for nonradioactive waste treatment are described in Section 3.6. Nonradioactive wastes generated by the new plant, including solid wastes, liquid wastes, and air emissions, are managed in accordance with applicable federal, state and local laws and regulations, and applicable permit requirements. No site-specific waste disposal activities are unique to the new plant. Management practices are equivalent to those for the existing HCGS and SGS, and include the following:

- Nonradioactive solid wastes (e.g., office waste, recyclables) are collected and stored temporarily on the new plant site and disposed of or recycled locally.
- Organic debris collected on circulating water traveling screens at the water intake structure is returned to the Delaware River. Mixed organic and man-made debris, such as wood, plastic, etc., collected from the trash racks is disposed of off-site.
- Scrap metal, universal wastes (federally designated as universal waste including batteries, pesticides, mercury-containing equipment and bulbs [lamps]), used oil and antifreeze are collected and stored, and recycled or recovered at an off-site permitted recycling or recovery facility, as appropriate.
- Water from cooling and auxiliary systems is discharged to the Delaware River watershed through permitted outfalls.
- Wastewater is treated by a permitted treatment system and residuals managed in compliance with the requirements of federal and state regulations.
- Sediments from cooling system maintenance (periodic dredging of intake structure and removed from cooling towers) are disposed of in an approved upland disposal facility.

5.5.1.1 Impacts of Discharges to Water

The operation of the new plant will comply with applicable permits and regulations including the NJPDES (NJAC 7:14A), New Jersey Surface Water Quality Standards (NJAC 7:9-B1), New Jersey Water Quality Management Planning Rule (NJAC 7:15), and the DRBC Water Code (18 CFR 410). Nonradioactive wastewater discharges to surface water from the new plant include cooling tower blowdown, permitted wastewater from the auxiliary systems, and stormwater runoff. Subsection 3.6.1 lists the typical chemicals that are used by the new plant and may be present in the plant’s discharge effluent.

PSEG currently maintains engineering and procedural controls that prevent or minimize the release of harmful levels of wastewater constituents to the Delaware River watershed consistent with federal, state and local requirements, including those of the DRBC related to surface water regulations. Concentrations of constituents in wastewater discharge are limited by NJPDES permit requirements and normally are minimal or undetectable in the river (Subsection 5.2.3). Wastewater discharges from the new plant are managed in a similar manner.

Chemical treatment of the safety-related cooling water system with biocides, dispersants, molluskicides, and scale inhibitors is required on a periodic basis. The chemicals are subject to review and approval for use by the NJDEP, and releases comply with an approved NJPDES permit. As required by NJDEP, chlorine produced oxidants, including those generated from the necessary use of sodium hypochlorite, are mitigated by dechlorination and the discharge is limited and monitored. The total residual chemical concentrations in the discharges to the Delaware River watershed are subject to limits established by the NJDEP. These limits are protective of the water quality of the Delaware River.

Concentrations of constituents in the cooling water and plant auxiliary system discharges of the new plant are subject to limitations imposed by applicable NJPDES permits. Extensive mixing of constituents in discharge blowdown occurs within the Delaware River as discussed in Subsection 5.3.2. Discharges from the new units are minor and do not warrant mitigation given the small volume of these constituents, the large volume of the receiving water body (the Delaware River) and the regular tidal mixing that is expected to occur.

PSEG will implement a stormwater pollution prevention plan designed to prevent the discharge of harmful quantities of pollutants with stormwater discharge. This plan incorporates drainage from all areas and facilities, and will be consistent with the existing stormwater pollution prevention plans at SGS and HCGS.

In conclusion, because of the use of engineering controls that prevent or minimize the release of harmful effluents, and the management of effluent concentrations to levels below permitted limits that are established to be protective of water quality and aquatic life, potential impacts of discharges to water are SMALL.

5.5.1.2 Impacts of Discharges to Land

Operation of the new plant results in an increase in the total volume of nonradioactive solid waste generated at the PSEG Site. The characteristics of these wastes and the way in which they are managed are not fundamentally different than current practices at the HCGS and SGS. The existing facilities are normally conditionally exempt small-quantity hazardous waste generators, generating less than 220 pounds per month combined. PSEG maintains the program required of a small quantity generator and monitors the amount of hazardous waste generated each month to determine the correct status. Hazardous waste is disposed of through licensed disposal facilities. Universal waste, such as paint waste, lead-acid batteries, used lamps, and mercury containing switches, is segregated and disposed of through licensed disposal facilities. Normal station waste (e.g., paper, plastic, river debris) is segregated and, as much as possible, processed for recycling. Two-thirds of the normal station waste is recycled, with the balance either incinerated or landfilled.

Applicable federal, state, and local requirements and standards for handling, transporting, and disposing of solid waste are met at the new plant. Consistent with current PSEG practice, solid wastes are reused or recycled to the extent possible. Wastes appropriate for recycling or reclamation (e.g., used oil, antifreeze, scrap metal, universal wastes) are managed using approved, licensed contractors. Nonradioactive solid waste destined for off-site landfill disposal are disposed of at approved, licensed off-site commercial waste disposal sites. Therefore, potential impacts from land disposal of nonradioactive wastes are SMALL.

5.5.1.3 Impacts of Discharges to Air

The new plant site lies within an ozone non-attainment area (Salem County, NJ) and adjacent to a non-attainment area for particulate matter smaller than 2.5 microns ($PM_{2.5}$) (New Castle County, DE). The new plant will comply with all regulatory requirements of the Clean Air Act, including requirements of the NJDEP Division of Air Quality and Delaware Department of Natural Resources and Environmental Control, Division of Air and Waste Management, thereby minimizing any impacts on state and regional air quality. An NJDEP Air Operating Permit under Title V of the Clean Air Act is required for the plant, addressing emissions and compliance with state and federal regulations.

Operation of the new plant increases gaseous and particulate emissions to the air by a small amount, primarily from equipment associated with plant auxiliary systems and the cooling towers. The primary sources of emissions from auxiliary systems are the auxiliary boilers, standby power units such as diesel generators or gas turbines, and engine driven emergency equipment. The auxiliary boilers are used for heating the new plant buildings, primarily during the winter months, and for process steam during plant startups. The diesel generators / gas turbines and engine driven emergency equipment are used intermittently and for brief durations. Low-sulfur fuels are used for all equipment, minimizing gaseous and particulate emissions during the periods when the equipment operates. The cooling tower(s) are the primary source of particulate emissions. Expected emissions from the cooling towers, auxiliary boilers, and diesel generators are provided in Table 5.8-1. Subsection 5.3.3.3 addresses cooling tower impacts on terrestrial ecosystems. Air emission sources associated with the new units are managed in accordance with federal, state, and local air quality control laws and regulations. As discussed in Subsection 5.8.1.4, final modeling of air quality impacts is expected to show that the impacts are SMALL.

5.5.1.4 Sanitary Waste

As described in Section 3.6, a new sewage treatment system is installed (or capacity of the existing system increased) to treat the daily flow from the new plant (Subsection 3.6.2). Sanitary wastes are treated on-site and discharged to the Delaware River in accordance with NJDEP and DRBC permits and requirements. Residuals are disposed of off-site in compliance with applicable laws, regulations, and permit conditions imposed by federal, state, and local agencies. Potential impacts associated with increases in sanitary waste from operation of the new plant are SMALL.

5.5.2 MIXED WASTE IMPACTS

Mixed waste is radioactive waste containing chemical constituents classified as hazardous under USEPA or NJDEP regulations. Neither HCGS nor SGS currently have processes that result in the generation of mixed waste. In the past, most mixed wastes generated at HCGS and SGS resulted from the contamination of oils (hydraulic and lubricating) used in plant systems. All oils currently used in plant systems are non-hazardous and do not result in mixed waste if they become radiologically contaminated. There are currently no mixed wastes stored at either HCGS or SGS.

PSEG has contingency plans and spill prevention procedures in place for the existing units. These plans are implemented in the unlikely event of a mixed waste spill. Personnel designated to handle mixed waste or to respond to mixed waste upsets or other spills have the appropriate training to enable them to perform their work properly and safely. The existing emergency procedures provide for effective management of spills and limit impacts.

Processes for the new plant are similarly designed to prevent the generation of mixed waste. Therefore, any impacts from the treatment, storage and disposal of mixed wastes generated by the new plant are SMALL.

5.5.3 POLLUTION PREVENTION AND WASTE MINIMIZATION PLAN

PSEG has pollution prevention and waste management programs for company facilities. Pollution prevention and waste minimization planning provides the framework for promoting environmental stewardship and educating employees in the environmental aspects of activities occurring in the workplace, in their community, and in their homes. The new plant will have pollution prevention and waste minimization plans that include the following:

- Waste minimization for the various phases of the new plant construction and operation
- Employee training and education on general environmental activities and hazards regarding the new plant facility, operations and the pollution prevention program, as well as waste minimization requirements, goals, and accomplishments
- Employee training and education on specific environmental requirements and issues.
- Responsibilities for pollution prevention and waste minimization
- Employees' recognition for efforts to improve environmental conditions
- Requirements for employees to consider pollution prevention and waste minimization in day-to-day activities and engineering

A plan similar to that currently in place for the HCGS and SGS will be developed for the new plant.

5.6 TRANSMISSION SYSTEM IMPACTS

This section addresses the operational impacts of the transmission system on terrestrial and aquatic ecosystems and members of the public. The degrees of any potential impacts are evaluated with regard to the transmission system and any rights-of-way associated with the new plant. Additional discussions of the transmission systems (existing and proposed) are provided in Subsections 2.2.3, 2.3.1, 2.4, 3.7, 4.3, and 5.1.2.

PSEG has identified two off-site transmission corridor alternatives that may be considered in future transmission routing studies in the event a new transmission line is necessary to accommodate grid stability requirement (Subsection 9.4.3). A particular corridor has not been selected, as this is dependent on a variety of factors including the selection of a reactor technology, formal transmission impact studies, and regional transmission planning efforts.

Transmission needs for the new plant include two or three new on-site transmission lines crossing between two proposed switchyards on the PSEG Site and a potential off-site transmission line.

5.6.1 TERRESTRIAL ECOSYSTEMS

PSEG or PSE&G maintains the transmission lines and rights-of-way associated with HCGS and SGS in NJ to ensure the protection of important terrestrial habitats and important terrestrial species in accordance with resource agency approved best management practices (Subsection 5.1.2). Pepco Holdings (PHI) performs the same functions for existing rights-of-way in Delaware. Potential impacts from operation and maintenance of the new transmission systems is based on the established procedures PSE&G uses for existing lines.

PSE&G transmission lines and rights-of-way are patrolled approximately five times each year to ensure that the physical and electrical integrity of transmission line supports, hardware, insulators, and conductors are acceptable for safe and reliable service. This periodic transmission line patrol is conducted by helicopter and ground patrols. Climbing inspections of structures are performed approximately every 3 yr depending on the age of the line (Section 3.7).

Maintenance measures used by PSE&G to keep woody vegetation at least 30 ft. from the conductors will be used in wooded areas crossed by transmission lines. Mechanical clearing is the primary method used for maintenance of the transmission line rights-of-way. In identified wetland areas, rights-of-way maintenance is typically performed manually in accordance with resource agency approved BMPs. Herbicide application is used to prevent sprouts from fast-growing woody vegetation (Reference 5.6-5) in accordance with an integrated pest management program. Should herbicide application be necessary in or near waterways or wetlands, only herbicides specifically labeled for use in waterways are used, consistent with USEPA label requirements and NJDEP regulations. The transmission line rights-of-way are periodically inspected to ensure appropriate clearances between tall vegetation and the conductors.

As discussed in Subsection 4.1.2, the potential off-site transmission line is expected to cross a variety of land uses. The on-site transmission lines cross habitat consisting of coastal wetland dominated by the invasive strain of common reed (*Phragmites australis*). As such, maintenance to keep woody vegetation at least 30 ft. away from the conductors is not likely to be required on-site.

5.6.1.1 Important Habitats

As discussed in Subsection 2.4.1, jurisdictional and unmapped coastal wetlands are the only important terrestrial habitats identified on-site. Transmission line right-of-way maintenance on-site is not anticipated because the on-site transmission lines are located in an herbaceous coastal wetland area dominated by common reed. On-site coastal wetlands are disturbed habitats dominated by common reed which does not grow tall enough to come in contact with overhead transmission lines. Consequently, only minimal mechanical clearing and/or herbicide application is anticipated as part of on-site transmission line maintenance activities. Thus, impacts to important habitats on-site are not anticipated.

Important habitats are expected to include wetlands as detailed in the macro-corridor analysis discussed in Subsection 9.4.3. Procedures to maintain rights-of-way within important habitats of off-site transmission corridors follows established BMPs. Operational impacts to the Delaware River and wetlands associated with the maintenance and operation of the proposed off-site transmission line rights-of-way are SMALL.

Impacts to important terrestrial habitats resulting from the operation and maintenance of transmission line systems are SMALL.

5.6.1.2 Important Species

Only one important plant species, saltmarsh cordgrass (*Spartina alterniflora*), is identified in Subsection 2.4.1. Saltmarsh cordgrass is essential to the function of the coastal marsh and an important component of coastal wetlands in marsh restoration sites. It has not been observed in on-site areas near the planned transmission lines for the new plant. Furthermore, the transmission lines are elevated and the routine use of herbicide or mechanical clearing as part of on-site transmission line maintenance procedures is not anticipated. As such, impacts to saltmarsh cordgrass associated with the maintenance and operation of the on-site transmission lines are not anticipated.

Important commercial mammal species discussed in Subsection 2.4.1 include river otter (*Lutra canadensis*) and muskrat (*Ondatra zibethica macrodon*). White-tailed deer (*Odocoileus virginianus*) is the only important recreational mammal species discussed in Subsection 2.4.1. As discussed above, the transmission lines are elevated and periodic impacts to terrestrial habitats due to periodic maintenance are minor. Thus, impacts to important mammals associated with the maintenance and operation of the on-site transmission lines are not anticipated.

Twenty important bird species from the site and vicinity are discussed in Subsection 2.4.1. These include 13 recreational waterfowl species, in addition to six NJ and DE state-listed threatened and endangered species. The NJ state-listed species include the Cooper's hawk (*Accipiter cooperii*), red-shouldered hawk (*Buteo lineatus*), northern harrier (*Circus cyaneus*), bald eagle (*Haliaeetus leucocephalus*), osprey (*Pandion haliaetus*), and red-headed woodpecker (*Melanerpes erythrocephalus*) (Reference 5.6-4). The DE state-listed species include the northern harrier and the bald eagle (Reference 5.6-1). Potential impact to birds from the operation of the transmission lines may include electrocution or physical collision. Appropriate measures are included in transmission line designs to reduce avian power line interaction. The planned transmission lines for the new plant are spaced in a manner designed to minimize collision. Thus, impacts to birds from maintenance and operation of the transmission line are SMALL.

Although no important plant or animal species were identified during the macro-corridor off-site transmission line analysis, procedures are in place to avoid impacts to threatened or endangered species during maintenance of the rights-of-way (References 5.6-7 and 5.6-8). Thus, impacts to important species associated with the maintenance and operation of the potential off-site transmission line are SMALL.

5.6.1.3 Wildlife Management Practices

As described in Subsection 2.4.1, wildlife utilize established transmission towers as perching or nesting sites. For example, ospreys regularly nest on transmission towers in the vicinity of the PSEG Site, and other raptors use towers as perching sites. Wildlife management practices applicable to the proposed transmission lines of the new plant include compliance with the Migratory Bird Treaty Act regarding nest removal for periodic maintenance activities, as applicable.

5.6.2 AQUATIC ECOSYSTEMS

The new 500-kilovolt (kV) transmission lines connect the two new switchyards in the northeastern corner of the PSEG Site. This subsection considers the effects of the transmission facility operation and maintenance on aquatic ecosystems.

PSE&G has guidelines and procedures for its transmission engineering and delivery personnel to ensure that transmission lines are maintained and transmission rights-of-way are managed so that important aquatic habitats are preserved and important aquatic species are protected (Reference 5.6-5). The predominant habitat type in the area is coastal wetland dominated by common reed. Operations and maintenance procedures for the transmission lines are similar to procedures currently in use for the existing lines. Maintenance of the transmission corridor includes efforts to keep vegetation disturbance to a minimum and to minimize disruption of streams by maintenance vehicles.

5.6.2.1 Important Habitats

The on-site transmission lines are distant from the Delaware River, so no essential fish habitat associated with the river is affected by line maintenance. Switchyard runoff from transformer pads is routed through the appropriate oil/water separators. Coastal and unmapped coastal wetlands constitute the only important habitats on-site. Potential impacts to these habitats may occur as a result of periodic tower maintenance activities. There may be temporary exposure of aquatic biota to decreases in water quality due to transmission line maintenance activities. It is expected that such maintenance activities entail the use of temporary work mats to access towers or other low impact measures. Herbicide application within the coastal wetlands as part of transmission line operation and maintenance is not needed based on the characteristics of the marsh species present. However, should herbicide application be deemed necessary in or near waterways or wetlands, only herbicides specifically labeled for use in waterways are used in accordance with NJDEP regulations and federal labeling requirements. BMPs are used to assure maintenance activities are managed in such a way to preserve habitats and protect important species (e.g., if herbicides are applied near waterways, only those specifically identified for such use are applied). Thus, the impacts to important aquatic habitats due to operation and maintenance of the on-site transmission system are SMALL.

The potential new off-site transmission line is expected to cross a variety of aquatic habitats. Procedures are in place to avoid impacts to threatened or endangered species during maintenance of the rights-of-way (References 5.6-7 and 5.6-8). Impacts to important habitats associated with the maintenance and operation of the potential new off-site transmission line are SMALL.

5.6.2.2 Important Species

Four important species, American eel, Atlantic menhaden, white perch, and striped bass, have been collected from small marsh creek segments in the general area potentially impacted by the new on-site and potential off-site transmission lines (Table 2.4-14). Only Atlantic menhaden was common, the other species are represented by only one or a few individuals. Each of the four species is common in large segments of marsh creeks (Table 2.4-16) and in the Delaware River (Table 2.4-23) and specimens encountered in small marsh creek segments are likely strays. Each of these species is highly mobile and could avoid temporary effects associated with maintenance of the new transmission corridor. Indirect impacts of corridor maintenance can be avoided by adherence to the management practices listed in this section. Therefore, the impacts to important species due to the operation and maintenance of the transmission system are SMALL.

5.6.3 MEMBERS OF THE PUBLIC

5.6.3.1 Electrical Shock

Objects located near transmission lines can become electrically charged due to their presence within the lines’ electric field. This charge results in a current that flows through the object to the ground in an induced fashion as there is no direct connection between the line and the object. The induced current can also affect a person who touches the object. An object that is insulated from the ground can capacitively store a charge. A person standing on the ground and coming in contact with such an object can receive an electrical shock due to the discharge of the capacitive charge. After the initial discharge, a steady-state current can develop, the magnitude of which depends on several factors including:

- The strength of the electric field which, in turn, depends on the voltage of the transmission line as well as its height and geometry
- The size of the object on the ground
- The extent to which the object is grounded

The National Electrical Safety Code (NESC) has a provision that describes how to establish minimum vertical clearances to the ground for electric lines having voltages exceeding 98 kV. The clearance must limit the induced current due to electrostatic effects to 5 milliamperes if the largest anticipated vehicle or equipment is short-circuited to ground (Reference 5.6-3).

PSEG designs new transmission lines to ensure compliance with the 5-milliamp NESC standard (Reference 5.6-3). Consequently, impacts associated with electrical shock are SMALL.

5.6.3.2 Electromagnetic Field Exposure

Potential chronic effects due to exposure to electromagnetic fields (EMF) are frequently an issue of concern related to human health. However, there is no scientific consensus regarding the health effects of EMFs produced by operating transmission lines. Therefore, PSEG did not quantify the chronic effects of EMF associated with a potential off-site transmission line.

In 1992, the U.S. Congress established a program designed to determine if exposure to extremely low frequency EMF is harmful to humans. The research and information compilation effort was conducted by the National Institute of Environmental Health Sciences (NIEHS), the National Institutes of Health, and the Department of Energy. This study found that powerline frequency (50 to 60 Hz) EMF did not result in stress responses or biological impacts in human cells (Reference 5.6-6).

The NRC considered EMF impacts in its environmental assessment for the HCGS Electric Power Uprate Application. The NRC also concluded that, to date, there is not sufficient data to cause the NRC staff to change its position with respect to the chronic effects of electromagnetic fields (Federal Register, Volume 73, No. 48).

Only New York and Florida have established right-of-way limits for magnetic fields from new transmission lines. In 1990, New York established a 200-milligauss limit for transmission lines. In 1989, Florida established a 150-milligauss limit for 230,000-volt lines and smaller, and a 250-milligauss limit for 500,000-volt double-circuit transmission lines. Both the New York and Florida limits for new transmission lines are based on the maximum fields from the existing lines in those states at the time.

If an off-site transmission line is needed, it will be designed and constructed in a manner to minimize EMF effects including appropriate conductor height / spacing and phase orientation with respect to neighboring lines to optimize field cancellation. Therefore, the potential for EMF related impacts to the public resulting from a new transmission line is SMALL.

5.6.3.3 Noise

High-voltage transmission lines can emit noise when the electric field strength surrounding them is greater than the breakdown threshold of the surrounding air, creating a discharge of energy. This energy loss, known as corona discharge, is affected by ambient weather conditions such as humidity, air density, wind, and precipitation and by irregularities on the energized surfaces (Reference 5.6-2). PSEG transmission lines are constructed with hardware and conductors designed to eliminate corona discharge. Nevertheless, during wet weather, the potential for corona loss increases, and nuisance noise could be present. As a representative example of audible noise levels expected from a new 500kV transmission line, the noise analysis performed as part of PSE&G's development of the Susquehanna - Roseland 500kV transmission line project identifies a typical noise level of 35-40 dBA at the edge of a 200 foot transmission right of way (Reference 5.6-9). This noise level is less than the New Jersey limit of 50 dBA for continuous noise emanating from a commercial or industrial facility (Reference 5.6-10). As a point of comparison, this noise level is equivalent to the noise generated by a refrigerator or a soft whisper. In the event a new transmission line is necessary to accommodate a new reactor, a similar noise study would be performed and appropriate noise level thresholds established as part of the design and permitting of the line. Therefore, no audible noise issues are expected from the proposed transmission lines and impacts are SMALL.

5.6.3.4 Radio and Television Interference

The presence of corona discharge in high-voltage transmission lines can produce electrical noise in the radio-frequency spectrum that can result in radio and television interference. As described in Subsection 5.6.3.3, PSEG transmission lines are designed to be corona-free up to their maximum operating voltage. Radio and television interference from any potential new lines is SMALL.

5.6.3.5 Visual Impacts

If an off-site transmission line is needed, it will be located in accordance with established industry practices and procedures that take into consideration environmental and visual impacts. Natural vegetation is retained at road crossings to help minimize ground-level visual impacts, where possible. Contractors performing routine vegetation control on the transmission lines are instructed to maintain a screen of natural vegetation in the rights-of-way on each side of major highways and water-ways, unless safety or engineering requirements dictate otherwise. Accordingly, the visual impacts to members of the public from the transmission system are SMALL.

5.6.4 REFERENCES

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5.6-7 PSEG, Letter to Wendy Walsh of USFWS Regarding Endangered Species Compliance during Electric Transmission Right-of-Way Vegetation Maintenance Activities, October 13, 2009.

5.6-8 U.S. Fish and Wildlife Service, Letter to Edward Keating of PSEG Regarding Federally Listed Threatened and Endangered Species in the Vicinity of Salem and Hope Creek Generating Stations, September 9, 2009.

5.6-9 K & R Consulting, Electrical Effects from the New Jersey Section of the Susquehanna – Roseland 500 kV Transmission Line; January 7, 2009.

5.6-10 State of New Jersey Noise Control Code N.J.A.C 7:29-1.

5.7 URANIUM FUEL CYCLE AND TRANSPORTATION IMPACTS

Subsection 5.7.1 addresses the environmental impacts from the uranium fuel cycle. Subsection 5.7.2.1 addresses the conditions in subparagraphs 10 CFR 51.52(a)(1) through (5) regarding use of Table S-4 to characterize the impacts of radioactive materials transportation in this Environmental Report. An analysis of the transportation effects was performed because not all the conditions set forth in 10 CFR 51.52(a) are met. Subsection 5.7.2.2 addresses the incident-free transportation of radioactive materials. Postulated accidents due to transportation of radioactive materials are discussed in Section 7.4.

5.7.1 URANIUM FUEL CYCLE IMPACT

This subsection discusses the environmental impacts from the uranium fuel cycle for the new plant at the PSEG Site. The evaluations of potential environmental effects of the new plant are based on bounding information from the PPE. The reactor types considered are the Advanced Boiling Water Reactor (ABWR), AP1000, U.S. Evolutionary Power Reactor (U.S. EPR), and U.S. Advanced Pressurized Water Reactor (US-APWR). A description of the development and intended use of the PPE is provided in Section 1.3 of the SSAR.

The uranium fuel cycle is defined as the total of those operations and processes associated with provision, utilization, and ultimate disposition of fuel for nuclear power reactors.

The regulations in 10 CFR 51.51, *Uranium Fuel Cycle Environmental Data – Table S-3*, paragraph (a), state:

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

NRC Table S-3 is used to assess environmental impacts associated with the uranium fuel cycle. Its values are normalized for a reference 1000 megawatts electric (MWe) light water reactor (LWR) at an 80 percent capacity factor. The 10 CFR 51.51(a), Table S-3 values are reproduced as the Reference LWR column in Table 5.7-1. For the new plant, the bounding technology with respect to power level is a dual unit AP1000. A scale factor based on MWe and capacity factor is used to develop S-3 values for a dual unit AP1000. For this analysis the scale factor is 2.77. A comparison of the bounding technology to the reference LWR is included in Table 5.7-1.

Specific categories of natural resource use are included in NRC Table S-3 (and duplicated in Table 5.7-1). These categories relate to land use, water consumption and thermal effluents, radioactive releases, burial of transuranic and high-level and low-level wastes, and radiation doses from transportation and occupational exposures. In developing NRC Table S-3, the NRC initially considered two fuel cycle options, which differed in the treatment of spent fuel removed from a reactor. No recycle treats all spent fuel as waste to be stored at a federal waste repository. Uranium only recycle involves reprocessing spent fuel to recover unused uranium and return it to the system for reuse. Neither cycle involves the recovery of plutonium. The contributions in NRC Table S-3 resulting from reprocessing, waste management, and transportation of wastes are maximized for both of the two fuel cycles (uranium only recycle and no recycle); that is, the cycle that results in the greater impact is used.

The United States does not currently reprocess spent fuel, therefore only the no recycle option is considered . As described in NUREG-1555, natural uranium is mined in either open-pit or underground mines, or by an in situ mining process. In situ leach mining, the primary form of mining in the United States today, involves injecting a lixiviant (leaching solution) into the uranium ore body to dissolve uranium and then pumping the solution to the surface for further processing. The ore or in situ leach solution is transferred to mills where it is processed to produce yellow-cake (U_3O_8). A conversion facility prepares the uranium oxide by converting it to uranium hexafluoride (UF_6), which is then processed by an enrichment facility to increase the percentage of the more fissile isotope uranium-235 (U-235) and decrease the percentage of the nonfissile isotope uranium-238. At a fuel-fabrication facility, the enriched uranium is converted to uranyl acetate (UO_2). The UO_2 is pelletized, sintered, and inserted into tubes to form fuel assemblies. The fuel assemblies are placed in the reactor to produce power. When the content of the uranium-235 reaches a point where the nuclear reactor has become inefficient with respect to neutron economy, the fuel assemblies are withdrawn from the reactor. After on-site storage for sufficient time to allow for short-lived fission product decay and to reduce the heat generation rate, the fuel assemblies will be transferred to a federal repository for internment. Disposal of spent fuel elements in a repository constitutes the final step in the no-recycle option.

The following assessment of the environmental impacts of the fuel cycle for the bounding technology at the PSEG Site is based on the values in NRC Table S-3 and the NRC's analysis of the radiological impacts from radon-222 and technetium-99 provided in NUREG-1437. NUREG-1437 provides a detailed analysis of the environmental impacts from the uranium fuel cycle. Although NUREG-1437 is specific to impacts related to license renewal, the information is relevant to this review because the reactor technologies being considered use the same type of fuel.

The fuel impacts in NRC Table S-3 are based on a reference 1000-MWe LWR operating at an annual capacity factor of 80 percent for a net electric output of 800 MWe. When evaluating the new plant, NUREG-1555, Section 5.7.1, directs that the impacts in Table S-3 are scaled to the net electric output for the new plant. For the uranium fuel cycle impact analysis, the net electrical output is defined as the gross electrical output multiplied by the maximum potential capacity factor. For the dual unit AP1000, the surrogate AP1000 from NUREG-1815, Appendix G is used. The gross electric output of the surrogate AP1000 in NUREG-1815 is 1150 MWe per unit; thus, the combined gross electric output for two units is 2300 MWe. Using the 96.3 percent capacity factor, the net electric output for dual units used to determine fuel cycle impacts is calculated to be 2215 MWe. These results are provided in Table 5.7-1.

As shown in Table 5.7-2, the new plant may require more than 35 metric tons of uranium (MTU) per yr. This table also shows the fuel cycle uranium requirements. The requirements for natural UF_6, enriched UF_6, U_3O_8 and separative work units (SWU) are based on the approach used in the Idaho National Engineering and Environmental Laboratory, *Early Site Permit Environmental*

Report Sections and Supporting Documentation, (Reference 5.7-2), i.e., scaled from the reference plant using the annual fuel load. The uranium requirements may exceed 35 MTU because the generating capacity is greater than the reactor designs that were considered when NUREG-1437 was issued. At least two of the reference 1000 MWe LWRs may be required to provide the generating capacity of the new plant (Reference 5.7-2).

Recent changes in the fuel cycle may reduce environmental impacts in the United States. The NRC calculated the values in NRC Table S-3 from industry averages for the performance of each type of facility or operation associated with the fuel cycle. The NRC chose assumptions so that the calculated values are not underestimated. This approach was intended to ensure that the actual values are less than the quantities shown in NRC Table S-3 for all LWR nuclear power plants within the widest range of operating conditions. Since NRC Table S-3 was promulgated, changes in the fuel cycle and reactor operations have occurred. For example, the estimated quantity of fuel required for a year's operation of a nuclear power plant can now reasonably be calculated assuming a 60-yr lifetime (40 yr of initial operation plus a 20-yr license renewal term). This is described in NUREG-1437, for both BWRs and PWRs, and the highest annual requirement, 35 MTU made into fuel for a BWR, was used as the basis for the reference reactor year.

Since the original estimates in 1979 were made for Table S-3, a number of fuel management improvements have been adopted by nuclear power plants to achieve higher performance and to reduce fuel and separative work (enrichment) requirements. These improvements are estimated to reduce the annual fuel requirement by 10 to 15 percent.

In addition, the Table S-3 estimates for enrichment are based on the gaseous diffusion process, which has been used in the United States since the earliest days of the nuclear power program. The largest impacts of the gaseous diffusion process are attributable to the large requirement for electric energy to run the plant (especially to the assumption that the electricity will come from coal-fired power plants) and to the large amount of cooling water used in the gaseous diffusion process equipment. The centrifuge process uses 90 percent less electrical energy and therefore, has far lower impacts attributable to coal-fired power plants and the use of cooling water. The assumption of continued use of United States diffusion enrichment services ensures that environmental impacts are not underestimated.

Factoring in changes to the fuel cycle suggests that the environmental impacts of mining and tail millings could drop to levels below those in NRC Table S-3. Section 6.2 of NUREG-1437 discusses the sensitivity of these changes in the fuel cycle on the environmental impacts.

5.7.1.1 Land Use

As shown in Subsection 6.2.2 of NUREG-1437, the total annual land requirements for the fuel cycle supporting the 1000-MWe LWR are 46 hectares (ha) (113 ac.). This includes 5 ha (13 ac.) that are permanently committed, and 41 ha (100 ac.) that are temporarily committed. The total annual land requirements for the fuel cycle supporting the new plant are scaled up from the reference reactor and provided in Table 5.7-1. The total land requirement (both temporary and permanent land commitments) for the new plant is 127 ha (313 ac.). A temporary land commitment is a commitment for the life of the specific fuel cycle plant (e.g., a mill, enrichment plant, or succeeding plants). Following decommissioning, the land could be released for unrestricted use. Permanent commitments represent land that may not be released for use after decommissioning because the decommissioning does not result in the removal of sufficient radioactive material to meet the limits of 10 CFR 20, Subpart E for release of an area for unrestricted use.

In comparison to the new plant land use values in Table 5.7-1, a coal plant of 1000 MWe (800 MWe net) capacity using strip-mined coal requires 81 ha (200 ac.) per year for fuel alone (NUREG-1555, Subsection 5.7.1). Using a scale factor of 2.77 shows that a 2300 MWe (2215 MWe net) coal plant requires 224 ha (554 ac.). As a result, the impacts on land use for the new plant are SMALL.

5.7.1.2 Water Use

According to Section 6.2.2.7 of NUREG-1437, principal water use for the fuel cycle is that required to remove waste heat from the power stations supplying electricity to the enrichment process. NUREG-1437 indicates that on a thermal-effluent basis, annual discharges from the nuclear fuel cycle are 4 percent of those from the reference 1000-MWe LWR using once-through cooling. The consumptive water use of 0.6×10^6 m^3/yr (1.6×10^8 gallons/yr) is 2 percent of that from the model 1000-MWe LWR using cooling towers. The maximum consumptive water use (assuming that all plants supplying electrical energy to the nuclear fuel cycle used cooling towers) are 6 percent of that of the model 1000-MWe LWR using cooling towers. In NUREG-1437, it was determined that these combinations of thermal effluents are SMALL. The fuel cycle water use for the new plant is provided in Table 5.7-1.

5.7.1.3 Fossil Fuel Impacts

Electric energy and process heat are required during various phases of the fuel cycle process. The electric energy is usually produced by the combustion of fossil fuel at conventional power plants. Electric energy associated with the fuel cycle represents 5 percent of the annual electric power production of the reference 1000 MWe LWR.

Process heat is primarily generated by the combustion of natural gas. As concluded in NUREG-1437, this gas consumption, if used to generate electricity, is less than 0.4 percent of the electrical output from the reference reactor. As a result, the direct and indirect consumption of electrical energy for fuel cycle operations is SMALL relative to the power production of the new plant.

The natural gas consumption associated with the fuel cycle for the new plant is greater than the reference reactor because the new plant has a significantly higher generating capacity. However, if a comparative basis is established by scaling the reference reactor to the new plant, this figure remains less than 0.4 percent of the new plant output.

5.7.1.4 Chemical Effluents

The quantities of liquid, gaseous and particulate discharges associated with the fuel cycle processes are given in NRC Table S-3 (Table 5.7-1) for the reference 1000 MWe LWR. The quantities of effluents for the new plant are approximately three times those in NRC Table S-3 (Table 5.7-1). The principal effluents are SO_x, NO_x, and particulates. Based on the 1997 Annual Report of the Council on Environmental Quality, Chapter 5 Air Quality, the new plant emissions constitute a small fraction of the national sulfur and nitrogen oxide annual emissions (Reference 5.7-1).

Liquid chemical effluents produced in the fuel cycle processes are related to fuel enrichment and fabrication and may be released to receiving waters. All liquid discharges into navigable waters of the United States from facilities associated with fuel cycle operations are subject to requirements and limitations set by an appropriate federal, state, regional, local or tribal regulatory agency, thus assuring minimum impact.

As concluded in NUREG-1555, tailing solutions and solids are generated during the milling process, but are not released in quantities sufficient to have a significant impact on the environment. Impacts from the above-listed chemical effluents for the new plant are SMALL.

5.7.1.5 Radioactive Effluents

As stated in Section 5.7.1 of NUREG-1555, radioactive gaseous effluents estimated to be released to the environment from waste management activities and certain other phases of the fuel cycle are set forth in NRC Table S-3 (Table 5.7-1). Using these effluents and NUREG-1437 data, the 100-yr involuntary environmental dose commitment to the United States population from the LWR-supporting fuel cycle for 1 yr of operation of the model 1000-MWe LWR was calculated. These calculations determine that the overall whole body gaseous dose commitment to the United States population from the fuel cycle (excluding reactor releases and the dose commitment from radon-222 and technetium-99) is approximately 4 person-sievert (Sv) (400 person-rem) per year of operation of the 1000-MWe LWR scaled model; this reference reactor year is scaled to reflect the total electric power rating for the site for a year (based on net capacity ratio). The additional whole body dose commitment to the United States population from radioactive liquid effluents due to all fuel cycle operations other than reactor operation is approximately 2 person-sievert (200 person-rem) per year of operation. Thus, the estimated 100-yr environmental dose commitment to the United States population from radioactive gaseous and liquid releases due to these portions of the fuel cycle is approximately 6 person-sievert (600 person-rem) (whole body) for the 1000-MWe LWR scaled model. The corresponding scaled values for the new plant are provided in Table 5.7-3.

Currently, the radiological impacts associated with radon-222 and technetium-99 releases are not addressed in Table S-3. Principal radon releases occur during mining and milling operations and as emissions from mill tailings, whereas principal technetium releases occur from gaseous diffusion enrichment facilities. The radon-222 releases and doses from mining and milling, operation, and from mill tailings were estimated in NUREG-1437 for each reactor year of operation of the reference 1000-MWe LWR. The major risks from radon-222 are from exposure to the bone and the lung, and there is a small risk from exposure to the whole body. The organ-specific dose weighting factors from 10 CFR Part 20 were applied to the bone and lung doses to determine the 100-yr dose commitment from radon-222 to the whole body. The population-dose commitments for these sources of radon-222 for mining and milling activities prior to tailings stabilization were also calculated in NUREG-1437. The estimated dose for the reference reactor year is 1.4 person-Sv (140 person-rem). This is scaled by the electric power rating for the new plant. The new plant scaled releases and doses are provided in Table 5.7-3.

NUREG-1437 also considers the potential health effects associated with the releases of technetium-99. The estimated releases of technetium-99 for the reference reactor year for the

1000 MWe LWR scaled model is 2.8E+08 becquerel (Bq) (0.007 curies [Ci]) from chemical processing of recycled UF_6 before it enters the isotope enrichment cascade and 1.9E+08 Bq (0.005 Ci) into the groundwater from a candidate high-level waste (HLW) repository. The major risks from technetium-99 are from exposure of the gastrointestinal tract and kidney. There is a small risk from exposure to the whole body. Applying the organ-specific dose weighting factors from 10 CFR Part 20 to the gastrointestinal tract and kidney doses, the total-body 100-yr dose commitment from technetium-99 was estimated to be 1 person-Sv (100 person-rem) for the 1000-MWe LWR scaled model. This is scaled by the electric power rating for the new plant. The new plant scaled releases and doses are provided in Table 5.7-3.

As stated in Section 5.7.1 of NUREG-1555, radiation may cause cancers at high doses and high dose rates. Currently there are no data that unequivocally establish the occurrence of cancer following exposure to low doses or low dose rates, below 100 millisieverts (mSv) (10,000 mrem). However, radiation protection experts conservatively assume that any amount of radiation may pose some risk of causing cancer or a severe hereditary effect and that the risk is higher for higher radiation exposures. Therefore, a linear, no-threshold dose response model is used to describe the relationship between radiation dose and detriments such as cancer induction. A report by the National Research Council (2006), the BEIR VII report (Reference 5.7-4), supports the linear, no-threshold dose response model. 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 overestimates those risks.

The radiological impacts associated with the new plant are provided in Table 5.7-3. Based on this model, risk to the public from the uranium fuel cycle can be estimated using the nominal probability coefficient for total detriment (730 fatal cancers, nonfatal cancers, or severe hereditary effects per 10,000 person-Sv [1.0E+06 person-rem]) from the International Commission on Radiation Protection (ICRP) Publication 60 and the estimated Total Effective Dose Equivalent (TEDE) from Table 5.7-3 (2327 person-rem/yr). These values yield approximately 1.7 fatal cancers, nonfatal cancers, or severe hereditary effects annually. This risk is small compared to the number of fatal cancers, nonfatal cancers or severe hereditary effects estimated to occur in the U. S. population annually from exposure to natural sources of radiation using the same risk estimation methods.

Based on these analyses, the environmental impacts of radioactive effluents from the fuel cycle are SMALL.

5.7.1.6 Radioactive Wastes

The quantities of buried radioactive waste material (low level, high level, and transuranic wastes) are specified in Table S-3. For low-level waste disposal at land burial facilities, the NRC indicates in Table S-3 that there are no significant radioactive releases to the environment. For high level and transuranic wastes, the NRC states that these are buried at a federal repository and that no release to the environment is associated with such disposal, although it has been assumed that all of the gaseous and volatile radionuclides contained in the spent fuel are released to the atmosphere before the disposal of the waste.

There is some uncertainty regarding the limits for off-site releases of radionuclides from the eventual repository site. Nevertheless, it is expected that future standards will be similar to the current post-closure individual protection standard in 10 CFR 63 Subpart L, *Postclosure Public Health and Environmental Standards*. This standard requires that the maximally exposed individual receive an annual dose of no more than 0.15 mSv (15 mrem) for 10,000 yr following disposal; and 1.0 mSv (100 mrem) after 10,000 yr, but within the period of geologic stability.

For the reasons stated above, the environmental impacts of waste disposal are SMALL.

5.7.1.7 Occupational Dose

As stated in Section 6.2.2.3 of NUREG-1437, the annual occupational dose for the reference 1000 MWe reactor attributable to all phases of the fuel cycle is 6 person-Sv (600 person-rem). The fuel cycle for the new plant is similar to the fuel cycle of the reference reactor and the annual occupational dose for all phases of the fuel cycle can be determined by normalizing the rated power of the new plant to the reference reactor. Using the scale factor of 2.77, the annual occupational dose for the fuel cycle for the new plant is 16.6 person-Sv (1660 person-rem). However, on a per MWe basis, the dose is the same. Doses will be less than the 10 CFR 20 limit of 0.05 Sv/yr (5 rem/yr) to any individual worker. The environmental impact from this occupational dose is SMALL.

5.7.1.8 Transportation

As indicated in NUREG 1555, the transportation dose to workers and the public totals 0.025 person-Sv (2.5 person-rem) annually for the reference 1000 MWe LWR per Table S-3. The scaled occupational dose for the new plant is provided in Table 5.7-1. For comparison, the estimated collective dose from natural background radiation to the population within 80 km (50 mi.) of the PSEG Site is 8312 person-Sv/yr (831,200 person-rem/yr). This is based on a 2010 population of 5,460,955, as shown in Table 2.5-7 of this ER, and an average individual dose of 152 mrem/yr in New Jersey (Reference 5.7-3). On the basis of this comparison, environmental impacts of transportation are SMALL.

5.7.1.9 Fuel Cycle

Only the no recycle option is considered here because the United States does not currently reprocess spent fuel. The data provided in Table S-3, however, includes the maximum recycle option impact for each element of the fuel cycle. The analysis of the uranium fuel cycle performed and the environmental impacts, as compared to Table S-3 impacts, are not affected by the specific fuel cycle selected.

5.7.1.10 Conclusion

Using an evaluation process specified in NUREG-1437, PSEG evaluated the environmental impacts of the uranium fuel cycle, considered the effects of radon-222 and technetium-99, and appropriately scaled the data for the new plant. Based on this evaluation, the environmental impacts of the uranium fuel cycle are SMALL.

5.7.2 TRANSPORTATION OF RADIOACTIVE MATERIALS

This subsection addresses the environmental impacts of incident-free transportation of radioactive materials from the PSEG Site and alternative sites. For the purposes of the evaluations in this subsection it is assumed that all shipments of fuel and radioactive waste are by truck.

The evaluations of the environmental impacts of incident-free transportation for the new plant are based on bounding information from the PPE. The reactor types considered are the ABWR (4300 megawatts thermal [MWt] version), AP1000, U.S. EPR, and US-APWR. A description of the development and intended use of the PPE is provided in Section 1.3 of the SSAR. Note that each of the reactor types was evaluated for the impacts of transportation of radioactive materials.

5.7.2.1 Transportation Assessment

The NRC evaluated the environmental effects of transportation of fuel and waste for light-water-cooled reactors in WASH-1238, *Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Plants* (Reference 5.7-10), and NUREG-75/038, *Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants, Supplement 1*, and found the impacts to be SMALL. These documents provided the basis for 10 CFR 51.52, *Environmental Effects of Transportation of Fuel and Waste -Table S-4*, that summarizes the environmental impacts of transportation of fuel and waste to and from one LWR of 3000 to 5000 MWt (1000 to 1500 MWe). Impacts are provided for normal conditions of transport and accidents in transport for a reference 1100 MWe LWR at an 80 percent capacity factor.

As stated in 10 CFR 51.52:

> "Under § 51.50, every environmental report prepared for the construction permit stage or early site permit stage or combined license stage of a light-water-cooled nuclear power reactor, and submitted after February 4, 1975, shall contain a statement concerning transportation of fuel and radioactive wastes to and from the reactor. That statement shall indicate that the reactor and this transportation either meet all of the conditions in paragraph (a) of this section or all of the conditions of paragraph (b) of this section."

10 CFR 51.52(a)(1) through (5) delineate specific conditions the reactor licensee must meet to use Table S-4 as part of its environmental report. For reactors not meeting all of the conditions in paragraph (a) of 10 CFR 51.52, paragraph (b) requires a further analysis of the transportation effects.

The technologies under consideration for the PSEG Site differ from some of the conditions of 10 CFR 51.52(a). Therefore, 10 CFR 51.52 (b) requires "… a full description and detailed analysis of the environmental effects of transportation of fuel and wastes to and from the reactor, including values for the environmental impact under normal conditions of transport and for the environmental risk from accidents in transport. The statement shall indicate that the values determined by the analysis represent the contribution of such effects to the environmental costs of licensing the reactor."

The parameters for each of the reactor technologies being considered are compared to the values in Table S-4, discussed in the following subsections and presented in Table 5.7-4. Table S-4 provides the environmental impact for "… one light-water-cooled nuclear powered reactor." A dual unit AP1000 is also being considered for the PSEG Site. A single unit AP1000 is evaluated for transportation impacts, to be consistent with the Table S-4 basis.

The detailed analyses required by 10 CFR 51.52 is performed using the TRAGIS (Reference 5.7-6) and RADTRAN (References 5.7-8 and 5.7-9) computer codes. The results of these analyses are summarized in Subsection 7.4.3. Input and output streams for these codes are contained in Appendix 7A.
Table 5.7-4 summarizes the characteristics of the reference reactor specified in 10 CFR 51.52 Table S-4, along with the characteristics of the reactor technologies under consideration.

5.7.2.1.1 Reactor Core Thermal Power

Subparagraph 10 CFR 51.52(a)(1) requires that the reactor core thermal power level not exceed 3800 MWt. The thermal power levels for all the reactors being considered for the PSEG Site exceed 3800 MWt, except for a single unit AP1000. Therefore, in accordance with 10 CFR 51.52(b), further analysis is provided in this subsection.

5.7.2.1.2 Fuel Form

Subparagraph 10 CFR 51.52(a)(2) requires that the reactor fuel be in the form of sintered UO_2 pellets. All of the technologies being considered for the new plant use a sintered UO_2 pellet fuel form.

5.7.2.1.3 Fuel Enrichment

Subparagraph 10 CFR 51.52(a)(2) requires that the reactor fuel have a U-235 enrichment not exceeding 4 percent by weight. The maximum fuel enrichment for new plant technologies exceeds 4 percent U-235 by weight, but is less than 5 percent by weight. Paragraph 10 CFR 51.52 (b) states that, for reactors not meeting the conditions of paragraph 51.52 (a), a full description and detailed analysis of the environmental effects of transportation of fuel and wastes to and from the reactor shall be provided. In accordance with 10 CFR 51.52(b), further analysis is provided in this subsection.

5.7.2.1.4 Fuel Encapsulation

Subparagraph 10 CFR 51.52(a)(2) requires that the reactor fuel pellets be encapsulated in zircaloy rods.

The AP1000 uses ZIRLO cladding. However, the requirement for zircaloy has been modified by 10 CFR 50.46 to allow the use of ZIRLO.

The U.S. EPR uses M5 cladding, which is not covered in 10 CFR 50.46. The NRC has approved the use of M5 cladding by approving Framatome ANP topical report BAW-10227P-A, *Evaluation of Advanced Cladding and Structural Material (M5) in PWR Reactor Fuel* (Reference 5.7-5).

5.7.2.1.5 Average Fuel Burnup

Subparagraph 10 CFR 51.52(a)(3) requires that the average burnup not exceed 33,000 MWd/MTU. The maximum burnup for new plant technologies exceeds 33,000 MWd/MTU. Paragraph 10 CFR 51.52 (b) states that, for reactors not meeting the conditions of paragraph 51.52 (a), a full description and detailed analysis of the environmental effects of transportation of fuel and wastes to and from the reactor shall be provided. In accordance with 10 CFR 51.52(b), further analysis is provided in this subsection.

5.7.2.1.6 Time after Discharge of Irradiated Fuel before Shipment

Subparagraph 10 CFR 51.52(a)(3) requires that no irradiated fuel assembly be shipped until at least 90 days after it is discharged from the reactor. Table S-4 assumes 150 days of decay time prior to shipment of any irradiated fuel assemblies. For the reactor technologies being considered, 5 yrs is the minimum decay time expected before shipment of irradiated fuel assemblies. The 5-yr minimum time is supported additionally by two current practices. One is per contract with DOE, which has ultimate responsibility for the spent fuel. Five yr is the minimum cooling time specified in 10 CFR 961, *Standard Contract for Disposal of Spent Nuclear Fuel and/or High-Level Radioactive Waste*, Appendix E. The other practice is that the NRC specifies 5 yrs as the minimum cooling period when they issue certificates of compliance for casks used for shipment of power reactor fuel. The new plant will have sufficient spent fuel storage capacity to ensure that irradiated fuel can be stored for at least 5 yr before being removed from the spent fuel pool. Therefore, the new plant technologies meet this condition.

5.7.2.1.7 Transportation of Unirradiated Fuel

Subparagraph 10 CFR 51.52(a)(5) requires that unirradiated fuel be shipped to the reactor site by truck. Unirradiated fuel shipments for the new plant will be by truck. Table S-4 includes a condition that the truck shipments not exceed 73,000 pounds (lb.) per truck as governed by federal or state gross vehicle weight restrictions. The unirradiated fuel shipments to the PSEG Site will comply with federal, state, and local weight restrictions.

5.7.2.1.8 Radioactive Waste Form and Packaging

As specified in paragraph 10 CFR 51.52(a)(4), with the exception of spent fuel, radioactive waste shipped from the reactor will be packaged and shipped in a solid form.

5.7.2.1.9 Transportation of Irradiated Fuel

Subparagraph 10 CFR 51.52(a)(5) allows for truck, rail, or barge transport of irradiated fuel. For the impact analysis described in Subsection 5.7.2, all irradiated fuel shipments are made using legal-weight trucks.

5.7.2.1.10 Transportation of Radioactive Waste

Subparagraph 10 CFR 51.52(a)(5) requires that the mode of transport of low-level radioactive waste be either truck or rail. For the impact analysis described in Subsection 5.7.2, it is assumed that all radioactive waste shipments will be made using legal-weight trucks. Radioactive waste will be shipped in compliance with federal, state, and local weight restrictions.

5.7.2.1.11 Number of Truck Shipments

As a method of limiting the environmental impact of transportation, Table S-4 limits traffic density to less than one truck shipment per day or three rail cars per month. The number of truck shipments required has been estimated assuming that all radioactive materials (fuel and waste) are received at the site or transported off-site via truck. The total number of truck shipments for the new plant is the sum of the unirradiated (new) fuel, irradiated (spent) fuel, and radwaste shipments.

A review of the unirradiated fuel shipment requirements for the technologies being considered indicates that the bounding case is the U.S. EPR with 7.5 shipments/yr. The annual unirradiated fuel shipment requirements are summarized in Table 5.7-5.

For the purposes of this evaluation, the annual quantity of irradiated fuel is assumed to be the same as the annual quantity of unirradiated fuel. Shipping cask capacity assumptions are based on current shipping cask designs. The irradiated fuel cask capacity is assumed to be 4000 lb. of uranium (1.8 MTU) consistent with NUREG-1811, *Environmental Impact Statement for an Early Site Permit (ESP) at the North Anna ESP Site*; NUREG-1815, *Environmental Impact Statement for an Early Site Permit (ESP) at the Exelon ESP Site*; and NUREG-1817, *Environmental Impact Statement for an Early Site Permit (ESP) at the Grand Gulf ESP Site*. The irradiated fuel shipments are summarized in Table 5.7-6. As shown in Table 5.7-6, the bounding case is 24.8 shipments/yr.

For the purposes of this evaluation, each radwaste container is assumed to be shipped separately, that is, one container per truck. The total number of radwaste containers is determined by assuming that dry active waste (DAW) is shipped in Sea-Land containers with an internal useable volume of 28.32 m^3 (1000 cubic feet [ft^3]), and all other waste (e.g., resins, filters, etc.) are shipped in high integrity containers (HICs) with a useable internal volume of 2.55 m^3 (90 ft^3). The annual new radwaste shipment requirements are summarized in Table 5.7-7. The annual truck shipment totals are summarized in Table 5.7-8.

5.7.2.1.12 Heat Load

In regards to the heat load, the US-APWR has the bounding value among the considered technologies. The heat load per irradiated fuel cask in transit for the US-APWR is 26,888 Btu/hr. This is less than the value of 250,000 Btu/hr given in Table S-4 of 10 CFR 51.52. Therefore, the heat load generated by the US-APWR fuel per spent fuel cask will not result in significant environmental effects during transit**.**

5.7.2.2 Incident-Free Transportation Impacts Analysis

Environment impacts of incident-free transportation of fuel are discussed in this subsection. Transportation accidents are discussed in Section 7.4.

5.7.2.2.1 Transportation of Unirradiated Fuel

Table S-4 of 10 CFR 51.52 includes conditions related to radiological doses to transport workers and members of the public along transport routes. These doses, based on calculations in WASH-1238 (Reference 5.7-10), are a function of the radiation dose rate emitted from the unirradiated fuel shipments, the number of exposed individuals and their locations relative to the shipment, the time of transit (including travel and stop times), and the number of shipments to which the individuals are exposed.

Calculation of worker and public doses associated with annual shipments of unirradiated fuel were performed using the TRAGIS (Reference 5.7-6) and RADTRAN (References 5.7-8 and 5.7-9) computer codes. One of the key assumptions in WASH-1238 (Reference 5.7-10) for the reference LWR unirradiated fuel shipments is that the radiation dose rate at 1 m (3.3 ft.) from the transport vehicle is 0.1 millirem/hr. This assumption is reasonable for the new plant technologies because the fuel materials will be low-dose rate enriched uranium and will be packaged similarly.

For unirradiated fuel shipments, highway routes are analyzed using the routing computer code TRAGIS (Reference 5.7-6). It is assumed that all unirradiated fuel shipments come from the fuel fabrication facility located in Richland, Washington (WA), which is the furthest from the PSEG Site. The commercial route setting was used to generate highway routes generally used by commercial trucks. The distance from the PSEG Site to Richland, WA is 2733 mi. The population summary module of the TRAGIS (Reference 5.7-6) computer code is used to determine the exposed populations within 800 m (2625 ft.) of either side of the route.

The per trip dose values are combined with the average annual number of shipments of unirradiated fuel to calculate annual doses to the public and workers for comparison to Table S-4 dose values. The number of shipments per year is obtained from Table 5.7-5. The results for the unirradiated fuel shipment based on the RADTRAN (References 5.7-8 and 5.7-9) analyses are provided in Table 5.7-9. The difference in incident-free consequences due to transporation of unirradiated fuel to the Alternative Sites is not significant due to the small differences in mileage between the Alternative Sites and the assumed fabrication facility.

5.7.2.2.2 Transportation of Irradiated Fuel

The environmental impacts of transporting spent fuel from the PSEG Site to a spent fuel disposal facility assume Yucca Mountain, Nevada (NV) as a possible location for a geologic repository. The impacts of the transportation of spent fuel to a possible repository in NV provides a reasonable determination of the transportation impacts to a monitored retrievable storage facility because of the distances involved and the representative exposure of members of the public in urban, suburban, and rural areas (NUREG-1811, NUREG-1815, NUREG-1817).

Incident-free transportation refers to transportation activities in which the shipments reach their destination without releasing any radioactive cargo to the environment. Impacts from these shipments are from the low levels of radiation that penetrate the heavily shielded spent fuel shipping cask. Radiation doses occur to the following:

- Persons residing along the transportation corridors between the PSEG Site and the proposed repository
- Persons in vehicles passing a spent fuel shipment
- Persons at vehicle stops for refueling, rest, and vehicle inspections
- Transportation crew workers

This analysis is based on shipment of spent fuel by legal-weight trucks in casks with characteristics similar to casks currently available (i.e., massive, heavily shielded, cylindrical metal pressure vessels). Each shipment is assumed to consist of a single shipping cask loaded on a modified trailer. These assumptions are consistent with assumptions made in evaluating environmental impacts of spent fuel transportation in Addendum 1 to NUREG-1437. As discussed in NUREG-1437, these assumptions are conservative because the alternative assumptions involve rail transportation or heavy-haul trucks that reduce the overall number of spent fuel shipments.

The transportation route selected for a shipment determines the total potentially exposed population and the expected frequency of transportation-related accidents. For truck transportation, the route characteristics most important to the risk assessment include the total shipping distance between each origin-destination pair of sites and the population density along the route.

For irradiated fuel, it is assumed that all irradiated fuel is sent to the site of the proposed Yucca Mountain repository. The distance from the PSEG Site to the proposed repository was determined to be 2780 mi. by the TRAGIS (Reference 5.7-6) computer code for a highway route-controlled quantity (HRCQ).

Routing and population data used in RADTRAN (References 5.7-8 and 5.7-9) for truck shipments are obtained from the TRAGIS (Reference 5.7-6) computer code. The population data in the TRAGIS (Reference 5.7-6) computer code is based on the 2000 U.S. census. All spent fuel shipments are transported by legal-weight trucks to the potential Yucca Mountain site over designated HRCQ routes.

Although shipping casks have not been designed for the advanced LWR fuels, the advanced LWR fuel designs are not significantly different from existing LWR designs. Current shipping cask designs are used for analysis.

The population doses are calculated by multiplying the number of spent fuel shipments per year by the per-shipment doses. The numbers of shipments per year are obtained from Table 5.7-6. The results for the irradiated fuel shipment based on the RADTRAN (References 5.7-8 and 5.7-9) analyses are provided in Table 5.7-10. The difference in incident-free consequences due to transporation of irradiated fuel from the Alternative Sites is not significant due to the small differences in mileage between the Alternative Sites in comparison to the distance of travel to the assumed repository.

5.7.2.2.3 Transportation of Radwaste

This subsection provides the environmental impacts of transporting radwaste from the PSEG Site to the repository in Barnwell, South Carolina (SC).

Incident-free transportation refers to transportation activities in which shipments reach their destination without releasing any radioactive cargo to the environment. Impacts from these shipments are from the low levels of radiation that penetrate the radwaste shipping containers. Radiation doses occur to the following:

- Persons residing along the transportation corridors between the PSEG Site and the proposed repository
- Persons in vehicles passing a radwaste shipment
- Persons at vehicle stops for refueling, rest, and vehicle inspections
- Transportation crew workers

This analysis is based on shipment of radwaste by legal-weight trucks in either sea-land containers or HICs similar to those currently available. Each shipment is assumed to consist of a single shipping container.

The transportation route selected for a shipment determines the total potentially exposed population and the expected frequency of transportation-related accidents. For truck transportation, the route characteristics most important to the risk assessment include the total shipping distance between each origin-destination pair of sites and the population density along the route.

For radwaste, because NJ is a member of the Northeast Interstate Low-Level Radioactive Waste Compact, the repository for the PSEG Site is Barnwell, SC. The route was determined by the TRAGIS (Reference 5.7-6) computer code to be 689 mi. for a commercial truck.

Routing and population data used in RADTRAN (References 5.7-8 and 5.7-9) for truck shipments are obtained from the TRAGIS (Reference 5.7-6) computer code. The population data in the TRAGIS (Reference 5.7-6) computer code is based on the 2000 U.S. census. All radwaste shipments are transported by legal-weight trucks to the Barnwell, SC site over commercial truck routes.

The population doses are calculated by multiplying the number of radwaste shipments per year by the per-shipment doses. The numbers of shipments per year are identified in Table 5.7-7. The results for the radwaste shipment based on the RADTRAN (References 5.7-8 and 5.7-9) analyses are provided in Table 5.7-11. The difference in incident-free consequences due to transporation of radwaste from the Alternative Sites is not significant due to the small differences in mileage between the Alternative Sites and the assumed radwaste repository.

5.7.2.3 Comparison to 10 CFR 51.52 Table S-4

For an equal comparison to the reference reactor in 10 CFR 51.52 Table S-4, the number of shipments in Table 5.7-8 for each of the reactor technologies being considered must be normalized. For each technology, the number of shipments is normalized based on net electric generation (see Table 5.7-4) relative to the 1100 MWe and 80 percent capacity factor reference reactor analyzed in WASH-1238 (Reference 5.7-10). Additionally, the unirradiated fuel shipments are adjusted to account for the initial core loading in the annual number of shipments for each reactor technology. The spent fuel shipments are scaled to reflect the capacity of 0.5 MTU/container used for the reference reactor. The radwaste shipments are scaled to reflect a capacity of 82.6 ft^3/shipment (2.34 m^3/shipment) for high activity waste used for the reference reactor. The DAW shipments reflect a capacity of 28.32 m^3/shipment. This container size is based on a 20 ft. SEALAND container. The resulting annual truck shipments normalized to the reference reactor are summarized in Table 5.7-13.

The incident-free consequences are determined based on the normalized number of shipments for each reactor technology. The doses per shipment for unirradiated fuel, irradiated fuel, and radwaste are indicated in Tables 5.7-9, 5.7-10, and 5.7-11, respectively. The summary of the incident-free doses are shown in Table 5.7-14.

5.7.2.4 Conclusion

A detailed analysis of the environmental impacts for the transportation of unirradiated fuel, irradiated fuel, and radioactive waste transported to and from the PSEG Site is performed in accordance with 10 CFR 51.52(b). An evaluation of the environmental impact due to transportation of unirradiated fuel, irradiated fuel, and radwaste at Alternative Sites 7-1, 7-2, 7-3, and 4-1 indicates that the alternative sites are not obviously superior to the PSEG Site.

The new plant has sufficient fuel pool storage capacity to enable a minimum cooling period of five years. At this time, it is assumed that there is sufficient storage capacity to permit irradiated fuel to cool sufficiently to meet the requirements of shipping casks available at the time the fuel is shipped. The analysis assumed all shipments are by truck. The shipping weight complies with federal, state, local, and tribal government restrictions as appropriate. The total number of shipments for the bounding plant, as outlined in Table 5.7-13, is 74.3 per year or 0.2 per day which meets the Table S-4 requirement of less than one per day. The radiological effects of incident-free conditions of transport are summarized in Table 5.7-14. The radiological effects of accidents in transport are provided in Section 7.4. The values determined by these analyses represent the contribution of such effects to the environmental costs of licensing the reactor.

The population doses to the transport crew and onlookers resulting from the new plant normalized to the reference reactor exceed Table S-4 values. Three key reasons for these higher population doses relative to Table S-4 are the shipping distances assumed for these analyses relative to the assumptions used in WASH-1238 (Reference 5.7-10), the use of the maximum dose rate in the RADTRAN (References 5.7-8 and 5.7-9) calculations, and the use of 30 minutes as the average time for a truck stop in the calculations.

- The analyses in WASH-1238 (Reference 5.7-10) used a typical distance for a spent fuel shipment of 1000 mi. The shipping distances used in this assessment range from 689 mi. to 2733 miles

- The shipping casks assumed in the Yucca Mountain Environmental Impact Statement (Reference 5.7-7) transportation analyses are designed for spent fuel that has cooled for 5 yr. In reality, most spent fuel has cooled for much longer than 5 yr before it is shipped to a possible geologic repository. NRC developed a probabilistic distribution of dose rates based on fuel cooling times that indicates that approximately three-fourths of the spent fuel to be transported to a possible geologic repository has dose rates less than half of the regulatory limit (Reference 5.7-11)

- Use of 30 minutes as the average time at a truck stop in the calculations. Most of the stops made for actual spent fuel shipments are short duration stops (i.e., 10 minutes) for brief visual inspections of the cargo (checking the cask tie-downs). These stops typically occur in minimally populated areas, such as an overpass or freeway ramp in an unpopulated area

The NRC concluded in NUREG-1815 that the use of more realistic dose rates and truck shipping conditions in RADTRAN (References 5.7-8 and 5.7-9) calculations substantially reduce the environmental effects of normal conditions of transport.

Based on the analyses and above discussion, the environmental impacts of transportation during the fuel cycle are SMALL.

5.7.3 REFERENCES

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5.7-3 Mauro, J. and N.M. Briggs, “Assessment of Variations in Radiation Exposure in the United States,” Prepared for U. S. Environmental Protection Agency Office of Radiation and Indoor Air Quality, July 15, 2005

5.7-4 National Research Council. 2006. *Health Risks from Exposure to Low Levels of Ionizing Radiation: BEIR VII - Phase 2*. Committee to Assess Health Risks from Exposure to Low Levels of Ionizing Radiation, National Research Council, National Academy Press, Washington, D.C.

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5.7-6 Oak Ridge National Laboratory, P. Johnson, and R. Michelhaugh, “Transportation Routing Analysis Geographic Information System (TRAGIS) User’s Manual,” ORNL/NTRC-006, 2003.

5.7-7 Office of Civilian Radioactive Waste Management, USDOE, Washington, D.C., “Final Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada,” USDOE/EIS-0250.

5.7-8 Sandia National Laboratories, K. S. Neuhauser, F.L. Kanipe and R. F. Weiner, “RADTRAN 5,” SAND2000-1256, 2000.

5.7-9 Sandia National Laboratories, R. Weiner, D. Osborn, G. Mills, D. Hinojosa, T. Heames and D. Orcutt, “RADCAT 2.3 User Guide,” SAND2006-6315, 2006.

5.7-10 U.S. Atomic Energy Commission, Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants, WASH-1238, U.S. Atomic Energy Commission, Washington, D.C., December 1972.

5.7-11 U.S. Nuclear Regulatory Commission, Washington, D.C., Sprung, J.L., D.J. Ammerman, N.L. Breivik, R.J. Dukart, F.L. Kanipe, J.A. Koski, G.S. Mills, K.S. Neuhauser, H.D. Radloff, R.F. Weiner and H.R. Yoshimura, “Reexamination of Spent Fuel Shipment Risk Estimates,” NUREG/CR-6672, 2000.

Table 5.7-1 (Sheet 1 of 3)
Uranium Fuel Cycle Data[(a)]

Parameter	Reference LWR Table S-3	New Plant Bounding Value
MWe	1000	2300[(g)]
Capacity Factor	0.80	0.963
MWe (Net)	800	2215
Scale Factor[(b)]	1.00	2.77
Environmental Considerations		
Land (Acres)		
Temporarily committed[(c)]	100	277
Undisturbed area	79	219
Disturbed area	22	61
Permanently committed	13	36
Overburden moved (millions of MT)	2.8	7.8
Water (millions of gallons)		
Discharged to air	160	443
Discharged to water bodies	11,090	30,719
Discharged to ground	127	352
Total	11,377	31,514
Electrical energy (thousands of MW-hour)	323	895
Equivalent coal (thousands of MT)	118	327
(Estimated CO_2, thousands of U.S. tons)	(381)	(1055)
Natural gas (millions of scf)	135	374
(Estimated CO_2, thousands of U.S. tons)	(8.25)	(22.9)
Effluents-Chemical (MT)		
SO_x	4400	12,188
NO_x[(d)]	1190	3296
Hydrocarbons	14	39
CO	29.6	82.0
Particulates	1154	3197
F	0.67	1.86
HCl	0.014	0.039
SO_4-	9.9	27.4
NO_3-	25.8	71.5
Fluoride	12.9	35.7
Ca^{++}	5.4	15.0
Cl^-	8.5	23.5
Na^+	12.1	33.5
NH_3	10.0	27.7
Fe	0.4	1.1
Tailings solutions (thousands of MT)	240	665
Solids	91,000	252,070
Effluents-Radiological (Curies)		
Rn-222[(e)]	Note (e)	Note (e)
Ra-226	0.02	0.06
Th-230	0.02	0.06

Table 5.7-1 (Sheet 2 of 3)
Uranium Fuel Cycle Data[(a)]

Parameter	Reference LWR Table S-3	New Plant Bounding Value
Uranium	0.034	0.094
Tritium (thousands)	18.1	50.1
C-14	24	66
Kr-85 (thousands)	400	1108
Ru-106	0.14	0.39
I-129	1.3	3.6
I-131	0.83	2.30
Tc-99[(e)]	Note (e)	Note (e)
Fission products and TRU[(f)]	0.203	0.562
Liquids:		
Uranium and daughters	2.1	5.8
Ra-226	0.0034	0.0094
Th-230	0.0015	0.0042
Th-234	0.01	0.03
Fission and activation products	5.9E-06	1.6E-05
Solids (buried on site):		
Other than HLW[(f)] (shallow)	11,300	31,301
TRU[(f)] and HLW[(f)] (deep)	1.1E+07	3.1E+07
Effluents – thermal (billions of Btu)	4063	11,255
Transportation (person-rem)		
Exposure of workers and general public	2.5	6.9
Occupational exposure	22.6	62.6

Notes:

a) In some cases where no entry appears in NRC Table S-3 it is clear from the background documents that the matter was addressed and that, in effect, the table should be read as if a specific zero entry had been made. However, there are other areas that are not addressed at all in the table. NRC Table S-3 does not include health effects from the effluents described in the table, or estimates of releases of radon-222 from the uranium fuel cycle or estimates of technetium-99 released from waste management or reprocessing activities. Radiological impacts of these two radionuclides are addressed in NUREG-1437, “Generic Environmental Impact Statement for License Renewal of Nuclear Plants,” dated May 1996, and it was concluded that the health effects from these two radionuclides posed a small risk.

Data supporting this table are given in the “Environmental Survey of the Uranium Fuel Cycle," WASH-1248, April 1974; the "Environmental Survey of Reprocessing and Waste Management Portion of the LWR Fuel Cycle," NUREG-0116 (Supp. 1 to WASH-1248); the "Public Comments and Task Force Responses Regarding the Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle," NUREG-0216 (Supp. 2 to WASH-1248); and in the record of final rulemaking pertaining to Uranium Fuel Cycle Impacts from Spent Fuel

Table 5.7-1 (Sheet 3 of 3)
Uranium Fuel Cycle Data[(a)]

Reprocessing and Radioactive Waste Management, Docket RM-50-3. The contributions from reprocessing, waste management, and transportation of wastes are maximized for either of the two fuel cycles (uranium only and fuel recycle). The contribution from transportation excludes transportation of cold fuel to a reactor and of irradiated fuel and radioactive wastes from a reactor which are considered in Table S-4 of § 51.20(g). The contributions from the other steps of the fuel cycle are given in columns A-E of Table S-3A of WASH-1248.

b) The Scale Factor is the net MWe of the bounding new plant (Dual Unit AP1000) divided by the net MWe of the Table S-3 reference LWR rounded to the nearest hundredth decimal place.

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

d) 1.2 percent from natural gas use and process.

e) Radiological impacts of radon-222 and technetium-99 are addressed in NUREG-1437. The Generic Environmental Impact Statement concluded that the health effects from these two radionuclides pose a small risk.

f) TRU means transuranic; HLW means high level waste.

g) The value of 2300 MWe is based on the rating identified for a dual unit AP1000 reactor in NUREG-1815, Appendix G.

Table 5.7-2
Annual Fuel Cycle Uranium Requirements

Parameter	Table S-4 Reference LWR	New Plant Bounding Value[(b)]
Annual Fuel Load (MTU)	35	48.8
Scale Factor	1.00	1.39
Annual Ore supply		
(MT)	272,000	378,000
(kg)	272,000,000	378,000,000
(lb)[a]	600,000,000	834,000,000
Annual Yellowcake, U_3O_8		
(MT)	293	407
(kg)	293,000	407,000
(lb)[a]	646,000	898,000
Annual UF_6		
(MT)	360	500
(kg)	360,000	500,000
(lb)[a]	794,000	1,100,000
Enriched UF_6		
(MT)	52.0	72.3
(kg)	52,000	72,300
(lb)[a]	115,000	160,000
Annual SWU		
(MT)	127	177
(kg)	127,000	177,000
(lb)[a]	280,000	389,000
Enriched UO_2		
(MT)	40.0	55.6
(kg)	40,000	55,600
(lb)[a]	88,200	123,000

Notes:

a) Conversion: kg to lb = 2.2046200
b) New Plant Bounding Value column values obtained by using the scale factor of the bounding new plant (Dual AP1000) annual fuel load divided by the reference LWR fuel load.

Table 5.7-3
Total Effective Dose Equivalent from Uranium Mining and Milling

Parameter	Reference LWR	New Plant Bounding Value
MWe	1000	2300
Capacity Factor	0.80	0.963
MWe (Net)	800	2215
Scale Factor[(a)]	1.00	2.77
Rn-222 (Ci/yr)	5191	14,379
Tc-99 (Ci/yr)	0.012	0.033
100 yr Dose Commitment		
Rn-222 (person-rem)	140	388
Tc-99 (person-rem)	100	277
Gaseous effluents excluding Rn-222 and reactor operation (person-rem)	400	1108
Liquid effluents excluding reactor operations (person-rem)	200	554
Total 100 yr dose commitment (person-rem)	840	2327

a) The Scale Factor is the net MWe of the bounding new plant (Dual Unit AP1000) divided by the net MWe of the reference LWR.

Table 5.7-4
10 CFR 51.52 Table S-4 Conditions and Reactor Technologies Attributes

10 CFR 51.52 Condition	Parameter	10 CFR 51.52 Table S-4	ABWR	AP1000	U.S. EPR	US-APWR
(a)(1)	Power Level (MWt)	3800	4300	3400	4590	4451
(a)(2)	Fuel Form	Sintered UO_2 Pellets	Sintered UO_2 Pellets	Sintered UO_2 Pellets	Sintered UO_2 Pellets	Sintered UO_2 Pellets
(a)(2)	Maximum Enrichment (wt%)	4	4.9	4.95	4.95	<5
(a)(2)	Clad	Zircaloy	Zircaloy-2	Zirlo	M5	Zirlo
(a)(3)	Burnup (MWd/MTU)	33,000	52,000	48,700	54,000	54,200
	Peak Rod Burnup		62,000	62,000	62,000	62,000
(a)(3)	Cooling Period	90 Days	5 years	5 years	5 years	5 years
(a)(4)	All radioactive waste is shipped in solid form	All radioactive waste is shipped in solid form	All radioactive waste is shipped in solid form	All radioactive waste is shipped in solid form	All radioactive waste is shipped in solid form	All radioactive waste is shipped in solid form
(a)(5)	Shipment Mode (Unirradiated Fuel, Irradiated Fuel, Radioactive Waste)	Truck	Truck	Truck	Truck	Truck
N/A	Electric Generation (MWe)	1000	1500	1150	1600	1600
N/A	Annual Fuel Load (MTU)	35.0	44.7	24.4	37.5	35.0
N/A	Radwaste Volume m^3/yr (ft^3/yr)	108 (3814)	165.0 (5827)	55.6 (1964)	187.4 (6618)	432.6 (15,277)
N/A	Radwaste Activity MBq/yr (Ci/yr)	N/A	7.10E+08 (19,186)	6.77E+07 (1830)	7.40E+07 (2000)	4.37E+10 (1.18E+06)
N/A	Heat load per irradiated fuel cask in transit (Btu/hr)	250,000	<26,888	8,330	18,600	26,888

Table 5.7-5
New Fuel Shipment Data

ABWR		AP1000		U.S. EPR		US-APWR	
Annual Reload Quantity (MTU)	Annual Number of Shipments	Annual Reload Quantity (MTU)	Annual Number of Shipments	Annual Reload Quantity (MTU)	Annual Number of Shipments	Annual Reload Quantity (MTU)	Annual Number of Shipments
44.7	6.1	24.4	3.8	37.5	7.5	35.0	5.3

Table 5.7-6
Irradiated Fuel Shipment Data

Cask	ABWR		AP1000		U. S. EPR		US-APWR	
Capacity (MTU)	Annual Reload Quantity (MTU)	Annual Number of Shipments	Annual Reload Quantity (MTU)	Annual Number of Shipments	Annual Reload Quantity (MTU)	Annual Number of Shipments	Annual Reload Quantity (MTU)	Annual Number of Shipments
1.8	44.7	24.8	24.4	13.6	37.5	20.8	35.0	19.4

Table 5.7-7
Radwaste Shipment Data

Waste Type	**Container Type**		**ABWR**			**AP1000**			**U. S. EPR**			**US-APWR**		
Waste Type	Internal Volume (m^3)	Containers per Truck	Waste Volume (m^3)	Number of Containers	Number of Shipments	Waste Volume (m^3)	Number of Containers	Number of Shipments	Waste Volume (m^3)	Number of Containers	Number of Shipments	Waste Volume (m^3)	Number of Containers	Number of Shipments
Spent Resin, Evaporator Concentrates, etc.	2.55	1	10.0	3.9	3.9	15.5	6.1	6.1	10.7	4.2	4.2	15.3	6.0	6.0
Filters	2.55	1				1.0	0.4	0.4	3.4	1.3	1.3	1.9	0.7	0.7
Sludge	2.55	1	40.0	15.7	15.7			0.0	1.2	0.5	0.5	1.2	0.5	0.5
DAW	28.32	1	115.0	4.1	4.1	39.1	1.4	1.4	172.1	6.1	6.1	414.3	14.6	14.6
Total			165.0	23.7	23.7	55.6	7.9	7.9	187.4	12.1	12.1	432.7	21.8	21.8

Table 5.7-8
Annual Shipment Summary

	ABWR	AP1000	U.S. EPR	US-APWR
	Shipments per year	Shipments per year	Shipments per year	Shipments per year
New Fuel	6.1	3.8	7.5	5.3
Spent Fuel	24.8	13.6	20.8	19.4
Radwaste	23.7	7.9	12.1	21.8
Total	54.6	25.3	40.4	46.5

Table 5.7-9
Unirradiated (New) Fuel Shipment Cumulative Dose

Exposed Population	Dose per Shipment (person-Sv)	ABWR		AP1000		U.S. EPR		US-APWR	
		Shipments per Year	Dose per Year (person-Sv)	Shipments per Year	Dose per Year (person-Sv)	Shipments per Year	Dose per Year (person-Sv)	Shipments per Year	Dose per Year (person-Sv)
Transportation Workers	1.44E-05	6.1	8.78E-05	3.8	5.47E-05	7.5	1.08E-04	5.3	7.63E-05
General Public									
Transit	4.90E-06	6.1	2.99E-05	3.8	1.86E.05	7.5	3.68E-05	5.3	2.60E-05
Stops	2.92E-05	6.1	1.78E-04	3.8	1.11E-04	7.5	2.19E-04	5.3	1.55E-04
Total	3.41E-05		2.08E-04		1.30E-04		2.56E-04		1.81E-04

Table 5.7-10
Irradiated Fuel Shipment Cumulative Dose

Exposed Population	Dose per Shipment (person-Sv)	ABWR		AP1000		U.S. EPR		US-APWR	
		Shipments per Year	Dose per Year (person-Sv)	Shipments per Year	Dose per Year (person-Sv)	Shipments per Year	Dose per Year (person-Sv)	Shipments per Year	Dose per Year (person-Sv)
Transportation Workers	1.98E-03	24.8	4.92E-02	13.6	2.68E-02	20.8	4.13E-02	19.4	3.85E-02
General Public									
Transit	4.68E-04	24.8	1.16E-02	13.6	6.34E-03	20.8	9.75E-03	19.4	9.10E-03
Stops	3.79E-03	24.8	9.41E-02	13.6	5.14E-02	20.8	7.90E-02	19.4	7.37E-02
Total	4.26E-03		1.06E-01		5.77E-02		8.87E-02		8.28E-02

Table 5.7-11
Radwaste Shipment Cumulative Dose

Exposed Population	Dose per Shipment (person-Sv)	ABWR		AP1000		U.S. EPR		US-APWR	
		Shipments per Year	Dose per Year (person-Sv)	Shipments per Year	Dose per Year (person-Sv)	Shipments per Year	Dose per Year (person-Sv)	Shipments per Year	Dose per Year (person-Sv)
Transportation Workers	4.91E-04	23.7	1.16E-02	7.9	3.85E-03	12.1	5.93E-03	21.8	1.07E-02
General Public									
Transit	1.72E-04	23.7	4.06E-03	7.9	1.35E-03	12.1	2.07E-03	21.8	3.75E-03
Stops	9.47E-04	23.7	2.24E-02	7.9	7.44E-03	12.1	1.14E-02	21.8	2.07E-02
Total	1.12E-03		2.65E-02		8.78E-03		1.35E-02		2.44E-02

Table 5.7-12
Total Shipment Cumulative Dose Summary

Exposed Population	ABWR	AP1000	U.S. EPR	US-APWR
	Dose per Year person-Sv (person-rem)	Dose per Year person-Sv (person-rem)	Dose per Year person-Sv (person-rem)	Dose per Year person-Sv (person-rem)
Transportation Workers	6.09E-02[(a)] (6.09E+00)	3.07E-02 (3.07E+00)	4.75E-02 (4.75E+00)	4.92E-02 (4.92E+00)
General Public				
Transit	1.57E-02 (1.57E+00)	7.71E-03 (7.71E-01)	1.19E-02 (1.19E+00)	1.29E-02 (1.29E+00)
Stops	1.17E-01 (1.17E+01)	5.89E-02 (5.89E+00)	9.06E-02 (9.06+00)	9.44E-02 (9.44E+00)
Total	1.32E-01[(a)] (1.32E+01)	6.66E-02 (6.66E+00)	1.02E-01 (1.02E+01)	1.07E-01 (1.07E+01)

1 person-Sv = 100 person-rem

a) Bounding Value

Table 5.7-13
Annual Normalized Shipment Summary

Shipments/year	Reference LWR	Normalized ABWR	Normalized AP1000	Normalized U.S. EPR	Normalized US-APWR
New Fuel	6	4.3	3.5	4.9	3.5
Spent Fuel	60	54.5	39.0	42.7	39.8
Radwaste	46	15.5	6.7	7.2	12.8
Total	112	74.3	49.2	54.8	56.1

Table 5.7-14
Total Normalized Shipment Cumulative Dose Summary

		ABWR	AP1000	U.S. EPR	US-APWR
Exposed Population	10 CFR 51.52 Table S-4 person-Sv (person-rem)[a]	Dose per Year person-Sv (person-rem)	Dose per Year person-Sv (person-rem)	Dose per Year person-Sv (person-rem)	Dose per Year person-Sv (person-rem)
Transportation Workers	4.0E-02 (4.0E+00)	1.16E-01[b] (1.16E+01)	8.05E-02 (8.05E+00)	8.81E-02 (8.81E+00)	8.51E-02 (8.51E+00)
General Public					
Transit		2.82E-02 (2.82E+00)	1.95E-02 (1.95E+00)	2.13E-02 (2.13E+00)	2.08E-02 (2.08E+00)
Stops		2.22E-01 (2.22E+01)	1.54E-01 (1.54E+01)	1.69E-01 (1.69E+01)	1.63E-01 (1.63E+01)
Total	3.0E-02 (3.0E+00)	2.50E-01[b] (2.50E+01)	1.74E-01 (1.74E+01)	1.90E-01 (1.90E+01)	1.84E-01 (1.84E+01)

a) 1 person-Sv = 100 person-rem
b) Bounding Value

5.8 SOCIOECONOMIC IMPACTS

The socioeconomic impacts of plant operation within the 50-mi. region surrounding the PSEG Site and Region of Influence (Cumberland, Gloucester, and Salem counties in NJ, and New Castle County in DE) are addressed in this section. An assessment of potential impacts to the economic bases, political tax jurisdictions, housing, education, recreation, tax structure, land use, community infrastructure, and transportation of these geographic areas during operation of the new plant is included. The new plant at the PSEG Site requires a day-to-day operational workforce of 600 employees (SSAR Table 1.3-1, Item 17.5.1). An additional 1000 workers are on-site every 18 or 24 months for refueling operations (SSAR Table 1.3-1, Items 17.5.2, 17.7). Most of the new operational and temporary refueling outage employees come from within a 50-mi. radius of the new plant. The operation of the new plant generates additional income, jobs, taxes, and sales within the Region of Influence and 50-mi. region which may create additional demands on services in these areas. This section assesses the impacts of these economic inputs and demands to the 50-mi. region and Region of Influence, and, if necessary, identifies appropriate mitigation measures.

5.8.1 PHYSICAL IMPACTS OF PLANT OPERATION

This subsection addresses the direct physical impacts of plant operation on the communities within the vicinity of the PSEG Site. Direct physical impacts include the effects from noise, air and thermal emissions, and visual intrusion. These physical impacts are evaluated for their effects on local communities, buildings, recreational facilities, roads and the local viewscape. This evaluation indicates the magnitude of potential impacts and whether mitigation measures are required.

The design of the new plant includes a closed-cycle cooling system that consists of either mechanical or natural draft cooling towers (NDCT) (Subsection 3.4.2). Although a specific reactor technology has not been selected, two NDCTs are used as the bounding condition for this assessment. The NDCTs are taller than mechanical draft cooling towers (590 ft. versus approximately 46 ft., respectively) (SSAR Table 1.3-1 Items 2.5.20 and 2.4.20, Table 3.4-2). Consequently, far-field air quality effects evaluated in this subsection are greater with NDCTs and is bounding as to the highest potential for impacts to local community and regional resources.

5.8.1.1 Plant Layout

The new plant is located adjacent to the site of the existing HCGS and SGS. The site is remote from regional population centers (Subsection 2.5.1). As described in Section 2.1, the nearest residences in DE and NJ are 2.8 mi. away to the west in DE, and 3.4 mi. to the east-northeast in NJ. The nearest community is Hancocks Bridge, NJ, which is 4.8 mi. to the east of the new plant (Subsection 4.4.1). The new plant is bounded by the HCGS and SGS on the south, the Delaware River on the west, and the Delaware River and coastal marsh to the north and east. The NDCTs are the tallest structures on the PSEG Site and are located north of the power block. The tallest power block building of the new plant is 234 ft. (Subsection 3.1.2). A general layout based on a combined area footprint for the four reactor technologies is shown in the Site Utilization Plan described in Section 3.1 (Figure 3.1-2).

5.8.1.2 Distribution of Community Population, Buildings, Roads and Recreational Facilities

The total projected 2010 populations (resident and transient) within 3 and 5 mi. of the PSEG Site are 82 and 2311 people, respectively (Tables 2.5-3 and 2.5-5). As indicated in previous sections, the nearest residents are located in an unnamed community adjacent to Bayview Beach, DE (2.8 mi. to the west). The largest population center near the new plant is Salem City, NJ (estimated 2007 population of 5678) (Table 2.5-4), which is 7-1/2 mi. to the northeast. Population distributions for residential and transient populations for 2000 to 2081, within each of 16 sectors within a 10-mi. radius of the PSEG Site are shown on Table 2.5-7.

There are no business, commercial, school, or other buildings located within 5 mi. of the PSEG Site (Reference 5.8-1). The closest school is Elsinboro Township Elementary School which is located 5.4 mi. to the north-northeast (Table 2.5-11).

Figure 2.2-6 identifies major roads and highways in the 50-mi. region, and Figure 2.5-7 depicts the NJ state and county highways in the proximity of the PSEG Site. The HCGS and SGS have an access road to the east of the site that is connected to Alloway Creek Neck Road, which in turn connects to Locust Island Road in Hancocks Bridge. The new plant has a proposed separate access causeway connecting with local roads to provide access to NJ Route 49 and NJ Route 45. The new plant also has direct access to the Delaware River via a barge unloading facility. As stated in Subsection 2.2.1.2, the nearest operating rail line is 8.2 mi. to the north-northeast of the new plant center point.

Construction traffic on local roads may have adverse impacts to the level of service (LOS) at several intersections in and around Salem City (Table 4.4-2). Based on the traffic impact analysis conducted in 2009, a number of improvements to mitigate impacts to LOS as a result of increased traffic volume during construction are under consideration (Subsection 4.4.1). The traffic impact analysis shows that installation of traffic controls, signal lights and additional turn lanes at some of the impacted intersections improves the LOS to projected preconstruction levels (Table 4.4-2). The impacts from construction traffic are higher because the peak traffic volume during construction is approximately 2200 cars to and from the plant site as compared to approximately 1200 cars during operation and refueling outages (Reference 5.8-1). Improvements in LOS shown for some of the recommended mitigation measures, and reduced levels of operations-related traffic result in no additional adverse impacts on LOS. It is anticipated that LOS at these intersections will improve, because the intersections are upgraded to handle the higher construction traffic volumes.

The mitigation measures used to offset the construction impacts (Subsection 4.4.1.5) are sufficient to offset operational impacts to LOS, and therefore impacts to local roads are SMALL.

The primary recreational areas in DE that are within 5 mi. of the new plant are the Augustine Beach Boat Ramp (3.1 mi. to the northwest), Augustine WMA (3.6 mi. to the north-northwest), Port Penn Interpretive Center (3.7 mi. to the northwest), and Cedar Swamp WMA (4.1 mi. to the southwest). Abbott Meadows WMA (4 mi. to the north-northeast) and Mad Horse Creek WMA (just to the east of the new plant site) are the closest recreational lands in NJ (Figure 2.5-5). The main public access to Mad Horse Creek WMA is 7 mi. to the east-southeast of the PSEG Site (Table 2.5-13). Therefore, public use of this WMA near the PSEG Site is limited. The three recreation areas in DE are located on the west side of the Delaware River across from the PSEG Site. Therefore, impacts to recreational areas are SMALL and no mitigation is required.

5.8.1.3 Noise

The principal noise sources associated with operation of the new plant are the switchyard, transformers, and cooling towers. Fan-assisted natural draft, mechanical draft, and NDCTs are all being considered. The bounding noise level for operational noise emissions is associated with the fan assisted NDCTs. The estimated noise emission for this type of cooling tower is 60 dBA at 1000 ft. (SSAR Table 1.3-1, Items 2.6.10), whereas the estimated noise emission for the mechanical and NDCTs are 58 dBA and 50 dBA at 1000 ft., respectively (SSAR Table 1.3-1, Items 2.4.10 and 2.5.10).

A 2009 baseline noise survey indicates that the noise from sources at the existing plant attenuate to levels that meet the State of NJ and DE standards of 65 dBA (A-weighted decibels) for daytime at the PSEG Site property boundaries. As described in Subsection 4.4.1, Section NJAC 7:29 provides regulatory limitations for continuous noise levels at the residential property line from industrial, commercial, public service, or community service facilities. For continuous noise sources, the limit is 65 A-weighted decibels (dBA) at the property line of industrial facilities, and 65 dBA during the day and 50 dBA during the night at residential property lines. The similar DE limits (Part VII, Title 7, Chapter 71 of the Delaware Code) provide for a protective level of 65 dBA during the day and 55 dBA during the night for residential receptors.

The fan-assisted NDCT is a continuous noise source during plant operation. Based on the natural attenuation of noise levels over distance noise levels for both the fan-assisted natural draft and natural draft cooling towers are estimated at a distance of 10,000 ft. The closest residences are 14,700 ft. to the west and 15,900 ft. east of these boundaries. Noise from on-site sources attenuates to levels that will meet the NJ nighttime noise level standards at the property boundary of the nearest residence. For example, a NDCT with a noise emission level of 50 dBA at 1000 ft. has a noise level of 31 dBA 10,000 ft. from the source, and a fan-assisted NDCT with a noise emission level of 60 dBA at 1000 ft has a noise level of 41 dBA at 10,000 ft. Thus, the impact of noise from operation of the new plant on nearby residences is SMALL.

Traffic associated with the plant workforce traveling to and from the PSEG Site also generates noise. The increase in noise relative to background conditions is most noticeable during the shift changes in the morning and afternoon. The 600 additional employees work in shifts, with the largest shift working during the day. Posted speed limits and existing and proposed traffic controls diminish traffic noise during the weekday business hours. The potential noise impacts to the community, therefore, are intermittent and limited primarily to shift changes. Thus, the impact from noise from operations-related traffic to nearby residences and recreational areas is SMALL.

Potential indirect impacts to off-site areas are associated with the roadway network and adjacent residences and lands beyond the terminus of the causeway. Noise related impacts result from an increased traffic volume and resultant increases in traffic generated noise as discussed above. Noise levels during shift changes in these off-site areas increase, as these residences are currently located within a roadway network that is characterized by low traffic volumes and low traffic noise levels. Within off-site areas, distances of residential receptors to existing roadways range from approximately 25 ft. within the urban areas of Salem and Hancocks Bridge to approximately 990 ft. in the more rural areas of Elsinboro and Lower Alloways Creek townships, with a mean of 396 feet. Based on the greater distances within rural areas, the intermittent increase in traffic volume associated with shift changes, and the natural noise attenuation over distance, noise levels at most receptors attenuate to levels below the NJ standard for continuous noise levels. Therefore noise impacts due to traffic are SMALL.

Overall noise impacts to off-site areas are SMALL.

5.8.1.4 Air and Thermal Emissions

The PSEG Site is located in Salem County, NJ, which is part of the Metropolitan Philadelphia Air Quality Control Region (40 CFR 81.15). The Clean Air Act and its amendments establish National Ambient Air Quality Standards (NAAQS) for ambient pollutant concentrations that are considered harmful to public health and the environment. Similarly, NJ has established the New Jersey Ambient Air Quality Standards (NJAAQS). Primary standards set limits to protect public health and secondary standards set limits to protect public welfare such as decreased visibility, and damage to animals, crops, vegetation, and buildings. The principal pollutants for which NAAQS have been set are carbon monoxide (CO), nitrogen dioxide (NO_2), lead, sulfur dioxide (SO_2), particulate matter less than 10 microns in diameter (PM_{10}), particulate matter less than 2.5 microns in diameter ($PM_{2.5}$), and ozone (O_3). One or more averaging times are associated with each pollutant for which the standard must be attained.

Areas having air quality as good or better than, the NAAQS are designated as attainment areas. Areas having air quality that is worse than the NAAQS are designated as nonattainment areas. Salem County is next to (but not included in) the Philadelphia-Wilmington $PM_{2.5}$ nonattainment area and is located in the Philadelphia-Wilmington-Atlantic City 8-hr. ozone nonattainment area.

The principal air emission sources associated with new plant operation are cooling towers, auxiliary boilers for plant heating and start-up, engine driven emergency equipment, and emergency power supply system diesel generators and/or combustion turbines. Based on the bounding assumptions for the PPE (SSAR Table 1.3-1), the PSEG Site has six backup generators (four emergency and two normal) as part of the emergency power supply system. The anticipated annual auxiliary boiler and diesel generator air emissions, which include nitrogen oxides (NO_x), sulfur oxides (SO_X), CO, hydrocarbons in the form of volatile organic compounds (VOC), and particulates are provided on Table 5.8-1. Modifications to the SGS and HCGS Title V Operating Permit under the Clean Air Act are required for the new plant, addressing emissions and compliance with state and federal regulations.

The AERMOD modeling system was used to assess the impacts of pollutants generated by the new plant at the PSEG Site, including the cooling towers and the auxiliary boilers. Cooling towers used in the modeling consisted of both LMDCT and NDCT. Standby emergency electric power generators are operated for limited periods of time for testing and therefore are not modeled. The auxiliary boilers are modeled assuming 4 months of continuous operation from mid-November to mid-March when they are needed to provide heat for the new facility. The auxiliary boilers operate for shorter periods of time during unit start-up to provide process and sealing steam.

Three years of site-specific meteorology supplemented with National Weather Service observations of cloud cover from Wilmington, DE and upper air data from Sterling, Virginia is processed to generate the required meteorological parameters for AERMOD. A nested grid of receptors (locations around the site at which impacts are modeled) extended 6.8 mi. from the site boundary. Modeled ambient concentrations at the DE/NJ boundary from the new plant are below the NAAQS for each pollutant.

The resulting concentrations, based on the AERMOD modeling runs, are shown in Table 5.8-2 with the appropriate NAAQS averaging times, background concentrations, total concentrations, the NAAQS standard, and Prevention of Significant Deterioration (PSD) increment for each pollutant. The procedure used to calculate the standard for each pollutant and averaging period is used to estimate the predicted impacts. Table 5.8-3 compares the highest impacts from the sources at the proposed plant at the PSEG Site to the significant impact levels (SILs) for annual and short term averages.

Primary NAAQS standards provide public health protection and the secondary standards provide public welfare protection such as damage to animals and crops. Table 5.8-2 shows that all pollutants (predicted impacts plus background) for all averaging periods are in compliance with the NAAQS. For the combined natural draft cooling towers and auxiliary boilers (NDCT case), the impacts range from 5 percent (for 3-hr. SO_2) to 85 percent (24-hr. $PM_{2.5}$) of the NAAQS. For the combined linear mechanical draft cooling towers and auxiliary boilers (LMDCT case), the impacts range from 4 percent (for 3-hr. SO_2) to 87 percent (24-hr. $PM_{2.5}$) of the NAAQS.

The SILs establish the concentration below which the impact is presumed not to cause or contribute to a violation of a NAAQS or NJAAQS. The computed impacts for each pollutant and averaging time are compared to the SILs in Table 5.8-3. The H1H impacts for PM_{10} and $PM_{2.5}$[1] exceed the respective 24 hr. SILs for the LMDCT case and $PM_{2.5}$

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[1] The 24-hr. SIL for $PM_{2.5}$ previously in use by NJDEP was 2.0 μg/m^3. However, subsequent to USEPA's promulgation of a lower 24-hr. $PM_{2.5}$ NAAQS, NJDEP has adopted a lower SIL of 1.2 μg/m^3. A memorandum entitled "Revised Interim Permitting and Modeling Procedures for New or Modified Sources Emitting between less than 100 Tons per Year of $PM_{2.5}$ (Fine Particulates) and Proposing between 10-99 ton per year increase in $PM_{2.5}$", John Preczewski (NJDEP), December 2010. (Reference 5.8-2) indicates that NJ will apply the lower SIL in evaluation of both attainment and nonattainment sources.

impacts exceed the 24-hr. SIL in the NDCT. In addition, the 1-hr. NO_X impacts for both the NDCT and LMDCT cases exceed the SIL of 7.5 μg/m^3. The only impacts where the SIL is exceeded across the state line in Delaware is for the 24-hr. $PM_{2.5}$ impacts.

All SO_2 and CO impacts are below the respective SILs. Thus, emissions of SO_2 and CO from the new plant do not cause or contribute to a violation of an NAAQS/NJAAQS for all averaging periods. Since the SILs for the PM_{10}, $PM_{2.5}$, and 1-hr NO_X are exceeded, determining compliance with the NAAQS/NJAAQS requires detailed design and equipment specification to be completed, consideration of background concentrations and other nearby sources of these pollutants.

A cumulative modeling analysis will be conducted during the PSD permitting phase that includes background concentration and other sources to demonstrate compliance with the NAAQS and PSD increments. PSD increment is the term for the amount of additional pollutant allowed beyond a baseline pollutant level and apply only to $PM_{2.5}$, PM_{10}, NO_x (annual only), and SO_2 impacts. PSD increments for Class II areas for $PM_{2.5}$ were finalized in October 2011 by EPA at 9 μg/m^3 for the 24-hr increment and 4 μg/m^3 for the annual increment. As shown in Table 5.8-2, the PSD increment is not exceeded for any pollutant and averaging time..

In summary, the analyses presented here do not represent a complete compliance determination, but do show impacts that are expected from the new sources alone. Several assumptions are made regarding the physical locations of the sources and auxiliary boiler parameters and building size. With these assumptions, initial AERMOD analyses suggest that the emissions from cooling towers and auxiliary boilers from the new facility result in modeled exceedances of the EPA SILs for 1-hr NO_X and 24-hr $PM_{2.5}$ for both NDCT and LMDCT cases, and an exceedance of the 24-hr PM_{10} SIL for the NDCT case. The modeling indicates that predicted impacts plus background concentration from the sources at the new facility do not exceed the NAAQS for any of the pollutants and averaging times.

After a reactor technology is selected and detailed design is completed for the cooling towers and combustion sources (including auxiliary boiler equipment), PSEG will consult with NJDEP and perform more detailed emissions modeling. Applicable emissions rates in effect at the time will be used in detail design and specification of equipment, along with identification of the appropriate engineering and operational controls. The final modeling will demonstrate that the new plant complies with the NAAQS, NJAAQS, and PSD increments, and assure that the impacts to air quality are SMALL.

The additional operations-related traffic also results in vehicular air emissions. NO_2 is of particular concern as it contributes to ozone formation and Salem County is an 8-hr. ozone non-attainment area. Nominal localized increases in emissions occur due to the increased numbers of cars, trucks, and delivery vehicles that travel to and from the PSEG Site. Most of the increased traffic is associated with employees driving to and from work. Once the workers are at the site, the volume of traffic and its associated emissions is expected to decrease. The workforce will also be staggered in shifts, which further reduces the amount of traffic during peak traffic times.

Therefore, impacts to local and regional air quality from operations-related traffic impacts are SMALL.

Air emissions also include salt deposition from water droplets leaving the top of the cooling towers of the circulating water supply system. As the droplets evaporate, solids fall to the ground. As discussed in Subsection 5.3.3, the salt deposition does not have an impact on the adjacent salt marsh communities. Plant communities that experience salt deposition are currently adapted to fluctuations in salt levels due to the euryhaline nature of the coastal marsh and Delaware River. Although salt deposition does occur outside the site boundary as shown in Figures 5.3-2 and 5.3-3, the impact to the surrounding areas is SMALL due to the nature of the vegetation subject to salt deposition.

Air emissions sources are also controlled to comply with Occupational Safety and Health Administration (OSHA) standards. 29 CFR 1910.1000 places limits on certain vapors, dusts, and other air contaminants. Dust suppression methods such as watering exposed areas minimize dust emissions. Reseeding or otherwise stabilizing disturbed areas after construction promotes the development of ground cover that further minimizes fugitive dust emissions in the operational phase. Thus, the impact from air emissions from operation of the new plant to nearby residences and recreational areas is SMALL.

Operational impacts of thermal discharges are addressed in Section 5.3, Cooling System Impacts. The two thermal discharges from the new plant originate from the circulating water supply system. Delaware River water is used to cool and condense the steam used to drive the power plant turbines via a closed-cycle cooling system. The heat is rejected to the cooling towers where it is dissipated to the atmosphere. The remaining residual heat is discharged to the Delaware River as cooling tower blowdown. Thermal emissions from the tower are above ground level and any impacts to the public, fauna, or flora are SMALL because of the height of the towers (minimum of 46 ft. LMDCT, SSAR Table 1.3-1, Item 2.4.20).

The discharge of the heated blowdown from the cooling towers to the Delaware River results in a thermal plume. As discussed in Section 5.3, the heat in this plume dissipates in a small area due to the volume of receiving water, the turbulent discharge from the outfall and the extensive mixing created by tidal exchange. The size of the plume is also regulated under the required NJDEP NJPDES permit and DRBC docket. Therefore, impacts from this heated blowdown to the public and local communities are SMALL.

5.8.1.5 Visual Intrusion

NUREG-1437 presents criteria for the assessment of visual impacts for relicensing of existing units. However, these criteria are also appropriate for operation of new units. These criteria are based on inputs from the public regarding their sense of change or diminution of their enjoyment of the affected physical environment, and impacts to socioeconomic institutions and processes. These criteria are:

SMALL	no complaints from public and no measurable impacts to socioeconomic institutions and processes.
MODERATE	some complaints from the affected public, and measurable impacts that do not alter the continued functioning of socioeconomic institutions and processes.
LARGE	continuing and widely shared opposition from the public and measurable social impacts that perturb the continued functioning of community institutions and processes.

The new plant is located at a low elevation on the eastern shore of the Delaware River. The predominant features are the cooling towers. The HCGS and SGS generally block the view of other plant features from the south. The new plant is visible at ground level from limited points to the east of the site due to the elevated terrain and upland woods. The plant site and associated buildings and structures are visible from the west and from the Delaware River. Recreational users of the Delaware River have a clear view of the new plant. Similarly, residents in DE have an unobstructed view of the new plant across the Delaware River, albeit at a greater distance. Because of this distance, visible features are primarily limited to the cooling towers and containment buildings. Upper portions of the cooling tower are visible to residents north and east of the plant site and from travelers crossing the DE Memorial Bridge, 15 mi. to the north of the PSEG Site. The cooling towers have warning lights, as required by the Federal Aviation Administration, and these lights are visible from several miles at night.

The PSEG Site is in a remote location, and is co-located with two existing plants that include a natural draft cooling tower, three reactor containment buildings, and other structures. As such, the new plant is not expected to significantly change the existing viewscape and complaints from the public are minor and no measurable impacts to socioeconomic institutions and processes are anticipated. Therefore, visual impacts to the public, local communities, and recreational users are SMALL.

The water vapor plume from the cooling towers is also visible, given the height and extent of the plumes, especially during the winter months as discussed in Subsection 5.3.3. The frequency of the plume direction, its height, and its extent varies, depending on the season, wind speed, and wind direction. As a result, potential visual effects from the plume vary according to the viewpoint location, but are temporary as weather conditions and wind direction change frequently at the PSEG Site. With the exception of the on-site workforce and recreational and commercial users of the Delaware River, most observers see these plumes from several miles away. The plumes fluctuate in height and extent as weather conditions change, it is similar to that from the existing HCGS cooling tower, and off-site observation of the plumes is from a minimum of several miles away, and therefore, visual impacts are SMALL.

5.8.1.6 Standards for Noise and Gaseous Pollutants

Noise levels at the new plant are controlled by compliance with regulatory requirements. For worker protection, the OSHA noise-exposure limits identified in 29 CFR 1910.95 are met. For residential areas, the State of NJ noise level standards for continuous noise sources are met. As stated in Subsection 4.4.1, the maximum decibel sound level allowed for continuous noise sources at a residence in NJ is 65 dBA during daytime (7 a.m. to 10 p.m.) and 50 dBA at nighttime (10 p.m. to 7 a.m.). In DE these limits (Part VII, Title 7, Chapter 71 of the Delaware Code) provide for a protective level of 65 dBA during the day and 55 dBA during the night for residential receptors.

Air emissions are controlled by compliance with USEPA and NJDEP regulatory requirements. Additional air emission controls also result from recently promulgated USEPA regulations relating to non-road diesel engines and diesel fuel. Salem County is an 8-hr. ozone non-attainment area as discussed in Section 2.7. Non-road diesel engines include emission control technologies to meet applicable emission standards, and the engine model year and horsepower rating determine the emission levels Per 69FR38961, USEPA requires that NO_x, particulate matter, and hydrocarbon allowable emissions for large diesel engines be reduced starting in 2011 and then reduced again in 2015. Similarly, 40 CFR 80.524 requires sulfur dioxide levels be reduced through control of the sulfur content in diesel fuel. After June 2007, the maximum sulfur content in diesel fuel was reduced from approximately 3000 parts per million (ppm) to 500 ppm with a further reduction to 15 parts per million, starting in 2010.

5.8.1.7 Proposed Methods to Reduce Visual, Noise and Other Pollutant Impacts

As discussed in Subsection 5.8.1.3 through Subsection 5.8.1.6, the impacts of noise, other pollutants, and visual alteration at the site are SMALL. The noise levels will comply with NJ and DE regulations at off-site residential receptors and OSHA noise exposure limits for workers outside buildings. Excessive noise is expected inside some buildings (e.g. turbine building) and workers will wear personal protective equipment. Thus, the impact from noise to plant workers from operation of the new plant is considered to be MODERATE inside those buildings requiring hearing protection. The impact from noise to plant workers from operation of the new plant is SMALL outside buildings and inside other buildings that do not require hearing protection.
Air emissions will comply with the NJ Title V permit requirements and federal air quality standards. The auxiliary boilers, cooling towers, emergency engines, and emergency diesel generators and/or combustion turbines are required to meet the applicable emission limits in effect at the time of plant startup. OSHA standards are adhered to for on-site exposure to vapors, dusts and other air contaminants for workers. Employees working in a confined space or exposed to environments containing high concentrations of contaminants are equipped with appropriate breathing apparatus (regulator face mask, self-contained breathing apparatus, etc.) as protective equipment. Thus, the impact from air emissions to plant workers from operation of a new plant at the PSEG Site is anticipated to be MODERATE for work areas that require a respirator and SMALL outside buildings and inside other buildings that do not require breathing apparatus.

Thermal emissions are controlled through the NJPDES and DRBC regulatory processes for plant discharges to surface waters including the Delaware River

(Subsection 5.2.3). Thus, the impact from thermal emissions from operation of the new plant to the Delaware River are SMALL.

Visual impacts are minimized by co-locating the new plant with two existing plants that contain developed features and structures. The chosen site is remotely located and is surrounded by marshlands, other undeveloped land, and upland wooded areas to the north and east of the site. The Delaware River to the west and south of the site also acts as a buffer between the site and residential areas to the west. Visual impacts to the public and local communities are SMALL.

Air emission, OSHA, NJPDES and other permitting and regulatory requirements minimize most of the physical impacts to the public and local communities. Additionally, the remoteness of the site and its location next to the HCGS and SGS minimizes other impacts including visual.

Therefore, impacts from the operation of a new plant at the PSEG Site to the public, local communities, recreational users, and the operating workforce are SMALL.

5.8.2 SOCIAL AND ECONOMIC IMPACTS

This subsection evaluates the demographic, economic, infrastructure, and community impacts to the region as a result of operating a new plant at the PSEG Site. Potential operational impacts of a new plant on regional and local socioeconomic conditions are attributable to the size of the operational workforce, the routine and periodic capital expenditures needed to support operations, and the tax payments made to political jurisdictions. The analysis presented in this subsection is based on the PPE (Section 3.1) with the largest operational work force (both permanent and periodic) of the four alternatives. Operation of a two-unit facility requires approximately 600 on-site employees (SSAR Table 1.3-1, Item 17.5.1).

The evaluation assesses impacts of operation and of demands of the workforce on the region. This analysis assumes 2021 as the start date for commercial operations and a 60-yr period of operation, ending in 2081. The operation of the new plant overlaps for a time with the continued operation of the existing plants, which employ 1574 on-site staff. Relicensing of the two SGS units allows operations to continue until 2036 and 2040, and the HCGS until 2046 (Reference 5.8-1).

Refueling outages at HCGS and SGS last 3 to 4 weeks and require approximately 1000 additional workers. Each plant is refueled approximately once each 18 months. A refueling timeframe of 18 or 24 months is assumed for the new plant (SSAR Table 1.3-1, Item 17.7). Similarly, up to 1000 additional workers are on-site to support outage operations at the new plant (SSAR Table 1.3-1, Item 17.5.2). Refueling personnel constitute an additional work force periodically impacting the communities in the vicinity of the PSEG Site.

Additional features associated with the new plant include a proposed causeway connecting the new plant site to the local road network and a potential new off-site transmission line. Physical impacts associated with operation of these new facilities have been addressed in Subsection 5.8.1. Operation of these facilities has no incremental effect on the socioeconomic impacts associated with operation of the new plant.

5.8.2.1 Demography and Distribution of New Workforce

The 2000 population within the 50-mi. region of the new plant was 5,230,454 and is projected to grow to 8,138,635 by 2081 (Table 2.5-7). The four-county Region of Influence (Cumberland, Gloucester and Salem counties in NJ and New Castle County, DE) had a population of 965,661 in 2000, 1,040,472 in 2008 (Table 2.5-9) and individual growth rates which, collectively, are higher than the average for the 50-mi. region. 82.6 percent of the current SGS and HCGS workforces are distributed across the Region of Influence (Table 2.5-1).

Up to 600 workers are employed at the new plant to support operations. It is estimated that most of these new employees come from within 50-mi. of the new plant. Some of these employees, as well as most new workers from outside the 50-mi. region are expected to relocate to areas within the Region of Influence which provide convenient access to the new PSEG plant. A conservative assumption in this assessment of potential impacts to the most directly affected populations, is that residential distribution of the new plant workforce and their families within the Region of Influence closely resembles that of the current SGS and HCGS workforces. Thus, for purposes of this analysis, 82.6 percent of the new workforce resides within the four-county Region of Influence and all are counted as new residents.

PSEG further assumes that each employee of the new plant migrating into the Region of Influence brings a family. The average household size in NJ and DE are 2.7 and 2.5, respectively (Table 2.5-10). PSEG conservatively used the NJ household size of 2.7 to determine the population increase in the Region of Influence. An operational workforce of 496 (82.6 percent of 600) increases the population in the Region of Influence by 1338 persons.

The resulting numbers of new workers and net population growth within the Region of Influence are summarized in Table 5.8-4.

These net population numbers constitute 0.10 percent, 0.08 percent, 1.00 percent, and 0.05 percent of the 2008 estimated populations of Cumberland, Gloucester, Salem and New Castle counties, respectively. The remaining employees and their families are assumed to be scattered throughout the remaining 50-mi.region of the PSEG Site, where they represent a small percentage of the existing population.

5.8.2.2 Impacts to the Community

5.8.2.2.1 Economy

The employment of the operations workforce over the 60-yr period of operation has economic and social impacts on the surrounding region. Salem County, NJ is the most affected county within the 50 mi. region of the new plant. The relationship of the net economic benefits of a new plant to the total economy is greatest in Salem County because it has the smallest population of the four counties in the Region of Influence, and is expected to receive the largest number of new employees.

NUREG-1437 presents criteria for the assessment of economic impacts based on the operation-related employment as a percentage of total employment for the relevant study area. These criteria are:

SMALL	if operation-related employment is less than 5 percent of total study area employment.
MODERATE	if operation-related employment is 5 to10 percent of total study area employment.
LARGE	if operation-related employment is greater than 10 percent of total study area employment.

Capital expenditures, purchases of goods and services, and payment of wages and salaries to the operating workforce have multiplier effects during the operational phase that result in an increase in business activity, particularly in the retail and service industries. In the multiplier effect, each dollar paid to plant workers is either saved or expended for personal goods and services. Similarly, goods and services purchased as part of operations represent income to the recipient who likewise expends monies as part of payroll and goods and services. The number of times the final increase in consumption exceeds the initial dollar spent is called the "multiplier" (Reference 5.8-7). Based on a 2006 Nuclear Energy Institute (NEI) report (Reference 5.8-8), the multiplier effect from the purchase of goods and services for HCGS and SGS operation and maintenance was an additional $0.88 of economic output for the Region of Influence and additional $1.07 for the three-state area (DE, NJ, and PA) for each dollar spent.

Additional jobs in the Region of Influence and three-state area (DE, NJ, and PA) result from the multiplier effect attributable to the new plant expenditures. An additional 185 indirect jobs in the Region of Influence and 1267 indirect jobs in the three-state area may be created as a result of the purchases of goods and services in support of the new plant operation and maintenance. Most indirect jobs are service-related (teachers, police, health services, small business) and it is assumed that most indirect jobs are filled by the existing community workforce within the 50-mi. region of the new plant. It is further assumed that distribution of indirect jobs by county is the same as the distribution of direct jobs.

PSEG estimates that 246 direct operations workers (41 percent) relocate to Salem County, NJ. This has a positive impact on the economy by providing new business and job opportunities for local residents. In addition, these businesses and employees generate additional profits, wages, and salaries, upon which taxes are paid. Unemployment was lower in 2000 than 1995 and 2008, with 18,588 unemployed workers in the four-county Region of Influence and 1216 unemployed workers in Salem County (Table 2.5-25). Even at these lower unemployment numbers, there are sufficient workers available for the additional indirect jobs that are created by these new operations workers.

Because the number of operation employees relocating to the Region of Influence is lower than 5 percent of the available workforce (496 relocations as compared to a 2007 workforce of 600,000), the economic impacts of operating the proposed new plant are beneficial and SMALL. These impacts are considered beneficial since new direct and indirect jobs are created and economic activity is increased due to plant expenditures for goods and services.

5.8.2.2.2 Taxes

NUREG-1437 presents an assessment of off-site land use impacts based on the following:

- the size of plant-related population growth compared to the area's total population
- The size of the plant's tax payments relative to the community's total revenue
- The nature of the community's existing land-use pattern
- The extent to which the community already has public services in place to support and guide development

NRC presents an analysis of off-site land use during refurbishment (i.e. large construction activities) based on population changes caused by refurbishment activities. The NRC criteria and methodology are appropriate to evaluate socioeconomic impacts of operation of the new plant. NUREG-1437 NRC defines the tax impacts as:

SMALL	if the payments are less than 10 percent of revenue.
MODERATE	if the payments are between 10 and 20 percent of revenue.
LARGE	if the payments are greater than 20 percent of revenue.

The NRC determined that if the plant's tax payments are projected to be a dominant source of the community's total revenue, new tax-driven land-use change impacts are LARGE. This is especially true where the community has no preestablished pattern of development or has not provided adequate public services to support and guide development in the past.

Tax revenues associated with construction of a new plant include payroll taxes on wages and salaries of the construction work force, corporate income tax on taxable income from operation of the new plant, sales and use taxes on purchases made by PSEG and the operations workforce, property taxes related to the building of new nuclear plants, and property taxes on owned real property. Additional tax revenues are generated by economic activity resulting from the multiplier effect. Increased taxes collected are viewed as a benefit to the states and the local jurisdictions in the region.

5.8.2.2.2.1 Personal and Corporate Income Taxes

The existing SGS and HCGS operations result in payroll taxes (federal and state) for employees. The new plant also generates new employee payroll tax payments. Distribution of the new tax payments to states is expected to closely resemble the existing distribution, based on where plant employees choose to live. Public Service Enterprise Group Inc. pays corporate income tax to NJ (Subsection 2.5.2.2).

New or expanded businesses benefiting from the multiplier effect pay additional corporate income taxes, and hire workers who are taxed on wages and salaries. Thus, the tax base in the region will expand, particularly in the four counties most affected by the influx of new workers.

5.8.2.2.2.2 Sales Taxes

NJ counties surrounding the PSEG Site will experience an increase in the amount of sales taxes collected. Sales taxes are generated by retail expenditures of the operating workforce as well as by expenditures of businesses and employees resulting from the multiplier effect. Although sales tax revenue is paid directly to the state, some indirect benefit is received by the NJ counties within the four-county Region of Influence. DE does not currently collect sales tax.

Sales tax revenues also result from direct purchases by PSEG for materials, equipment and services supporting plant operations and maintenance. The distribution of these tax revenues is determined by the business locations of the material and service providers and likely reflects a broader distribution throughout the 50-mi. region of the new plant and beyond. In absolute terms, the amount of sales taxes collected over a potential 60-yr operating period is significant, but is minimal when compared to the total amount of taxes collected throughout the 50-mi region.

5.8.2.2.2.3 Property Taxes

As is discussed in Subsection 2.5.2.7.2, PSEG pays property taxes to Lower Alloways Creek Township and Salem City in Salem County, NJ. However, a portion of the property taxes collected are provided to Salem County, which in turn provides services to residents of the municipality. As described in Subsection 2.2.1, PSEG will acquire an additional 85 ac. of land. This represents an 11 percent increase in the amount of land that is currently owned, and property taxes may increase as a result.

An additional source of property taxes comes from housing purchased by the workforce of the new plant. New workers moving into the area with their families are expected to purchase existing housing, expand or remodel some housing, or construct new housing. These actions increase home values and property tax assessments by reducing the amount of vacant housing, increasing the demand for existing housing, and increasing value through remodeling or new home construction. For the larger municipalities in the region, the increase in property taxes paid, though important and large when aggregated over time, is insignificant compared to the total property taxes collected. In less populated jurisdictions, such as Salem County, the effects are more notable.

5.8.2.2.2.4 Summary of Tax Impacts

Based on the case-study analysis of refurbishment, in NUREG-1437 NRC defined the magnitude of tax impacts as: SMALL, if the payments are less than 10 percent of revenue. The impact of additional taxes on the economy of the region and the four-county Region of Influence are beneficial but SMALL. In Salem County specifically, the impact of additional taxes is beneficial, results in payments that do not exceed 10 percent of revenue, and therefore is SMALL.

5.8.2.2.3 Land Use

NUREG-1437 presents an assessment of off-site land use impacts (i.e., operations) based on the following:

- The size of plant-related population growth compared to the area's total population
- The nature of the community's existing land-use pattern
- The extent to which the community already has public services in place to support and guide development

The NRC presents an analysis of off-site land use during refurbishment (i.e. large construction activities) based on population changes caused by refurbishment activities. The NRC criteria and methodology are appropriate to evaluate socioeconomic impacts of operation of the new plant.

Based on the case-study analysis of refurbishment, in NUREG-1437 NRC concluded that impact of all new land-use changes at nuclear plants is:

SMALL	if population growth results in very little new residential or commercial development compared with existing conditions and if the limited development results only in minimal changes in the area's basic land use pattern
MODERATE	if plant-related population growth results in considerable new residential and commercial development and the development results in some changes to an area's basic land use pattern
LARGE	if population growth results in large-scale new residential or commercial development and the development results in major changes in an area's basic land-use pattern

Second, the NRC defined the magnitude of refurbishment-related population changes as follows:

SMALL	if plant-related population growth is less than 5 percent of the study area's total population, especially if the study area has established patterns of residential and commercial development, a population density of at least 60 persons per sq. mi., and at least one urban area with a population of 100,000 or more within 50 mi.
MODERATE	if plant-related growth is between 5 and 20 percent of the study area's total population, especially if the study area has established patterns of residential and commercial development, a population density of 30 to 60 persons per sq. mi., and one urban area within 50 mi.
LARGE	if plant-related population growth is greater than 20 percent of the area's total population and density is less than 30 persons per sq. mi.

5.8.2.2.3.1 Off-Site Land Use in Region of Influence and Salem County

All of the counties in the four-county Region of Influence have planning departments that maintain land use plans, zoning ordinances, and related documents that are primarily implemented at the municipal level. Population data for the Region of Influence counties and municipalities are presented in Table 2.5-9. In NJ, the counties provide resources and services to municipalities and townships and participate in regional planning organizations. NJ is developing a statewide land use plan and has established a cross-acceptance procedure for certifying county and local plans under the state plan. All three NJ counties within the Region of Influence participate in the statewide Farmland Preservation Program, which receives policy and funding support through the state plan. Additional discussion of county land use practices is presented in Subsection 2.5.2.8.

Salem County, NJ is the primary focus of the land use analysis because it is the county where the new plant is located and receives the largest percentage of the new workforce. Salem County, Salem City and Lower Alloways Creek Township all receive property tax benefits from PSEG.

Other counties in the Region of Influence are more heavily populated and receive smaller shares of the new workforce. Land use changes in these counties are more influenced by a variety of other socioeconomic forces (e.g., closer proximity to major population centers or employers). Those forces significantly dilute potential land use impacts created by the operation of the new plant.

Salem County has several measures in place to provide sustainable economic development while protecting its rural character. These measures are organized under a Smart Growth Plan (Reference 5.8-4) that focuses on directing future commercial and industrial growth toward the western side of the county (including Salem City) where existing infrastructure and major roadways exist to support development. Residential growth is encouraged in existing communities and an Open Space and Farmland

Preservation Plan (Reference 5.8-5) focuses on controlling growth in the eastern and central portions of the county to protect the traditional agrarian economy of the area. The population of Salem County in 2008 was estimated at 66,141 and the land area of the county 338 sq. mi.

Salem City is the county seat of Salem County, and had a population of 5678 in 2007 (Table 2.5-9). In 1999, “Salem Main Street” was formed to stimulate business opportunities, historic preservation, and community growth. Salem Main Street created the Main Street Revitalization Master Plan (Master Plan), which acts as a road map for future land use for Salem City. The Master Plan focuses on creating a cohesive town core and encourages coordination with Salem County to reduce competition between the city and the county (References 5.8-5 and 5.8-6).

Lower Alloways Creek Township occupies approximately 47 sq. mi. in the southwest corner of Salem County and had a population of 1883 in 2007 (Table 2.5-9). The PSEG Site, along with the SGS and HCGS, is located at the western edge of the township. Lower Alloways Creek Township’s land use plan focuses on preserving farmland and open spaces and directing growth toward areas of the community most capable of providing necessary services (Reference5.8-5). The 2005 Master Plan Reexamination Report for Lower Alloways Creek Township states that there has been little change in the Township’s land use patterns since the last Master Plan review in 1999.

Cumberland County, NJ has a land area of approximately 500 sq. mi. and an estimated population of 156,830 in 2008 (Table 2.5-9). Existing land use patterns in Cumberland County are similar to those of Salem County, and consist of extensive wetlands along the Delaware Bay coastline, an agricultural landscape inland, and population centers in the central and northeastern portions of the county.

Gloucester County, NJ, is located north of Salem County and is approximately the same size at 337 sq. mi. The estimated population of 287,860 in 2008 is primarily concentrated in suburban communities in the northern part of the county, which is adjacent to major population centers in Philadelphia and Delaware counties in Pennsylvania (PA) and Camden County, NJ. Another concentration of population is clustered around Glassboro, in the center of the county. South and southeast portions of the county are predominantly rural and more closely resemble the agricultural character of Salem and Cumberland counties.

New Castle County, DE is located to the west of Salem County and has a land area of 426 sq. mi. In New Castle County, zoning ordinances at the municipal and county level set forth the permitted uses and intensities of uses. State-certified comprehensive plans adopted by the county and municipalities establish future land uses for these jurisdictions and guide development patterns. Zoning must reflect the future land-use designation in the comprehensive plan. New Castle County’s Comprehensive Plan 2007 Update generally calls for medium to high density residential and commercial development along major roadways and within existing developments in northern New Castle County. This part of the county is most accessible to PSEG employees via the bridge from Wilmington, DE to Pennsville, NJ. The 2008 estimated population of New Castle County was 529,641 (Table 2.5-9).

Population growth from the new plant operations workforce results in limited new residential and commercial development compared with existing conditions and minimal changes in the area's basic land use pattern. Therefore impacts are SMALL.

5.8.2.2.3.2 Operations-Related Population Growth

This analysis assumes that 82.6 percent of the workforce needed to operate the new plant resides in the Region of Influence. As is reflected in Table 2.5-9, the 2008 estimated population of Cumberland, Gloucester, New Castle and Salem Counties was 156,830; 287,860; 529,641; and 66,141, respectively. Based on these 2008 population estimates and the estimated increase in population in the Region of Influence due to the operations workforce, the net increase in population for the Region of Influence is 0.13 percent (Table 5.8-4). Most of the operations workforce is expected to live Salem County and it is estimated that Salem County gains 246 new families and 664 people.

Per NUREG 1437, impacts of operations-related population changes are considered small if plant-related population growth is less than 5 percent of the study area's total population, the area has an established pattern of residential and commercial development, a population density of at least 60 persons per sq. mi., and at least one urban area with a population of 100,000 or more within 50 miles. The Region of Influence meets all of the NUREG-1437 criteria and the impact to the population of the Region of Influence due to operations is SMALL.

5.8.2.2.3.3 Tax Revenue-Related Impacts

NRC determined in NUREG 1437 that, if the plant's tax payments are projected to be a dominant source of the community's total revenue, the potential impact of new tax-driven land-use changes will be LARGE. This is especially true where the community has no pre-established pattern of development or has not provided adequate public services to support and guide development in the past. As described in Subsection 5.8.2.2.2, the new plant generates similar property tax revenue for Salem County. Salem County has a well-established pattern of development and established public services to support and guide development. Therefore, the effect of tax-driven land-use changes is SMALL.

5.8.2.2.3.4 Conclusion

Salem County is predominantly rural. Major future land uses in the county will likely continue to be agricultural, open space recreation and wetlands. Salem County has several planning initiatives in place that are designed to maintain existing patterns and to focus new residential developments within existing communities. As stated in Subsection 2.5.2.4.2, Salem County had 2240 vacant housing units as of 2005 to 2007. Therefore the influx of operations workers and their families will not spur extensive residential development, particularly as the operations workforce will arrive as the construction workforce is leaving the area. The population and land use patterns in Salem County have remained relatively stable since construction of the SGS and HCGS, indicating that the tax revenues are not inducing secondary development. Additional tax revenues from the new plant provide additional funding support to schools, emergency management systems, road maintenance, and county facilities.

After the new plant comes on-line, property tax payments remain within the NRC criteria for SMALL effect or impact. Therefore, the combined impact of new plant operations and tax revenue related impacts on off-site land use changes in Salem County and throughout the four-county Region of Influence are SMALL.

5.8.2.2.4 Housing

While it is difficult to accurately determine the number of available housing units at the commencement of operations, Subsection 2.5.2.4.2 and Table 2.5-32 review the years 1990, 2000, and 2005 to 2007 availability of housing in the four-county Region of Influence.

NUREG-1437 presents criteria for the assessment of housing impacts based on the discernible changes in housing availability, prices, and changes in housing construction or conversions. These criteria are:

SMALL	small and not easily discernible change in housing availability; increases in rental rates or housing values equal or slightly exceed the statewide inflation rate; and no extraordinary construction or conversion of housing.
MODERATE	discernible but short-lived change in housing availability; rental rates or housing values increase slightly faster than state inflation rate with rates realigning as new housing added; and minor and temporary conversions of non-living space to living space.
LARGE	very limited housing availability; rental rates or housing values increase well above normal inflation rate for state; and substantial conversions of housing units and overbuilding of new housing units.

In 2000, there were 1863 vacant housing units in Salem County, NJ and a total of 20,506 vacant housing units in the four-county Region of Influence (Table 2.5-32). For 2005 to 2007, vacant housing units increased to 2240 in Salem County and 30,181 in the Region of Influence. Adequate housing is expected to be available within the Region of Influence at the time the nonresident workforce moves into the area. A total of 41 percent (246 employees and their families) of the new workforce is expected to move into Salem County. While there is currently enough housing to accommodate all these new families in Salem County, not all housing may be the type sought by the new workforce. Therefore, a percentage of the operations workforce that may reside in Salem County could either choose to live elsewhere in the four-county Region of Influence or construct new homes.

In all four counties of the Region of Influence, the average income of the new workforce is higher than the median or average income in the county; therefore, the new workforce may concentrate in the high-end housing market and some new construction could result. Salem County is the most likely county in which this could occur. However, the small amount of potential new home construction is unlikely to have any effect on established residential development patterns.

Refueling outages create a periodic demand for temporary housing. Refueling outages occur once every 18 months per unit and PSEG currently schedules to avoid overlapping outages. PSEG estimates that the maximum temporary increase in workforce is up to 1000 outage workers per refueling outage. These workers may need temporary housing for an average of 3 to 4 weeks per refueling outage. The temporary housing market within the four-county Region of Influence has provided sufficient capacity to support the needs of refueling workers servicing SGS and HCGS. It is anticipated that the existing temporary housing market will be adequate to support the expanded needs of this workforce because refueling outages do not overlap. The outage workforce is not expected to affect the permanent housing market in the region.

Because of the large number of available vacant housing units in the four-county Region of Influence and the relatively small requirements for the operation workforce, the potential impacts of operation on housing are SMALL in Cumberland, Gloucester, Salem and New Castle counties.

5.8.2.2.5 Public Services

5.8.2.2.5.1 Water Supply Facilities

The new plant uses water for cooling and process needs and smaller quantities for on-site domestic and sanitary uses. The majority of process water is drawn from the Delaware River via a new intake structure. The total intake from the Delaware River for the new plant is 78,196 gpm (normal) and 80,600 gpm (maximum).

As stated in Subsection 3.3.1, the fresh water aquifer that currently supplies SGS and HCGS also supplies the new plant. This includes the potable and sanitary water system, demineralized water distribution system, fire protection system, and other miscellaneous systems. The total intake for the new plant from the fresh water aquifer is 210 gpm (normal) and 953 gpm (maximum). The fresh water aquifer used for the new plant is remote from municipal groundwater sources and modeling of groundwater availability from these aquifers indicates that recharge rates can support a higher withdrawal of water than PSEG's current groundwater withdrawal permit. The additional withdrawal is not expected to impact municipal supplies (Subsection 5.2.2). Therefore, the impacts of groundwater use for plant operations and by the additional on-site workforce are SMALL and do not require mitigation.

The impact to the local water supply systems from operations-related population growth in off-site areas can be estimated by calculating the amount of water required by these individuals and their families relative to the available water supply. Subsection 2.5.2.9.1 and Table 2.5-38 describe the public water supply systems in the area, their permitted capacities, and current demands. The average per capita water usage in the United States is 90 gpd per person; including personal use, bathing, laundry and other household uses. The total operation-related population increase of 1620 people (operational workforce and their families) could increase consumption by 145,800 gpd. The excess public water supply capacity in Salem County is 2,860,000 gpd and 64,100,000 gpd in the Region of Influence (Table 2.5-38). Therefore, impacts to municipal water suppliers from the operations related population increase are SMALL.

5.8.2.2.5.2 Wastewater Treatment Facilities

PSEG has an on-site wastewater treatment facility sized for the three existing units at SGS and HCGS. The proposed new plant wastewater demand exceeds the capacity of the existing treatment facility. As described in Subsection 3.6.2, a new sewage treatment system will be installed, or current capacity increased, to treat the daily flow from the new plant. The new system is sized to meet needs during construction of the new plant as well as long term operational needs. No wastewater from the new plant is treated at off-site facilities.

Subsection 2.5.2.9.1 and Table 2.5-39 describe the public wastewater treatment systems in the four-county Region of Influence, their permitted capacities, and current demands. The impact to local wastewater treatment systems from operations-related population increases can be determined by calculating the amount of water that is used and disposed of by these individuals. The average person in the United States uses 90 gpd. PSEG conservatively estimates that 100 percent of this water is disposed of through the wastewater treatment facilities. The operations-related population increase of 1620 people could require 145,800 gpd of additional wastewater treatment capacity. The excess treatment capacity in Salem County is 1.78 million gpd and 50.2 million gpd in the four-county Region of Influence (Table 2.5-39). Based on this excess treatment capacity, impacts to wastewater treatment facilities from the operational workforce and their families are SMALL.

5.8.2.2.5.3 Police Services

Police services within the four-county Region of Influence are addressed in Subsection 2.5.2.9.2.1 and summarized in Table 2.5-40. Services at the county level are compared to average service levels throughout the 25 counties within the 50-mi. region. Additional detail is provided for localities within Salem County, including Salem City and Lower Alloways Creek Township. On a per capita basis, Salem County has the highest level of police service in the four-county Region of Influence, with one police officer per 241 residents. Gloucester County has the lowest level of police service, with one officer per 832 residents. The overall average for counties within the 50-mi. region ranged from 424 residents per officer in Maryland (MD) to 566 in NJ. The four-county Region of Influence averages one officer per 485 residents.

As shown in Table 5.8-4, 162 new residents will live in Cumberland County, 237 in Gloucester County, 664 in Salem County and 275 in New Castle County. These numbers constitute 0.10 percent, 0.08 percent, 1.0 percent, and 0.05 percent of the 2008 estimated populations of Cumberland, Gloucester, Salem and New Castle counties, respectively. Salem County is estimated to experience the largest influx of new residents, which changes the service level from 241 residents per officer to 243 per officer.

Based on the net increase in police service needs, operations-related population increases do not adversely affect existing police services in the four-county Region of Influence. Consequently, the potential impacts of new plant operations on police services in the Region of Influence and in the 50-mi. region are SMALL.

5.8.2.2.5.4 Fire Protection Services

Subsection 2.5.2.9.2.2 and Table 2.5-40 cover the provision of fire protection services in the four-county Region of Influence and the 50-mi. region of the PSEG Site. For purposes of comparison, county level staffing of this service class is presented as residents per service provider. Fire protection services typically include ambulance, emergency medical response, accident scene, and specialty rescue in addition to traditional firefighting response. A large percentage of these services are provided by volunteer personnel. Within the Region of Influence, and throughout the 50-mi. region, staffing levels ranged from 109 to 319 residents per fire protection provider.

For the new plant operations, Salem County is estimated to experience an influx of 664 new residents. In order to maintain the current service level (number of residents to staff) only a negligible increase in fire protection personnel will be required. To provide a similar level of service to the additional Region of Influence population of 1338, only a negligible increase in personnel will be necessary. Based on the limited increase in need, operations-related population increases do not have a significant impact on existing fire protection services in the four-county Region of Influence or in the 50-mi. region. The potential impacts of the new workforce on fire protection services are SMALL.

5.8.2.2.6 Medical and Social Services

5.8.2.2.6.1 Medical Services

Information on medical services in the four-county Region of Influence is provided in Subsection 2.5.2.9.2.3. Table 2.5-41 lists the number of licensed beds and number of physicians per county. Salem County, NJ is among the counties with the lowest number of licensed beds and the lowest number of physicians. However, the same data indicates that the NJ, seven-county average of 2.2 beds per 1000 falls between the minimum (1.5 in MD) and maximum (3.0 in PA) average values for counties within the 50-mi. region. The small population and rural character of Salem County suggests that residents rely on the larger supply of physicians and beds available in the adjacent counties of Gloucester and New Castle. The provision of multi-county mobile care services may also result in Salem County residents receiving hospital services in other counties.

Medical facilities in the four-county Region of Influence provide complete medical care services to the local population. Any specialized services not fully available locally can be found within the 50-mi. region. The operations workforce increases the population in Salem County by 1.0 percent and the population of the four-county Region of Influence by less than 0.1 percent. Therefore, the potential impacts of operations on medical services are SMALL.

5.8.2.2.6.2 Social Services

As discussed in Subsection 2.5.2.9.2.4, all four counties have programs to meet the social service needs of their residents. These programs provide services including: child-support enforcement; communicable disease response; education; Medicaid and Medicare assistance; affordable housing for people with disabilities; environmental investigations, monitoring and enforcement; nursing; public health preparedness and response; subsistence support for people having difficulty meeting their basic needs; sexually transmitted disease clinic and immunizations; counseling; health screening and special needs children. Some services are consolidated through a coalition between Salem and Cumberland counties. Similar services are provided through county agencies elsewhere in the 50-mi. region.

The population growth associated with operation of the new PSEG plant economically benefits Salem and other counties in the Region of Influence. The new direct jobs increase indirect jobs within the four-county Region of Influence, some of which could be filled by currently unemployed or underemployed workers, thus reducing the social services burden. It is likely that Cumberland, Gloucester, New Castle and Salem Counties will all experience some reduction in the burden on social services due to these indirect benefits. However, the impact of these indirect benefits on the social services burden might be more noticeable in Salem County, because of its smaller economic base. Impacts are SMALL and positive.

5.8.2.2.7 Education

Schools and student populations are discussed in Subsection 2.5.2.5. Regional school resources are summarized in Table 2.5-33 and Region of Influence schools are addressed in Table 2.5-34. As shown in Table 2.5-10, 18.1 percent of the population of NJ and 18.2 percent of DE was 5 to 17 yr old in 2000. Table 2.5-34 indicates that student enrollments vary from a low of 12,137 for Salem County to a high of 73,926 for New Castle County. These enrollments represent 14.0 percent of the New Castle County and 18.4 percent of the Salem County 2008 populations, 529,641 and 66,141, respectively Using the highest figure of 18.4 percent, PSEG estimates that, of an operations-workforce related population of 1338, 246 are school-aged.

Salem County is estimated to experience the largest increase in school-age population of 122 students or just over 1.0 percent of current school populations. An increase of 122 students in a school system with a teacher to student ratio of 1:30 needs 4 additional teachers.

Increased property and sales tax revenues as a result of the increased population, and, in the case of Salem County, property taxes on the new plant, may fund additional teachers and facilities. The number of additional staff needed to maintain the current teacher to student ratio is minor. Therefore, impacts to the four-county Region of Influence county school systems and school systems within the 50-mi. region are SMALL.

5.8.3 ENVIRONMENTAL JUSTICE IMPACTS

The potential disproportionate adverse environmental impacts on low income and minority populations (environmental justice populations) associated with operation of a new plant at the PSEG Site are addressed in this section. Potential impacts include the physical, socioeconomic and other factors addressed in Subsections 5.8.1 and 5.8.2. The discussion includes potential impacts at three geographic scales: the 50-mi. region, the four-county Region of Influence and Salem County, NJ. Following NRC guidance in NUREG-1555, the 50-mi. region encompasses the population most broadly influenced by physical and socioeconomic effects of past operations and related activities. The Region of Influence includes those areas where the majority of the new workforce is expected to seek permanent housing. Salem County, NJ is addressed individually because it is the county where the new plant is located, and therefore, has the greatest potential for operational impacts.

5.8.3.1 Distribution of Environmental Justice Populations

The distribution of environmental justice populations, as defined by NRC criteria, is presented in Subsection 2.5.4. As illustrated in Table 2.5-47 and Figures 2.5-10 through 2.5-16, the majority of all classifications of environmental justice populations are concentrated within Philadelphia County, PA, at a distance of 30 to 50 mi. from the PSEG Site. Other counties in the approximate 20 to 50-mi. range with notable concentrations of environmental justice populations include Montgomery and Delaware counties in PA, and Camden County, NJ.

Within the Region of Influence, the majority of environmental justice populations are located in New Castle County, DE at a distance of 10 to 20 mi. from the PSEG Site. Several smaller concentrations occur in Cumberland and Gloucester Counties between 20 and 40 mi. from the PSEG Site. No other populations or groups (e.g., subsistence populations) are identified that represent environmental justice populations.

Within 10 mi. of the PSEG Site, all three of the census block groups that encompass Salem City record minority populations of Black and Aggregate categories. One of the Salem City block groups meets the NRC criterion for low-income households. In Middletown, DE, one block group meets the NRC criteria for Black and Aggregate minority populations. No other block groups within the 10-mi. vicinity of the PSEG Site meet any of the NRC criteria for minority, ethnic or low-income household classification. There are no populations meeting NRC criteria within 5 mi. of the PSEG Site; the closest populations are in Salem City, between 7 and 9 mi.

Also in Salem County, Pennsville has several Black and Aggregate block groups, one Hispanic and one low-income block group. A single minority block group meeting NRC criteria for Black populations is located in rural Pilesgrove Township.

5.8.3.2 Summary of Plant Operation Impacts

Subsections 5.8.1 and 5.8.2 have analyzed operational impacts as they affect the general population. The result of this analysis indicates that most of the impacts to the environment and public are SMALL. The identified impacts primarily affect unpopulated or sparsely populated areas and do not have the potential to disproportionately affect environmental justice populations in Salem City or Pennsville. In general, operational impacts within the 50-mi. region and the four-county Region of Influence are diluted by the size of the population, the developed nature of community infrastructure and the receipt of tax revenues with which to address the impacts. In all cases, potential adverse impacts at these regional scales are SMALL and do not require mitigation. Additionally, no potential adverse impacts are disproportionately concentrated in such a manner as to impact environmental justice populations within the 50-mi. region or the four-county Region of Influence.

5.8.3.3 Potentially Adverse Disproportionate Impacts

As discussed in Subsection 5.8.2, Salem County, NJ is the place of residence for more workers of the new plant than any other county. Although most potential impacts at the scale of the county are SMALL, the concentration of environmental justice populations in Salem City and in Pennsville or Pilesgrove townships introduce the possibility that some populations may be vulnerable with respect to operations-related impacts.

On-site physical impacts of plant operations, as described in Subsection 5.8.1 are concentrated in close proximity to the new plant. Other potential impacts associated with close proximity to the plant include water transportation, aesthetic and recreational impacts. Due to the remote location, low population within 5 mi., and buffering effect of wetlands, woodlots and agriculture surrounding the PSEG Site, potential impacts to all populations are SMALL. Potential impacts to the cultural, economic, or human health characteristics of these populations are also SMALL, because of the large distances between the PSEG Site and identified environmental justice populations. Similarly, potential environmental justice populations in Salem City, Pennsville and Pilesgrove are not disproportionately or adversely affected in comparison to the general population.

Off-site impacts associated with operation of the proposed causeway and potential transmission line are not disproportionately close to existing environmental justice populations.

The discussion of road transportation issues during plant construction (Subsection 4.4.1) identified potential impacts associated with the concentration of commuting workers in the proximity of Salem City that require mitigation. Portions of the affected transportation routes are located within or in close proximity to Salem City. However, the concentration of traffic volumes during peak commuting hours associated with operation and maintenance of the new plant is greatly reduced compared to the levels that occur during construction. In addition, the mitigation measures that address the construction related impacts remain in place and provide improved levels of service at the affected intersections and roadways.

Economic impacts associated with plant operations, and tax revenues associated with construction of the new plant produce generally beneficial effects to local communities including Lower Alloways Creek, Salem City and elsewhere through Salem County and the four-county Region of Influence. These benefits are proportionately spread across the general and environmental justice populations

The potential effect of land use impacts on residential or commercial development patterns result in SMALL impacts to the general population and will not result in disproportionate impacts to environmental justice communities.

As discussed in Subsection 5.8.2, population growth associated with operation of the new plant will have a SMALL impact on the general population.

The potential that environmental justice populations may be disadvantaged in their ability to find or keep housing in competition with an expanded residential workforce was also assessed. Factors affecting the degree of disadvantage include the amount of vacant housing on the market and the size of the work force relocating into the area. Competition from new residents for housing introduces a limited risk that demand can drive up costs and possibly force some low-income families to relocate.

As shown in Table 5.8-4, 246 new workers are expected to relocate into Salem County, with a total of 496 for the four-county REGION of Influence. Salem County reported a total of 1863 vacant housing units in the 2000 Census and 2240 vacant units as of 2005 to 2007 (Table 2.5-32). These numbers suggest the availability of several vacancies for each non-resident worker expected to relocate into Salem County. Even if only one-third of the available housing was suitable to the needs of the new residential workforce, there are enough vacancies to meet demand without creating a competitive shortage of housing.

Total housing vacancies within the Region of Influence ranged from 20,506 to 30,181 between the years 2000 and 2005 to 2007 (Table 2.5-32) with the majority of this housing in New Castle County, DE. If larger than expected numbers of workers create a shortage of housing within Salem County, there is sufficient availability of housing in other portions of the four-county Region of Influence to meet this demand. The availability of this alternative could reduce the degree of competition for housing within Salem County thereby reducing potential impacts to environmental justice populations.

Under the category of public services, the existing level of service was found to be generally adequate to the needs of the existing community populations. Excess capacity of existing water and sewer services was found adequate to meet the service demands of the projected population increase (Tables 2.5-38 and 2.5-39). Indices of police, fire and emergency response services showed Salem County in the mid-range of equivalent services in neighboring counties (Table 2.5-40). Medical and social services and public education (Table 2.5-34) meet local needs with capacity for some additional growth. Finally, operation of the new plant generates income, including property and sales tax revenues that can be applied to upgrade public services in response to the needs of an expanded population. Therefore, the level of impact for these categories, is SMALL for the general population, and is also SMALL for environmental justice populations.

5.8.3.4 Conclusion

Subsections 5.8.1 and 5.8.2 conclude that physical and socioeconomic impacts of PSEG plant operations have SMALL impacts on communities and general populations within the 50-mi. region of the PSEG Site and the four-county Region of Influence. Additionally, no potential adverse impacts are disproportionately concentrated in such a manner as to impact environmental justice populations within the 50-mi. region or the four-county Region of Influence.

There are environmental justice populations within Salem County (in Salem City and Pennsville). All of the potentially adverse impacts of plant operations affecting the general population are SMALL. Based on factors including the isolated location of the new plant, the established adequacy of community infrastructure and public services, effective planning procedures, and sufficient tax revenues generated by plant operations and workforce spending, potential impacts to environmental justice populations within Salem County are SMALL and not disproportionate.

5.8.4 REFERENCES

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5.8-2 New Jersey Department of Environmental Protection, Division of Air Quality, Revised Interim Permitting and Modeling Procedures for sources Emitting Between 10-100 Tons per Year of $PM_{2.5}$ (Fine Particulate) (Revised to include 2008 $PM_{2.5}$ Monitoring Data), March 17, 2009.

5.8-3 Nuclear Energy Institute, ESP Plant Parameter Envelope Worksheet, Washington, DC, 2003.

5.8-4 Rukenstein and Associates, Smart Growth Plan: Delaware River and I-295/NJ Turnpike Planned Growth Corridor, Salem County, New Jersey, January 2004.

5.8-5 Salem County, Open Space and Farmland Preservation Plan, Volume 1: Open *Space and Recreation,* Salem County, New Jersey, December, 2006.

5.8-6 Stand Up for Salem, Inc., Salem Main Street Revitalization Master Plan. Salem, New Jersey, 2003.

5.8-7 U.S. Department of Commerce, Bureau of Economic Analysis, *Regional Input-Output Modeling System (RIMSI*I), Website, http://www.bea.gov/regional/rims/index.cfm, accessed August 24, 2009.

5.8-8 Nuclear Energy Institute, *Economic Benefits of Salem and Hope Creek Nuclear Generating Stations: An Economic Impact Study by the Nuclear Energy Institute,* Washington, DC, September 2006.

Table 5.8-1
Annual Estimated Emissions from Cooling Towers, Auxiliary Boilers and Emergency Power Supply System Diesel Generators at the PSEG Site

Emission Effluent	Cooling Towers (Pounds)[(a)]	Auxiliary Boilers (Pounds)[(b)]	Diesel Generators(Pounds)[(c)]
Nitrogen Oxides	NA	76,088	28,968
Carbon Monoxide	NA	6996	4600
Sulfur Oxides	NA	460,000	5010
Volatile Organic Compounds[(d)]	NA	400,800	3070
Particulates (PM_{10})	122,000	138,000	1620

a) Based on 8760 hr. of operation at 13.9 lb/hr (14.63 gm/sec)
b) Based on 120 days of operation; PPE values are based on 30 days/year operation – to obtain emissions for 120 days, the value in the PPE is multiplied by 4
c) Based on 4 hr. of operation per month
d) As total hydrocarbon

Based on inputs from SSAR Table 1.3-4, 1.3-5, and Reference 5.8-3.

Table 5.8-2
Highest of the Modeled Concentrations by Pollutant over 3 Years

Pollutant	Averaging Period	Rank	AERMOD ($\mu g/m^3$)	Year	Bkgd. Conc. ($\mu g/m^3$)	Background Monitoring Site (Year)	Total Conc. ($\mu g/m^3$)	NAAQS [(a)] ($\mu g/m^3$)	PSD Increment ($\mu g/m^3$)
Natural Draft Cooling Tower (NDCT) + Aux Boilers									
PM10	24-hr	H2H	1.88	2006	85	Camden RRF (2010)	86.9	150	30
PM2.5	24-hr	98^{th} %	0.63	-	27.5	Gibbstown (2006-08 avg)[(C)]	28.1	35	9
	Annual	H1H	0.05	-	11.7	Gibbstown (2006-08 98^{th} %)[(C)]	11.8	15	4
NOx (as NO_2)[(b)]	1-hr	98^{th} %	10.37	-	109[(e)]	Camden Labs (2008, 98^{th} %)[(d)]	119.4	188[(e)]	None
	Annual	H1H	0.14	2007	61[(e)]	Camden Labs (2007)		100[(e)]	25
CO	1-hr	H2H	23.7	2006	3020[(e)]	Camden Labs (2007)	3043.7	40,000	None
	8-hr	H2H	6.43	2006	2517[(e)]	Camden Labs (2006)	2523.4	10,000	None
SO_2	1-hr	99^{th} %	0.44	-	71[(e)]	Clarksboro (2008, 99^{th} %)[(d)]	71.4	196[(e)]	None
	3-hr	H2H	0.404	2006	58[(e)]	Clarksboro (2008)	58.4	1300	512
	24-hr	H2H	0.121	2006	31[(e)]	Clarksboro (2009)	31.1	365	91
	Annual	H1H	0.0036	2007	19[(e)]	Clarksboro (2008)	19.0	80	20
Mechanical Draft Cooling Tower (MDCT) + Aux Boilers									
PM10	24-hr	H2H	6.80	2006	85	Camden RRF (2010)	91.8	150	30
PM2.5	24-hr	98^{th} %	1.21	-	27.5	Gibbstown (2006-08 avg)[(c)]	28.7	35	9
	Annual	H1H	0.19	-	11.7	Gibbstown (2006-08 98^{th} %)[(c)]	11.9	15	4
NOx (as NO_2)[(b)]	1-hr	98^{th} %	10.58	-	109[(e)]	Camden Labs (2008, 98^{th} %)[(d)]	119.6	188[(e)]	None
	Annual	H1H	0.13	2007	61[(e)]	Camden Labs (2007)	61.1	100[(e)]	25
CO	1-hr	H2H	13.20	2008	3020[(e)]	Camden Labs (2007)	3033.2	40,000	None
	8-hr	H2H	7.57	2008	2517[(e)]	Camden Labs (2006)	2424.6	10,000	None
SO_2	1-hr	99^{th} %	0.358	-	71[(e)]	Clarskboro (2008, 99^{th} %)[(d)]	71.4	196[(e)]	None
	3-hr	H2H	0.404	2006	58[(e)]	Clarksboro (2008)	58.4	1300	512
	24-hr	H2H	0.101	2008	31[(e)]	Clarksboro (2009)	31.1	365	91
	Annual	H1H	0.0035	2007	19[(e)]	Clarksboro (2008)	19.0	80	20

a) Primary standards except SO_2 3-hr, which is a secondary standard
b) NO_X modeled; assumed a 100% conversion rate of NO_x to NO_2
c) Background concentration from "Revised Interim Permitting and Modeling Procedures for New or Modified Sources Emitting between less than 100 Tons per Year of PM2.5 (Fine Particulates) and Proposing between 10-99 ton per year increase in PM2.5", John Preczewski (NJDEP), December 2010.
d) 98^{th} (NO_2) or 99^{th} (SO_2) percentiles for 1-hr averaging period from any one year
e) Converted from ppb or ppm

Table 5.8-3
Modeled Concentrations by Pollutant Compared to SIL

Pollutant	Averaging Period	Rank[(a)]	Predicted Impact ($\mu g/m^3$)[(b)]	Year	SIL ($\mu g/m^3$)
Natural Draft Cooling Towers (NDCT) + Aux Boilers					
PM10	24-hr	H1H	3.56	2006	5
PM2.5	24-hr	1H	**2.00**	3-yr avg	1.2
	Annual	1H	0.05	3-yr avg	0.3
NOx	1-hr	1H	**36.21**	3-yr avg	7.5
	Annual	1H	0.14	2007	1
CO	1-hr	H1H	43.1	2006	2,000
	8-hr	H1H	10.1	2006	500
SO_2	1-hr	1H	0.94	3-yr avg	7.8
	3-hr	H1H	0.69	2007	25
	24-hr	H1H	0.23	2006	5
	Annual	1H	0.004	2007	1
Linear Mechanical Draft Cooling Towers (LMDCT) + Aux Boilers					
PM10	24-hr	H1H	**6.82**	2006	5
PM2.5	24-hr	1H	**2.41**	3-yr avg	1.2
	Annual	1H	0.19	3-yr avg	0.3
NOx	1-hr	1H	**17.79**	3-yr avg	7.5
	Annual	1H	0.13	2007	1
CO	1-hr	H1H	14.5	2006	2,000
	8-hr	H1H	10.0	2006	500
SO_2	1-hr	1H	0.46	3-yr avg	7.8
	3-hr	H1H	0.50	2007	25
	24-hr	H1H	0.20	2006	5
	Annual	1H	0.004	2007	1

a) H1H – High 1st High; 1H – 1st Highest
b) Values in bold text exceed SIL values

Table 5.8-4
Estimated Number of New Workers and Net Population Increase for the Four-County Region of Influence

County	Number New Workers	Estimated Net Population Increase	2008 Estimated Population
Cumberland, NJ	60	162	156,830
Gloucester, NJ	88	237	287,860
Salem, NJ	246	664	66,141
New Castle, DE	102	275	529,641
TOTAL	**496**	**1338**	**1,040,472**
Net Increase as a Percent of Total Estimated Population		**0.13**	

5.9 DECOMMISSIONING IMPACTS

This section reviews the environmental impacts of decommissioning the new plant. The NRC defines decommissioning as the permanent removal of a nuclear facility from service, and the reduction of residual radioactivity to a level that permits release of the property and termination of the license (10 CFR 50.2, *Domestic Licensing of Production and Utilization Facilities, Definitions*).

Decommissioning occurs after ending operations per NRC regulations. The NRC regulations require licensees to evaluate environmental impacts from decommissioning activities (10 CFR 50.82). The information in NUREG-0586, *Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities*, Supplement 1, provides the guidance for licensees for existing reactors to address these impacts.

5.9.1 GENERIC ENVIRONMENTAL IMPACT STATEMENT REGARDING DECOMMISSIONING

NUREG-0586 describes decommissioning regulatory requirements, the decommissioning process, and environmental impacts of decommissioning. NUREG-0586 describes the NRC process for evaluating impacts. Activities and impacts that the NRC considers within the scope of NUREG-0586 include:

- Activities performed to remove the facility from service once the licensee certifies that the facility has permanently ceased operations, including organizational changes and removal of fuel from the reactor.
- Activities performed in support of radiological decommissioning, including decontamination and dismantlement of radioactive structures, systems, and components (SSC) and any activities required to support the decontamination and dismantlement process, such as isolating the spent fuel pool to reduce the scope of required safeguards and security systems so decontamination and dismantlement can proceed on the balance of the facility without affecting the spent fuel.
- Activities performed in support of dismantlement of non-radiological SSC, such as diesel generator buildings and cooling towers.
- Activities performed up to license termination and their resulting impacts as provided by the definition of decommissioning, including shipment and processing of radioactive waste.
- Nonradiological impacts occurring after license termination from activities conducted during decommissioning.
- Activities related to release of the facility.
- Human health impacts from radiological and nonradiological decommissioning activities.

As indicated in NUREG-1555, Appendix A of Section 5.9**,** studies of social and environmental effects of decommissioning large commercial power generating units have not identified any significant impacts beyond those considered in NUREG-0586. It evaluates the environmental impact of the following three decommissioning alternatives:

- DECON – The equipment, structures, and portions of the facility and site that contain radioactive contaminants are removed or decontaminated to a level that permits termination of the license shortly after cessation of operations.

- SAFSTOR – The facility is placed in a safe stable condition and maintained in that state until it is subsequently decontaminated and dismantled to levels that permit license termination. During SAFSTOR, a facility is left intact, but the fuel is removed from the reactor vessel and radioactive liquids drained from systems and components and then processed. Radioactive decay occurs during the SAFSTOR period, thus reducing the quantity of contaminated and radioactive material that must be disposed of during the decontamination and dismantlement.
- ENTOMB – This alternative involves encasing radioactive SSC in a structurally long-lived substance, such as concrete. The entombed structure is appropriately maintained and continued surveillance is carried out until the radioactivity decays to a level that permits termination of the license.

NRC regulations do not require an early site permit or combined license applicant to select one of these decommissioning alternatives or to prepare definite plans for decommissioning. These plans are required by 10 CFR 50.82 after a decision is made to cease operations.

According to the NRC, decommissioning a nuclear facility that has reached the end of its useful life generally has a positive environmental impact. The air quality, water quality, and ecological impacts of decommissioning are substantially smaller than power plant construction or operation because the level of land disturbance activity is greatly reduced. Radiological releases to the environment are smaller during decommissioning than during construction and operation. The major environmental impact, regardless of the specific decommissioning option selected, is the commitment of small amounts of land for waste burial in exchange for the potential reuse of the land where the facility is located. Socioeconomic impacts of decommissioning result from the demands on, and contributions to, the community by the workers employed to decommission a power plant (NUREG-0586, Supplement 1). In Table 6-1 of the NUREG-0586, Supplement 1, NRC concludes that environmental impacts associated with decommissioning are SMALL for those activities on-site and within the operational area.

Experience with decommissioned power plants has shown that the occupational exposures during the decommissioning period are comparable to those associated with refueling and plant maintenance when it is operational. Each of the three potential decommissioning alternatives has radiological impacts from the transport of materials to disposal sites. The expected impact from this transportation activity is not significantly different from normal operations (NUREG-0586, Supplement 1).

5.9.2 U.S. DEPARTMENT OF ENERGY STUDY ON DECOMMISSIONING COSTS

The DOE funded a study that compares activities required and costs to decommission existing reactors to those required for new advanced reactors, including the AP1000 and ABWR (Reference 5.9-1). The DOE report was prepared to assess the impacts of these new designs during construction, operation, and decommissioning. This report also includes an assessment of the impact of these designs on decommissioning funding estimates. Four reactor types were evaluated and the cost analysis described in the study is based upon the prompt decommissioning alternative, or DECON, as defined by the NRC.

The cost estimates prepared for decommissioning the advanced reactor designs consider the unique features of a generic site, including the nuclear steam supply systems, power generation systems, support services, site buildings, and ancillary facilities. Cost estimates are based on numerous fundamental assumptions, including regulatory requirements, project contingencies, and low-level radioactive waste disposal practices. The primary cost contributors are either labor-related or associated with the management and disposition of the radioactive waste (Reference 5.9-1).

The DOE study concluded that, with consistent operating and management assumptions, the total decommissioning costs projected for the advanced reactor designs are comparable to those projected for operating reactors with appropriate reductions in costs due to reduced physical plant inventories (Reference 5.9-1).

5.9.3 SUMMARY AND CONCLUSIONS

PSEG compared the activities analyzed in NUREG-0586 on the environmental impacts of decommissioning the existing fleet of domestic nuclear power reactors with the activities that form the basis for decommissioning cost estimates prepared by DOE for advanced reactor designs and determined that the scope of activities is the same. Projected physical plant inventories associated with advanced reactor designs are generally less than those for currently operating power reactors due to advances in technology that simplify maintenance and benefit decommissioning. Based on this comparison, PSEG has concluded that the environmental impacts identified in NUREG-0586 are representative of impacts that can reasonably be expected from decommissioning the AP1000, U.S. EPR, ABWR and US-APWR reactors.

5.9.4 REFERENCES

5.9-1 U.S. Department of Energy, Study of Construction Technologies and Schedules, O&M Staffing and Cost, and Decommissioning Costs and Funding Requirements for Advanced Reactor Designs, prepared by Dominion Energy, Inc., Bechtel Power Corporation, TLG, Inc., and MPR Associates for U.S. Department of Energy Cooperative Agreement DE-FC07-03ID14492, Contract DE-AT01-020NE23476, May 2004.

5.10 MEASURES AND CONTROLS TO LIMIT ADVERSE IMPACTS DURING OPERATIONS

This section summarizes potential adverse environmental impacts from the operation of the new plant, along with associated measures and controls to limit those impacts.

5.10.1 ADVERSE ENVIRONMENTAL IMPACTS

PSEG will avoid, minimize, or reduce adverse environmental impacts during operation activities where feasible and practical. The operation of the new plant results in certain adverse environmental impacts. The "Potential Impact Significance" columns in Table 5.10-1 list the elements identified in NUREG-1555, that relate to operation activities. The following list identifies elements with potential adverse environmental impacts that could be encountered during operation of the proposed facilities:

- Land
  - Land use
  - Cooling tower drift impacts
- Water
  - Surface water
  - Groundwater
  - Erosion and sediment
  - Water use
  - Effluents and wastes
- Ecology
  - Terrestrial ecosystem
  - Aquatic ecosystem
  - Transmission corridor maintenance impacts
- Socioeconomics
  - Air quality
  - Traffic
  - Noise
  - Demographics
  - Community
  - Historic Properties
- Radiation exposure to workers
- Site-Specific others

Table 5.10-1 uses the NRC's significance levels (SMALL, MODERATE, or LARGE) for each element. These significance levels are determined by evaluating the potential effects after any controls or mitigation measures are implemented. The significance levels used in the evaluation are developed using Council on Environmental Quality guidelines set forth in the footnotes to Table B-1 of 10 CFR 51, Subpart A, Appendix B:

- SMALL — Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource. For the purposes of assessing radiological impacts, the Commission has concluded that those impacts that do not exceed permissible levels in the Commission's regulations are considered small.

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

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

The impact categories evaluated in this chapter are the same as those used in NUREG-1437, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*, Volumes 1 and 2.

5.10.2 MEASURES AND CONTROLS TO LIMIT ADVERSE IMPACTS DURING OPERATION OF THE PROPOSED FACILITY

Table 5.10-1 lists and describes facility operational impacts that require mitigation along with corresponding measures and controls that may be committed to limit potential adverse environmental impacts. The listed measures and controls have been designed to achieve a practical level of mitigation that can be achieved through implementation. Further, the listed measures and controls are reasonable, specific, and unambiguous; and involve methods and techniques that are appropriate, achievable, and can be verified through subsequent field reviews and inspections. Finally, the environmental, economic, and social costs of implementing the measures and controls have been balanced against the expected benefits.

Examples of PSEG's measures to minimize impacts and protect the environment include:

- Using BMPs for operation activities
- Implementing plans to manage stormwater and to prevent and appropriately address accidental spills
- Managing and/or restoring wetlands and marsh creek channels
- Adhering to federal, state and local permitting requirements

In addition to the general measures discussed above, the following specific factors limit potential adverse environmental impacts related to operation activities for a new plant at the PSEG Site:

- Compliance with federal, state, and local laws, ordinances, and regulations intended to prevent or minimize adverse environmental effects (for example, solid waste management, erosion and sediment control, air emissions, noise control, stormwater management, discharge prevention and response, water intake and discharge, and hazardous waste management).

- Compliance with applicable permits and licenses required for operation of the new plant.

- Compliance with existing PSEG Site processes and/or procedures applicable to site environmental compliance activities for the new plant including solid waste management, hazardous waste management, and discharge prevention and response.

- Identification of environmental resources and potential effects during the development of this Environmental Report.

- Managing and minimizing solid, radiological, chemical and hazardous wastes

The potential mitigation measures and controls will be reviewed and revised as appropriate after PSEG selects a reactor technology for the new facility.

Table 5.10-1 (Sheet 1 of 12)
Summary of Measures and Controls to Limit Adverse Impacts of Plant Operation

Potential Impact Significance [a, b]

ER Section Reference	Elements: Air Quality	Aquatic Ecosystems	Erosion and Sediment	Groundwater	Land Use	Noise	Public Health & Safety	Radiation Exposure	Socioeconomic	Surface Water	Terrestrial Ecosystems	Traffic	Wastes	Water Use	Impact Description or Activity	Specific Mitigation Measures and Controls
5.1 Land-Use Impacts																
5.1.1 The Site and Vicinity					S										1. Increase in population within vicinity and region due to operational workforce. 2. Minor increase in local population and tax revenues.	Specific measures and controls are not needed; increased populations and tax revenues impacts are minor and in some cases positive.
5.1.2 Transmission Corridors and Off-site Areas					S										1. Routine vegetation inspection and maintenance activities (trimming) in potential off-site transmission line and proposed causeway corridors. 2. Disposal of low-level radiological wastes in existing permitted repository. 3. Disposal of non-radiological wastes in existing permitted off-site landfills / facilities.	1. Maintenance to follow established procedures and conform to regulations to minimize soil or water impacts. 2. Specific measures and controls are not needed; impacts are minor. 3. Specific measures and controls are not needed; impacts are minor.
5.1.3 Historic Properties and Cultural Resources									S						1. No historic properties on-site. 2. Potential for disturbance of historic properties in or along off-site corridors (proposed causeway, potential transmission).	1. Specific measures and controls are not needed. 2. Controls for protecting any resources identified in or near any new transmission line or the proposed causeway will be in accordance with appropriate State Historic Preservation Office requirements.

Table 5.10-1 (Sheet 2 of 12)
Summary of Measures and Controls to Limit Adverse Impacts of Plant Operation

Section Reference	Potential Impact Significance [(a,b)] Categories														Impact Description or Activity	Specific Mitigation Measures and Controls
	Air Quality	Aquatic Ecosystems	Erosion and Sediment	Groundwater	Land Use	Noise	Public Health & Safety	Radiation Exposure	Socioeconomic	Surface Water	Terrestrial Ecosystems	Traffic	Wastes	Water Use		
5.1.3 Historic Properties and Cultural Resources									S						3. Cooling towers change viewscape. 4. Transmission towers and lines change viewscape.	3. Specific measures and controls are not needed; impacts are minor. 4. Any new off-site transmission lines are to use or be located adjacent to existing transmission line rights-of-way to the extent possible to minimize visual impacts.
5.2 Water-Related Impacts																
5.2.1 Hydrologic Alterations and Plant Water Supply			S	S						S					1. Minor change in Delaware River freshwater flows due to consumptive use of surface water; minor change in Delaware River flow patterns from in-stream constructed features; very minor change in tidal conveyance in marsh creeks due to localized sedimentation in limited marsh creek channels. 2. Minor change in river flows and suspended solids due to increased stormwater runoff from on-site impervious surfaces. 3. Localized changes in groundwater levels due to consumptive water use by the plant.	1. Specific measures and controls are not needed; impacts are minor. 2. Stormwater BMPs and permit requirements to limit erosion and sedimentation due to runoff. 3. Specific measures and controls are not needed; impacts are minor.

Table 5.10-1 (Sheet 3 of 12)
Summary of Measures and Controls to Limit Adverse Impacts of Plant Operation

Section Reference	Potential Impact Significance [a,b] Categories														Impact Description or Activity	Specific Measures and Controls
	Air Quality	Aquatic Ecosystems	Erosion and Sediment	Groundwater	Land Use	Noise	Public Health & Safety	Radiation Exposure	Socioeconomic	Surface Water	Terrestrial Ecosystems	Traffic	Wastes	Water Use		
5.2.2 Water-Use Impacts				S						S				S	1. Potential for exacerbating effects of low flows in Delaware River due to surface water consumption by plant during drought condition. 2. No anticipated impacts to groundwater availability for other water users due to increased use at the PSEG Site.	1. During drought periods, water consumption is offset, as required by Delaware River Basin Commission (DRBC), by release of water from PSEG's existing allocation upstream reservoir water storage. 2. The additional demand is within the capacity of the aquifer and within the current daily and monthly permitted withdrawals.
5.2.3 Water Quality Impacts		S		S						S					1. Increases in suspended solids, chemical concentrations, and heat loading to Delaware River from water discharge structure and site runoff. 2. Increases in suspended solids in the Delaware River due to periodic maintenance dredging. 3. Localized increase in suspended solids due to scour from discharge. 4. Accidental discharges may degrade quality of shallow groundwater and associated surficial soils.	1. Chemical and thermal impacts are limited by New Jersey Pollutant Discharge Elimination System (NJPDES) permit requirements. Discharge structure designed to promote rapid mixing to minimize thermal and chemical impacts. 2. Best management practices (BMPs) for dredging and stormwater controls to limit sediment impacts on surface water quality. 3. Engineered discharge outfall minimizes scour. 4. BMPs and spill controls (including hazmat first response team and secondary containment designs) and counter-measures used to limit and contain chemical spills. Remedial measures are regulated by the NJDEP.

Table 5.10-1 (Sheet 4 of 12)
Summary of Measures and Controls to Limit Adverse Impacts of Plant Operation

Potential Impact Significance (a,b)

Section Reference	Categories														Impact Description or Activity	Specific Measures and Controls
	Air Quality	Aquatic Ecosystems	Erosion and Sediment	Groundwater	Land Use	Noise	Public Health & Safety	Radiation Exposure	Socioeconomic	Surface Water	Terrestrial Ecosystems	Traffic	Wastes	Water Use		
5.3 Cooling System Impacts																
5.3.1 Intake System																
5.3.1.1 Hydrodynamic Descriptions and Physical Impacts			S							S					Closed-cycle cooling system results in small and localized changes in ambient Delaware River flows in water intake area.	Design of new intake to comply with regulations on new facility intake structures; specific measures and controls are not needed; impacts are minor
5.3.1.2 Aquatic Ecosystems		S													1. Entrainment of aquatic organisms through the plant's cooling system. 2. Impingement of aquatic organisms on the cooling water intake traveling screens.	1. Design of new intake to comply with regulations on new facility intake structures; specific measures and controls are not needed; impacts are minor. 2. Design of new intake to comply with regulations on new facility intake structures; specific measures and controls are not needed; impacts are minor.

Table 5.10-1 (Sheet 5 of 12)
Summary of Measures and Controls to Limit Adverse Impacts of Plant Operation

Section Reference	Potential Impact Significance [a,b] Categories: Air Quality	Aquatic Ecosystems	Erosion and Sediment	Groundwater	Land Use	Noise	Public Health & Safety	Radiation Exposure	Socioeconomic	Surface Water	Terrestrial Ecosystems	Traffic	Wastes	Water Use	Impact Description or Activity	Specific Measures and Controls
5.3.2 Discharge Systems																
5.3.2.1 Thermal Discharges and Other Physical Impacts			S							S					1. Localized bottom scouring at discharge structure opening. 2. Small thermal plume with localized increases in near-field temperatures but no significant increases in far-field temperatures.	1. Bottom scour mitigated by engineered discharge pipe. 2. Discharge is controlled in accordance with NJPDES permit.
5.3.2.2 Aquatic Ecosystems		S													Localized increase in near-field temperatures and chemical concentrations, but minimal far-field increases; limited exposure of aquatic organisms to elevated temperature and chemical concentrated in small near-field plume area.	Discharge is controlled in accordance with NJPDES permit. Discharge limits are protective of aquatic biota.
5.3.3 Heat Dissipation Systems																
5.3.3.1 Modeling Methodology															Not Applicable.	Not Applicable.

Table 5.10-1 (Sheet 6 of 12)
Summary of Measures and Controls to Limit Adverse Impacts of Plant Operation

Section Reference	Potential Impact Significance [a,b] Categories														Impact Description or Activity	Specific Measures and Controls
	Air Quality	Aquatic Ecosystems	Erosion and Sediment	Groundwater	Land Use	Noise	Public Health & Safety	Radiation Exposure	Socioeconomic	Surface Water	Terrestrial Ecosystems	Traffic	Wastes	Water Use		
5.3.3.2 Heat Dissipation to the Atmosphere	S				S										1. Small localized changes to climate due to increased temperatures, humidity, fogging and shadowing from cooling tower plumes. 2. Small increase in salt concentrations with resultant deposition on surrounding lands.	1. Specific measures and controls are not needed; impacts are minor. 2. Specific measures and controls are not needed; impacts are minor.
5.3.3.3 Terrestrial Ecosystems						S					S				1. Small potential for bird collisions with cooling towers and other structures. 2. Increased deposition of salt to salt marsh vegetation. 3. Minor decreases in productivity of local vegetation due to short duration and infrequent occurrence of fogging and shadowing. 4. Increased noise from cooling tower operation.	Specific measures and controls for bird collisions, salt deposition, productivity, and noise impacts are not needed; impacts are minor.
5.3.3.4 Impacts to Members of the Public						S	S								1. Exposure of the public to concentrations of thermophilic microorganisms in cooling tower and blowdown discharges that are within guidelines for acceptable levels. 2. Noise impacts from cooling tower operation.	1. Specific measures and controls are not needed; impacts are minor 2. Noise attenuates to site boundary and off-site residences; no impact on public.

Table 5.10-1 (Sheet 7 of 12)
Summary of Measures and Controls to Limit Adverse Impacts of Plant Operation

Section Reference	Potential Impact Significance [a,b] Categories: Air Quality	Aquatic Ecosystems	Erosion and Sediment	Groundwater	Land Use	Noise	Public Health & Safety	Radiation Exposure	Socioeconomic	Surface Water	Terrestrial Ecosystems	Traffic	Wastes	Water Use	Impact Description or Activity	Specific Measures and Controls
5.4 Radiological Impacts of Normal Operation																
5.4.1 Exposure Pathways	S	S					S	S	S	S				S	Exposure, inhalation, and ingestion levels from radioactive liquid and gaseous releases are within regulatory limits. Direct dose radiation levels are negligible.	Specific measures and controls are not needed; impacts are minor.
5.4.2 Radiation Doses to Members of the Public							S	S							Addressed in Section 5.4.3.	Addressed in Section 5.4.3.
5.4.3 Impacts to Members of the Public							S	S							Calculated doses to the public are within the design objectives of 10 CR 50 Appendix I and within regulatory limits of 40 CFR 190.	An annual off-site Radiological Environmental Monitoring Program is conducted to evaluate potential exposures and doses to members of the public.

Table 5.10-1 (Sheet 8 of 12)
Summary of Measures and Controls to Limit Adverse Impacts of Plant Operation

Section Reference	Potential Impact Significance [a,b] — Categories														Impact Description or Activity	Specific Measures and Controls
	Air Quality	Aquatic Ecosystems	Erosion and Sediment	Groundwater	Land Use	Noise	Public Health & Safety	Radiation Exposure	Socioeconomic	Surface Water	Terrestrial Ecosystems	Traffic	Wastes	Water Use		
5.4.4 Impacts to Biota Other than Members of the Public		S						S			S				1. Potential doses to biota from liquid and gaseous releases. 2. Calculated doses to biota are less than 0.1 mrad/day.	An annual off-site Radiological Environmental Monitoring Program is conducted to evaluate potential exposures and doses to biota and the environment.
5.4.5 Occupational Radiation Doses							S	S							Exposure of operational workforce to radioactive doses that are below 10 CFR 50 Appendix I limits.	Monitoring program for workforce exposure.
5.5 Environmental Impacts of Waste																
5.5.1 Nonradioactive Waste System Impacts					S					S			S		Pollution of environment from plant waste streams and effects to human health from: 1. Air pollution 2. Solid wastes 3. Sanitary wastes	1. Emissions to the atmosphere and discharges to surfaces waters in accordance with federal, state and local regulations. These regulations are designed to be protective of air and water quality, aquatic and terrestrial ecosystems, and human health. 2. Solid wastes are recycled to the extent possible with remaining wastes disposed of in approved landfills. 3. Sanitary wastes from a new sewage treatment plant are managed on-site and disposed of off-site in compliance with applicable laws, regulations, and permit conditions.

Table 5.10-1 (Sheet 9 of 12)
Summary of Measures and Controls to Limit Adverse Impacts of Plant Operation

Section Reference	Potential Impact Significance [a,b] Categories: Air Quality	Aquatic Ecosystems	Erosion and Sediment	Groundwater	Land Use	Noise	Public Health & Safety	Radiation Exposure	Socioeconomic	Surface Water	Terrestrial Ecosystems	Traffic	Wastes	Water Use	Impact Description or Activity	Specific Measures and Controls
5.5.2 Mixed Waste Impacts								S			S		S		No mixed wastes are generated by the new plant.	Specific measures and controls are not needed.
5.5.3 Pollution Prevention and Waste Minimization Plan					S								S		Promotion of environmental stewardship and education of employees regarding environmental aspects of day-to-day work activities to reduce pollution and waste.	The new plant will have a plan similar to that currently in place for the adjacent SGS and HCGS.
5.6 Transmission System Impacts																
5.6.1 Terrestrial Ecosystems											S				1. Impacts on terrestrial ecosystems from maintenance of existing transmission corridors; infrequent localized emission and noise increases along transmission line corridor. 2. Impacts on birds due to contact with conductors or current.	1. BMPs to ensure transmission line maintenance activities are managed in a way to preserve important habitat and to protect important species; vegetation management primarily through mechanical clearing, with herbicide application in accordance with integrated pest management plans. 2. Towers and lines are designed to industry standards to minimize risks of avian contact with energized components.

Table 5.10-1 (Sheet 10 of 12)
Summary of Measures and Controls to Limit Adverse Impacts of Plant Operation

Section Reference	Potential Impact Significance [a,b] Categories														Impact Description or Activity	Specific Measures and Controls
	Air Quality	Aquatic Ecosystems	Erosion and Sediment	Groundwater	Land Use	Noise	Public Health & Safety	Radiation Exposure	Socioeconomic	Surface Water	Terrestrial Ecosystems	Traffic	Wastes	Water Use		
5.6.2 Aquatic Ecosystems		S													Potential water quality impacts from maintenance of transmission corridors on aquatic ecology.	Adherence to established PSE&G measures and BMPs. If herbicides have to be applied near waterways, only those specifically identified for use near waterways are be used.
5.6.3 Members of the Public						S	S								1. Elevated noise levels and electromagnetic fields (EMF). 2. Visual impacts associated with potential off-site transmission lines.	1. Specific measures and controls are not needed; impacts are minor. Transmission design meets edge of Rights-of-Way standards for EMF and noise. 2. Use of existing corridors and rights-of-way to extent practicable to minimize visual impact.
5.7 Uranium Fuel Cycle Impact	S	S	S	S	S	S	S	S	S	S	S	S	S	S	Increase in off-site energy requirements, land use, erosion, emissions and water use, and associated impacts to land use, water use, air and water quality, aquatic and terrestrial ecosystems, the public, construction workforce, and socioeconomic resources due to plants' fuel consumption.	Specific measures and controls are not needed; impacts are minor.

Table 5.10-1 (Sheet 11 of 12)
Summary of Measures and Controls to Limit Adverse Impacts of Plant Operation

Section Reference	Potential Impact Significance (a,b) Categories														Impact Description or Activity	Specific Measures and Controls
	Air Quality	Aquatic Ecosystems	Erosion and Sediment	Groundwater	Land Use	Noise	Public Health & Safety	Radiation Exposure	Socioeconomic	Surface Water	Terrestrial Ecosystems	Traffic	Wastes	Water Use		
5.8 Socioeconomic Impacts																
5.8.1 Physical Impacts of Plant Operation	S					S			S			S			1. Small increase in local traffic and noise levels due to operational workforce traffic in early morning and late afternoon. 2. Preliminary modeling results for cooling tower and auxiliary boiler emissions indicate that the $PM_{2.5}$ level exceeds the EPA SIL level for $PM_{2.5}$ in New Castle County, which is in a non-attainment area for 24-hr. $PM_{2.5}$. 3. Small changes in local viewscape due to presence of up to two new cooling towers.	1. Measures to mitigate impacts to level of service (LOS) for local roads from construction traffic will be left in place. 2. Coordination with NJDEP on final modeling of air emissions and ways to reduce $PM_{2.5}$ emissions to meet regulatory limits. 3. Specific measures and controls are not needed; impacts are minor as towers are co-located with existing natural draft tower.
5.8.2 Socioeconomic Impacts					S				S						1. Increase in direct and indirect employment and tax revenues. 2. Small increase in demand for local water supply and treatment, housing, and educational resources which have excess capacity. 3. Small increase in demand for police, fire, and medical and social services. 4. Small changes in local land-use due to new housing. *5.* Small decrease in LOS on local roads.	1. Specific measures and controls are not needed; impacts are beneficial. 2. Specific measures and controls are not needed; impacts are minor. 3. Specific measures and controls are not needed; impacts are minor. 4. Specific measures and controls are not needed; impacts are minor. 5. Measures to mitigate impacts to LOS for local roads from construction traffic will be left in place and be adequate to offset traffic impacts from operational workforce.

Table 5.10-1 (Sheet 12 of 12)
Summary of Measures and Controls to Limit Adverse Impacts of Plant Operation

Potential Impact Significance [a,b]

Section Reference	Categories														Impact Description or Activity	Specific Measures and Controls
	Air Quality	Aquatic Ecosystems	Erosion and Sediment	Groundwater	Land Use	Noise	Public Health & Safety	Radiation Exposure	Socioeconomic	Surface Water	Terrestrial Ecosystems	Traffic	Wastes	Water Use		
5.8.3 Environmental Justice Impacts									S			S			Potential for deterioration of LOS on roads through low income and minority population areas.	Measures to mitigate impacts to LOS for local roads from construction traffic will be left in place and be adequate to offset traffic impacts.
5.9 Decommission-ing Impacts *(Based on NUREG-0586)*	S	S	S	S	S	S	S	S	S	S	S	S	S	S	1. Small occupational exposure to radiation during decommissioning, including transportation of materials to disposal sites; small radiological releases to the environment and ingestion and inhalation of these by the public and biota. 2. Small air quality, ecological, and water quality impacts due to smaller level of land disturbance during decommissioning.	1. Specific impacts and significance of these impacts are unknown at this time as a decommissioning method has not been chosen and no mitigation measures or controls can be proposed at this time. 2. NUREG-0586 indicates that environmental impacts are substantially less because land disturbance is less during decommissioning than during construction and operation. Radiological releases are also less during decommissioning.

a) The assigned significance levels are based on the assumption that the associated proposed mitigation measures and controls are implemented.
b) Blanks in columns denote “no impact” for that specific category due to assessed impacts.