CHAPTER 6

ENVIRONMENTAL MEASUREMENTS AND MONITORING PROGRAMS

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ACRONYMS AND ABBREVIATIONS

Acronym	Definition
amsl	above mean sea level
bgs	below ground surface
BOD	biological oxygen demand
CDF	confined disposal facility
CFR	Code of Federal Regulations
COL	combined license
CWA	Clean Water Act
°C	degrees Celsius
°F	degrees Fahrenheit
DRBC	Delaware River Basin Commission
EEP	Estuary Enhancement Program
EPA	U.S. Environmental Protection Agency
ER	Environmental Report
ESP	early site permit
ft.	feet
HCGS	Hope Creek Generating Station
Hg	mercury
JFT	joint frequency table
m	meter
m/s	meters per second
Mgd	million gallons per day
mi.	mile
mph	miles per hour
NAD 83	1983 North American Datum
NAVD	North American Vertical Datum
NEI	Nuclear Energy Institute
NJAC	New Jersey Administrative Code

ACRONYMS AND ABBREVIATIONS (CONTINUED)

Acronym	Definition
NJDEP	New Jersey Department of Environmental Protection
NJPDES	New Jersey Pollutant Discharge Elimination System
NOAA	National Oceanic and Atmospheric Administration
NRC	U.S. Nuclear Regulatory Commission
ODCM	Off-Site Dose Calculation Manual
REMP	Radiological Environmental Monitoring Program
RG	Regulatory Guide
RGPP	Radiological Groundwater Protection Program
SACTI	Seasonal/Annual Cooling Tower Impact
SGS	Salem Generating Station
SSAR	Site Safety Analysis Report
TLD	thermoluminescent dosimetry
TOC	total organic carbon
TSS	total suspended solids
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey
yr	year

CHAPTER 6

ENVIRONMENTAL MEASUREMENTS AND MONITORING PROGRAMS

6.0 INTRODUCTION

This chapter describes the environmental measurement and monitoring programs for the new plant. Programs now in place for the Hope Creek Generating Station (HCGS) and Salem Generating Station (SGS) will be modified to include new plant requirements where appropriate. Proposed monitoring programs for the new plant are based on an understanding of the local environmental setting as developed during the early site permit (ESP) application process, and known and anticipated permitting requirements. The discussion of environmental measurements and monitoring programs is divided into the following sections:

- Thermal Monitoring (Section 6.1)
- Radiological Environmental Monitoring (Section 6.2)
- Hydrological Monitoring (Section 6.3)
- Meteorological Monitoring (Section 6.4)
- Ecological Monitoring (Section 6.5)
- Chemical Monitoring (Section 6.6)
- Summary of Monitoring Programs (Section 6.7)

Monitoring details, including sampling equipment, constituents, parameters, frequency, and locations for each phase of the overall program are described in each of these sections.

6.1 THERMAL MONITORING

Thermal monitoring is conducted in accordance with New Jersey Department of Environmental Protection (NJDEP) regulations; specifically, the New Jersey Pollutant Discharge Elimination System (NJPDES) permit process.

Subsection 2.3.1 provides a characterization of the Delaware River thermal conditions in the vicinity of the PSEG Site. Pertinent information related to HCGS and SGS thermal discharge monitoring is presented in the context of NJPDES permitting requirements in Subsection 2.3.3. Subsections 5.2.3 and 5.3.2 describe the analysis of the new plant predicted thermal plume.

Thermal monitoring associated with the preapplication, construction/preoperational, and operational phases of the project are described below. Water temperature acceptance criteria are based on federal, state, and regional requirements.

6.1.1 PREAPPLICATION MONITORING PROGRAM

Each of the existing plants on the PSEG Site holds an NJPDES permit: Permit Number NJ0025411 for the HCGS (Reference 6.1-1); and Permit Number NJ0005622 for the SGS (Reference 6.1-2). For both plants, their respective permits require a monitoring program that consists of continuous thermal monitoring of intake water temperature and discharge temperatures to the Delaware River. No other thermal monitoring within the Delaware River is required.

Preapplication thermal monitoring was conducted in association with the water quality characterization program for this ESP application. This program, described in Subsection 2.3.3, includes quarterly sampling of marsh creeks, on-site water bodies, and the Delaware River.

As discussed in Subsection 2.3.1, extensive data collection related to the SGS thermal discharge was completed in 1998. This included extensive field measurements within the Delaware River to document and evaluate horizontal and vertical temperature variability as part of the plant’s Section 316(a) demonstration. Routine or ongoing temperature monitoring is not required or performed for thermal characteristics within the Delaware River.

6.1.2 CONSTRUCTION AND PREOPERATIONAL MONITORING

During the construction phase, thermal monitoring consists of the continuation of the routine intake and discharge temperature monitoring associated with the NJPDES permit requirements at HCGS and SGS. This monitoring is ongoing and serves as a baseline during the construction phase.

6.1.3 OPERATIONAL MONITORING

Modeling conducted for this application indicates that the new plant discharge affects a small percent of the water column in the immediate discharge vicinity, and the effects dissipate over a short distance (Subsection 5.2.3).

A NJPDES permit is required for the new plant and it is anticipated that monitoring requirements will be similar to those for HCGS and SGS. Specifically, continuous temperature monitoring at the cooling water intake structures and at the discharge to the Delaware River.

6.1.4 REFERENCES

6.1-1 New Jersey Department of Environmental Protection, Final Surface Water Renewal Permit Action, Hope Creek Generating Station, NJPDES Permit Number NJ0025411, December 31, 2002.

6.1-2 New Jersey Department of Environmental Protection, Final Surface Water Renewal Permit Action, Salem Generating Station, NJPDES Permit Number NJ0005622, June 29, 2001.

6.2 RADIOLOGICAL ENVIRONMENTAL MONITORING

The new plant radiological environmental monitoring program (REMP) will be incorporated, as appropriate, into the existing PSEG monitoring program that is common to HCGS and SGS. The REMP was established to monitor and determine the effects of small amounts of radioactive material releases to the environment associated with normal operation of a nuclear power generating station.

6.2.1 PREAPPLICATION MONITORING

6.2.1.1 Existing Radiological Environmental Monitoring Program Basis

The existing REMP is described in detail in the respective HCGS and SGS Off-Site Dose Calculation Manuals (ODCM) (References 6.2-2 and 6.2-3), the Annual Radiological Environmental Operating Report (Reference 6.2-4), and in the following subsections.

6.2.1.2 Existing Radiological Environmental Monitoring Program Contents

Preoperational environmental radiological data collected from 1973 to 1976 provided a baseline for the existing HCGS and SGS REMP. The measurement of radiation levels, concentrations (including surface area), and/or other quantities of radioactive material are used to evaluate potential exposures and doses to members of the public and the environment.

The following radiation exposure pathways are routinely monitored as part of the REMP for the HCGS and SGS:

- Direct (dosimeters)
- Airborne (iodine and particulates)
- Waterborne (surface and ground water, drinking water, and sediment)
- Ingestion (milk, vegetation, fish and invertebrates)

Sampling results and locations are evaluated to determine the effects from seasonal yields and variations from baseline data. Figures 6.2-1 and 6.2-2 identify the existing sampling locations for the HCGS and SGS REMP (Reference 6.2-2). Table 6.2-1 provides details of the radiation exposure pathways monitored and the monitoring frequencies for those pathways (References 6.2-2 and 6.2-3). Sensitivity analyses provide information regarding changes in background levels. They also determine the adequacy of analysis techniques in light of program results and changes in technology, when compared to baseline measurements. Changes in program implementation (including sampling techniques, frequencies and locations) may be incorporated in response to monitoring results.

In late 2002, a leak of spent fuel pool water from SGS Unit 1 to the shallow groundwater immediately adjacent to the plant was identified. The original leak was stopped in early 2003. The tritium activity released is present in the shallow groundwater. The spread of the contaminated groundwater was partially contained by a foundation cofferdam system that surrounds both SGS units. During original construction, the area within the cofferdam was excavated to the top of the competent layer and backfilled with lean concrete. Materials within the cofferdam are compacted fill, lean concrete, structural fill, or pipe bedding. In 2003 PSEG initiated a NJDEP approved remediation project to remove and monitor the residual tritium

activity. Periodic reporting is provided to NJDEP and the NRC, as well as routine reporting in the annual Radiological Effluent Monitoring Report. In addition to the remediation wells, PSEG installed a number of monitoring wells to provide early detection of any migration of tritium outside the cofferdam, in both the shallow groundwater, and the Vincentown Formation. In general the tritium is immediately adjacent to SGS Unit 1 and several thousand feet downgradient from the PSEG Site. Additionally, PSEG has installed monitoring wells as part of the Radioactive Groundwater Protection Program (RGPP) that provides early detection of any groundwater radionuclide contamination. The RGPP was initiated by PSEG in 2006 to determine whether groundwater at, and in the vicinity of, HCGS and SGS is adversely impacted by any radionuclide releases (including tritium) related to nuclear station operations. The RGPP is a voluntary program implemented by PSEG in conjunction with the nuclear industry initiatives and associated guidance in Nuclear Energy Institute (NEI) 07-07 (Reference 6.2-1). Although it is designed to be separate, the RGPP complements the existing REMP. The long-term groundwater sampling program is one of the key elements of the RGPP that provides for early leak detection. The other key elements that comprise the RGPP and contribute to public safety are spill/leak prevention and effective remediation.

6.2.1.3 Existing Radiological Environmental Monitoring Program Reporting

An Annual Radiological Environmental Operating Report is submitted to the NRC in accordance with the respective HCGS and SGS Technical Specifications and ODCM. The Annual Radiological Environmental Operating Report includes summaries, interpretations, and an analysis of the radiological environmental surveillance activities for the report period. These reports include a comparison with preoperational studies with operational controls (as appropriate), previous environmental surveillance reports, and an assessment of the observed impacts of the plant operation on the environment (Reference 6.2-4).

A land use census is conducted annually to ensure that changes at and beyond the site boundary are identified and that modifications to the radiological environmental monitoring program are made, if required. This census entails door-to-door surveys, aerial surveys, and consultation with local agricultural authorities. The best information from the census is used. This census satisfies the requirements of Section IV.B.3 of 10 CFR Part 50, Appendix I, *Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion "As Low as is Reasonably Achievable" for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents.* (References 6.2-2 and 6.2-3) Land use census results are included in the Annual Radiological Environmental Operating Report. The Annual Radiological Environmental Operating Report also includes the status of the RGPP.

6.2.1.4 Existing Quality Assurance Program

An Inter-Laboratory Comparison Program ensures that independent checks are performed on the precision and accuracy of the measurements of radioactive material in environmental sample matrices. This is part of the quality assurance program for environmental monitoring demonstrating that the results are reasonably valid for the purposes of 10 CFR Part 50, Appendix I, Section IV.B.2 (References 6.2-2 and 6.2-3). The results are included in the Annual Radiological Environmental Operating Report.

The REMP is conducted in accordance with the U.S. Nuclear Regulatory Commission (NRC) Regulatory Guide (RG) 4.15, *Quality Assurance for Radiological Monitoring Programs (Normal*

Operations)-Effluent Streams and the Environment, Revision 1 (1979). Quality assurance is provided in the existing NRC-approved REMP through quality training, program implementation by periodic tests, the Inter-laboratory Comparison Program, and administrative and technical procedures.

6.2.2 CONTRUCTION/PREOPERATIONAL MONITORING

6.2.2.1 Radiological Monitoring Program

The existing PSEG REMP serves as the new plant construction/preoperational radiological monitoring program. Additional on-site thermoluminescent dosimetry (TLD) monitoring locations will be added to the north of the HCGS to support the ODCM/REMP for the construction and preoperational period. A description of the new monitoring locations and other applicable parameters will be provided in the combined license (COL) application.

6.2.3 OPERATIONAL MONITORING

6.2.3.1 Radiological Monitoring Program

As described in Subsection 6.2.2, the existing PSEG REMP serves as the new plant operational radiological monitoring program. The operational program for the new plant will comply with RG 4.1, *Radiological Environmental Monitoring for Nuclear Power Plants*, Revision 2 (2009), and *Radiological Assessment Branch Technical Position Regarding Radiological Environmental Monitoring Programs* (1979). The ODCM for the new plant operational monitoring program will be consistent with the HCGS and SGS ODCMs and the requirements of 10 CFR 50 Appendix I. Additional on-site TLD monitoring locations will be added to the north of the HCGS to support the ODCM/REMP for the new plant as shown in Figure 6.2-3. A description of the new monitoring locations and other applicable parameters will be provided in the COL application. The quality assurance program for the new plant REMP will be in accordance with RG 4.15, *Quality Assurance for Radiological Monitoring Programs (Inception through Normal Operations to License Termination) - Effluent Streams and the Environment*, Revision 2 (2007).

6.2.4 REFERENCES

6.2-1 NEI 07-07, Industry Groundwater Protection Initiative-Final Guidance Document, Nuclear Energy Institute, Washington, DC, June 2007.

6.2-2 PSEG Nuclear LLC, 2008 Annual Radioactive Effluent Release Report for the Salem and Hope Creek Generating Stations, May 2009, and Appendix C, Salem Offsite Dose Calculation Manual, Rev 21.

6.2-3 PSEG Nuclear LLC, 2006 Annual Radioactive Effluent Release Report for the Salem and Hope Creek Generating Stations, April 2007, and Appendix D, Hope Creek Offsite Dose Calculation Manual, Rev 23.

6.2-4 PSEG Power LLC, 2008 Annual Radiological Environmental Operating Report for Salem Generating Station Unit 1, Salem Generating Station Unit 2, Hope Creek Generating Station, April 2009.

Table 6.2-1
Radiological Monitoring Program (Pathways) [(a)]

Radiation Exposure Pathway Monitored	Parameters	Frequency of Analysis
Direct	Gamma Dose	Quarterly
Airborne	Radioiodine	Weekly
	Particulates: Gross beta radioactivity	Weekly after filter change.
	Gamma isotopic analysis	Quarterly
Waterborne	Surface water: Gamma isotopic analysis	Monthly
	Surface water: Tritium	Quarterly
	Groundwater: Gamma isotopic analysis	Monthly
	Groundwater: Tritium	Quarterly
	Drinking water: Radioiodine	Biweekly or monthly, depending on calculated dose
	Drinking water: Gross beta radioactivity and gamma isotopic analysis	Monthly
	Drinking water: Tritium	Quarterly
	Sediment: Gamma isotopic analysis	Semiannually
Ingestion	Milk: Gamma isotopic analysis and radioiodine	Semi-monthly when animals are on pasture; monthly at other times.
	Fish and invertebrates: Gamma isotopic analysis	Sample in season or semiannually if not seasonal; perform analysis on edible portions.
	Food products: Gamma isotopic analysis	Sample at time of harvest; analysis on edible portions.

a) Radiological monitoring program for preapplication, construction/preoperation, and operation.

6.3 HYDROLOGICAL MONITORING

This section discusses the new plant program for monitoring the effects of the new plant on hydrology. This program monitoring includes flow rates, water levels, sediment loads, and groundwater levels.

As described in Section 2.3, extensive hydrologic monitoring information in the vicinity of the site is available from ongoing monitoring associated with the existing HCGS and SGS. Monitoring was also conducted by various agencies associated with general data collection for the Delaware River (U.S. Geological Survey [USGS] and National Oceanic and Atmospheric Administration [NOAA]) or program-specific needs (e.g., the U.S. Army Corps of Engineers' [USACE] proposed deepening of the Delaware River navigation channel). This section describes site-specific hydrologic monitoring information for preapplication, construction and preoperation, and operations. Specific equipment and monitoring locations will be determined subsequent to reactor technology selection and detail design. Implementation procedures, schedules, and processes will be in accordance with detail terms and conditions of applicable NJDEP and DRBC permits.

6.3.1 PREAPPLICATION MONITORING

6.3.1.1 Surface Water

PSEG currently conducts surface water and surface water discharge monitoring in accordance with Clean Water Act (CWA) requirements, including NJPDES permits for the HCGS and SGS. Additionally, other short-term surface water monitoring has been completed for those facilities under various permit conditions. The HCGS NJPDES Permit and SGS NJPDES Permit both require monitoring and recording of cooling water intake/discharge rates (References 6.3-1 and 6.3-2). The NJPDES monitoring locations are shown in Figure 6.3-1; those that include a hydrological monitoring requirement are described on Table 6.3-1.

Surface water monitoring was conducted as part of the field effort for the development of the ESP Environmental Report (ER), including periodic stage or level measurements at a number of locations along tidal creek segments. These measurement locations are shown on Figure 2.3-15 and described on Table 6.3-2.

6.3.1.2 Groundwater

PSEG measures groundwater elevations in the different water-bearing zones under separate monitoring programs including:

- Groundwater supply well monitoring program
- ESP application baseline studies
- Radiological groundwater monitoring protection program
- Tritium remediation monitoring program (SGS)

Data from the well monitoring for the groundwater supply program and that collected from wells installed in support of the ESP application are used for this evaluation. These

wells are evaluated to assess the local geology and hydrogeology as discussed further in Section 2.3.

6.3.1.2.1 Groundwater Supply Wells

There are six water production wells that are permitted to withdraw groundwater for HCGS and SGS and four additional observation wells that are monitored to evaluate potential aquifer impacts under Water Allocation Permit No. WAP040001 (Reference 6.3-4). These wells are shown on Figure 6.3-2, and a summary of the monitoring program is presented in Table 6.3-3. The information from this monitoring program will be used in the design of the additional groundwater production wells.

6.3.1.2.2 ESP Application Wells

As described in Section 2.3, 16 well pairs were installed at the PSEG Site to evaluate groundwater flow, quality, and local hydrogeology. The wells were paired in the shallow water-bearing strata (riverbed sand and gravel) and the Vincentown aquifer. Monthly groundwater level measurements were collected, and the data is used to support groundwater flow estimates and the modeling effort. Well locations are identified on Figure 6.3-2 and Table 6.3-4. In addition, 10 shallow piezometers are installed within surface water bodies. At each of these locations, the depth to groundwater was compared to the depth to surface water to evaluate the hydraulic communication between the shallow groundwater and the surface water bodies. Piezometers located on the PSEG Site were measured monthly, whereas piezometers located in nearby streams were measured quarterly.

6.3.1.2.3 Radiological Groundwater Protection Program and Tritium Remediation Monitoring Wells

The wells installed for the RGPP at HCGS and SGS and for tritium remediation monitoring at SGS are generally located in the shallow water-bearing strata or the Vincentown aquifer, consistent with the wells installed in conjunction with the ESP Application. For each program, depth to groundwater was measured from a surveyed point using a slope indicator, air line, or tape (or equivalent) water level meter.

6.3.2 CONSTRUCTION AND PREOPERATIONAL MONITORING

6.3.2.1 Surface Water

Surface water discharges during construction includes storm water runoff and construction dewatering discharges. Hydrologic monitoring (turbidity) may be performed in conjunction with construction phase dredging activities for the new plant intake and barge facilities. Monitoring will be conducted in accordance with NJPDES and dredging permit requirements. Delaware River monitoring performed in accordance with HCGS and SGS permit requirements also provides information regarding hydrologic conditions of receiving water throughout the construction period.

6.3.2.2 Groundwater

Groundwater monitoring during construction includes test wells that measure water levels within the zone of influence created by dewatering activities and subsequent discharge or recharge areas. Monitoring includes wells screened within different water-bearing zones such as the hydraulic fill materials, the riverbed deposits, and the Kirkwood Formation-Vincentown Formation. Monitoring will be conducted in accordance with permit requirements and will include wells located at HCGS and SGS to monitor the extent of the dewatering influence and confirm no impact to the operating plants.

6.3.3 OPERATIONAL MONITORING

6.3.3.1 Surface Water

Surface water hydrologic monitoring during plant operation will be developed in coordination with the NJPDES permit requirements and the Delaware River Basin Commission (DRBC) docket requirements. It is anticipated that the monitoring requirements and program will be similar to the existing HCGS surface water hydrologic monitoring requirements and programs. The new plant has a closed-cycle cooling water system similar to the HCGS in terms of potential surface water hydrologic impacts.

The new plant is a new facility under the Phase I, New Facility requirements specified in 40 CFR 125.84 (Federal Register, 2001). Monitoring to demonstrate compliance with U.S. Environmental Protection Agency (EPA) requirements of 40 CFR 125.87 will be specified in the NJPDES permit. With regard to hydrology, the two elements of this proposed monitoring program are (1) velocity monitoring of the surface intake screen systems; and (2) visual/remote inspections of design and construction technologies. Results of these monitoring activities are used to support the interpretation of impingement and entrainment monitoring as described in Subsection 6.5.2.

6.3.3.2 Groundwater

NJDEP water allocation permit and DRBC docket requirements will provide ongoing monitoring requirements for the water supply wells.

6.3.4 REFERENCES

6.3-1 New Jersey Department of Environmental Protection, Final Surface Water Renewal Permit Action, Hope Creek Generating Station, NJPDES Permit Number NJ0025411, December 31, 2002.

6.3-2 New Jersey Department of Environmental Protection, Final Surface Water Renewal Permit Action, Salem Generating Station, NJPDES Permit Number NJ0005622, June 29, 2001.

6.3-3 New Jersey Department of Environmental Protection, NJPDES Surface Water Discharges in New Jersey, (1:12,000) Version 20090126, accessed January 7, 2010.

6.3-4 New Jersey Department of Environmental Protection, Water Allocation Permit – Minor Modification, Program Interest ID:2216P, Activity No WAP040001, December 30, 2004.

Table 6.3-1
Existing Surface Water Hydrological Monitoring Program

Monitoring Location	Units	Frequency	Type
Salem Generating Station			
048C (internal discharge to 481, 482, 484, and/or 485 on batch-type basis)	Mgd	Daily	Calculated
481A (cooling water)	Mgd	Daily	Calculated
482A (cooling water)	Mgd	Daily	Calculated
483A (cooling water)	Mgd	Daily	Calculated
484A (cooling water)	Mgd	Daily	Calculated
485A (cooling water)	Mgd	Daily	Calculated
486A (cooling water)	Mgd	Daily	Calculated
487B (#3 effluent skim tank)	Mgd	Discharge Event	Calculated
489A (south yard drain/Oil Water Separator)	Mgd	Monthly	Calculated
Hope Creek Generating Station			
462B (sewage treatment system effluent – internal; flows to 461A)	Mgd	Continuous	Metered
461C (Low Volume and Oily Waste System)	Mgd	Daily	Metered
461A (cooling tower blowdown)	Mgd	Continuous	Metered

Mgd = million gallons per day

References 6.3-1 and 6.3-2

Table 6.3-2
Surface Water Monitoring Locations in Support of the ESP Application

Sample ID	Location	Water Flow Measurements
AS-1 through AS-3	Proposed access road north of PSEG Site	Quarterly
AS-4 through AS-6, and AS-9	Surface Waters within the PSEG Site boundary	Monthly
AS-08	Delaware River near the new plant	Monthly
AS-10	Surface Waters along the East Site	Monthly
AS-11	Hope Creek, along current access road	Quarterly
AS-15	Within the confined disposal facility (CDF) Property	Quarterly

Table 6.3-3
Groundwater Monitoring Program to Support Water Allocation Permit

Well ID	Requirement	Frequency	Monitored Parameter	Monitoring Method
Well PW-2[(a)] (standby) Well PW-3[(a)] (standby) Well PW-5[(a)] Well HC-1[(a)] Well HC-2[(a)] Well PW-6[(a)] Well J[(b)] Well 6[(b)] Well I[(b)] Well G[(b)]	Static water levels for each well indicated shall be monitored and reported on forms provided by the NJDEP (New Jersey Administrative Code [NJAC] 7:19-2)	Monthly	Static Water Level	Airline, Tape, or Gage
Permit # WAP0400D1 Well PW-2 (standby) 3400000758, Well PW-3 (standby) 3400001031, Well PW-5 3400001073, Well HC-1 3400001074, Well HC-2 3400001512, Well PW-6	The monthly diversion shall be monitored and recorded on forms provided by the NJDEP (NJAC 7:19-2)	Monthly	Water Diverted	Meter
HCGS and SGS, 2216P Water Allocation Permit-All Diversion Sources	Total amount of water incorporated into product(s) during the calendar year shall be calculated at the end of each year. This value shall be recorded in the December block on the fourth Quarterly Report. [DRBC Resolution No. 2001-8]	Annually	Annual Total Water Incorporated in Product	Calculated
HCGS and SGS, 2216P Water Allocation Permit-All Diversion Sources	Total evaporative loss amount of all water diverted for the calendar year shall be calculated at the end of each year. This value shall be recorded in the December block on the fourth Quarterly Report. [DRBC Resolution No. 2001-8]	Annually	Annual Total Evaporative Loss	Calculated

Reference 6.3-4
a) Production wells
b) Observation wells

Table 6.3-4
Groundwater Monitoring Program to Support the ESP Application

Well Identification	Northing (U.S. ft., NAD 83)	Easting (U.S. ft., NAD 83)	Screen Interval (ft. bgs)	Reference Point Elevation (ft. NAVD 88)	Formation of Screen Installation	Monitoring Frequency
Wells						
NOW-1U	234542.7	198443.4	46-56	15.20	Alluvium	Monthly
NOW-1L	234564.0	198449.8	80-90	15.19	Vincentown	Monthly
NOW-2U	235207.4	197754.9	52-62	10.80	Alluvium	Monthly
NOW-2L	235227.7	197752.8	103-113	11.18	Vincentown	Monthly
NOW-3U	234552.8	197885.2	40-50	7.71	Alluvium	Monthly
NOW-3L	234565.5	197897.9	90-100	7.66	Vincentown	Monthly
NOW-4UB	233963.0	198147.1	42-52	13.56	Alluvium	Monthly
NOW-4L	233972.7	198147.9	73-83	14.08	Vincentown	Monthly
NOW-5U	234907.5	198444.5	20-30	10.23	Hydraulic Deposits	Monthly
NOW-5L	234927.5	198438.4	90-100	10.54	Vincentown	Monthly
NOW-6U	235269.4	198313.5	35-45	8.59	Alluvium	Monthly
NOW-6L	235287.9	198312.8	80-90	7.95	Vincentown	Monthly
NOW-7U	234975.8	199694.3	48-58	8.25	Alluvium	Monthly
NOW-7L	234973.4	199675.9	85-95	8.70	Vincentown	Monthly
NOW-8U	234141.6	199755.9	37-47	11.68	Alluvium	Monthly
NOW-8L	234139.1	199736.2	100-110	11.61	Vincentown	Monthly
EOW-1U	232321.6	202758.0	38-48	18.01	Alluvium	Monthly
EOW-1L	232297.6	202758.1	95-105	17.91	Vincentown	Monthly
EOW-2U	233274.6	202157.9	39-49	16.51	Alluvium	Monthly
EOW-2L	233271.5	202177.7	99-109	16.73	Vincentown	Monthly
EOW-4U	231791.9	202012.1	22-32	22.73	Hydraulic Deposits	Monthly
EOW-4L	231772.9	202021.2	110.2-120.2	22.31	Vincentown	Monthly
EOW-5U	233056.8	203007.3	35-45	15.85	Alluvium	Monthly
EOW-5L	233039.7	203021.5	110-120	16.17	Vincentown	Monthly
EOW-6U	232587.1	203281.4	47-57	15.99	Alluvium	Monthly
EOW-6L	232588.1	203300.7	90-100	15.23	Vincentown	Monthly
EOW-8U	231144.2	203520.4	30-40	18.38	Alluvium	Monthly
EOW-8L	231163.5	203516.0	67-77	17.89	Vincentown	Monthly
EOW-9U	230917.2	202826.0	50-60	20.67	Alluvium	Monthly
EOW-9L	230925.6	202844.6	117.5-127.5	18.21	Vincentown	Monthly
EOW-10U	231687.2	203521.3	17-27	14.79	Alluvium	Monthly
EOW-10L	231706.7	203521.9	85-95	14.27	Vincentown	Monthly
Piezometers						
AS-01	251116.5	207546.8	N/A	3.67	N/A	Quarterly
AS-02	243284.6	205316.6	N/A	4.17	N/A	Quarterly
AS-03	239115.6	204823.3	N/A	2.50	N/A	Quarterly
AS-04	234890.4	199526.2	N/A	6.27	N/A	Monthly
AS-05	234871.1	200189.1	N/A	6.51	N/A	Monthly
AS-06	234559.8	201798.2	N/A	4.15	N/A	Monthly
AS-08	233915.5	197783.4	N/A	4.78	N/A	Monthly
AS-09	234162.4	199619.5	N/A	8.12	N/A	Monthly
AS-10	231426.1	204401.6	N/A	6.22	N/A	Monthly
AS-11	229374.8	211156.9	N/A	3.91	N/A	Quarterly

ft. bgs = feet below ground surface, determined from well installation records.
NAD 83 = 1983 North American Datum, NAVD = North American Vertical Datum 88.

6.4 METEOROLOGICAL MONITORING

Meteorological monitoring associated with the preapplication, construction/preoperational, and operational phases of the project are discussed in the following subsections.

6.4.1 PREAPPLICATION MONITORING

The new plant preapplication meteorological monitoring program is the existing HCGS and SGS on-site monitoring program, which is described below.

6.4.1.1 General Program Description

The HCGS and SGS meteorological monitoring program conforms to the requirements of RG 1.23 Revision 0. PSEG maintains an existing on-site primary meteorological tower. It is a 300-foot (ft.) structure supported by guy wires. Its geographic coordinates are 39° 27’ 48.9” north latitude, 75° 31’ 11.76” west longitude. The primary tower location is 5470 ft. southeast of the new plant power block area. The base of the primary tower is at 11.3 ft. NAVD. As discussed in Site Safety Analysis Report (SSAR) Subsection 2.3.3.2, a portion of the site, including the new plant power block area will be raised 25 ft., to 36.9 ft. NAVD. That raised ground elevation does not affect the applicability of the meteorological tower measurements for this ER, or affect the suitability of future tower measurements for use during new plant operation. This is due to the distance from the new plant and lack of any substantial grade changes across the PSEG Site.

Terrain maps of topographic features within a 5-mile (mi.) radius of the PSEG Site and terrain elevation profiles along each of the 16 standard 22.5-degree compass radials out to a distance of 50 mi. from the new plant are shown in SSAR Figures 2.3.2-41 through 2.3.2-49. Those maps and profiles show that site region topographic relief is minimal. The major local feature is the Delaware River, which is 2.5 mi. wide and oriented north-south adjacent to and west of the PSEG Site. Regional ground surface character is mixed marsh, cropland, and woodland. The maximum terrain elevation within 5 mi. of the PSEG Site is less than 60 ft. above grade, in the west direction. The nearest topographic elevations greater than 500 ft. above grade are at a distance of 15 mi. in the northwest direction. Local topography is not a factor in meteorological instrumentation siting or exposure because it does not have significant effects on local airflow.

The primary tower is of lattice construction, which minimizes its effects on airflow. Primary tower instrumentation is mounted on booms oriented into the prevailing wind, which is from the northwest. The sensors are mounted on the booms at distances equal to more than twice the tower maximum horizontal width. The primary tower has been in operation for more than 30 years (yr) and has been a reliable source of data for on-site meteorological conditions during that period to support plant operations and reporting for the existing HCGS and SGS.

PSEG maintains a backup meteorological tower, consisting of a 10-meter (m) (33-ft.) utility pole. It is located 386 ft. south of the primary tower. The primary tower serves as the main source of site meteorological data. The backup tower is used for periods of equipment failure on the primary tower. Backup tower measurements include wind speed, wind direction, and sigma-theta determinations at the 10-m (33-ft.) elevation only. The existing primary and backup on-site meteorological systems include instrumentation as described in Table 6.4-1.

To meet RG 1.23 Revision 1, enhancements were made to the primary meteorological tower instrumentation during June 2008. Relative humidity sensors were added at the 300-ft. and 33-ft. levels. A dry bulb temperature sensor was added at the 300-ft. level. Wind direction, wind speed, sigma theta, and 197-33 ft. delta-temperature sensors were added at the 197 ft. level. Vertical temperature difference resolution was also upgraded to 0.01 degrees Celsius (°C). Those enhancements improved on a system that was already providing high quality data.

6.4.1.2 Location, Elevation, and Exposure of Instruments

As described above, the primary tower location is 5470 ft. southeast of the new plant power block area. The backup tower, as described above, is located 386 ft. south of the primary tower.

Whenever possible, wind measurements should be made at a distance of at least ten times the height of any nearby obstruction that exceeds one-half the height of the wind measurement. The tallest site structures are the existing HCGS and SGS containments and HCGS cooling tower, and the new plant containments and cooling towers. The existing HCGS and SGS containments are located at least 4500 ft. west of the meteorological towers and the tallest (HCGS) is 203 ft. high. This distance and height yield a distance/height ratio of 22.2:1, which meets the 10:1 distance/height ratio criterion. The existing HCGS cooling tower is located 4700 ft. northwest of the meteorological towers and is 512 ft. high. This distance and height yield a distance/height ratio of 9.2:1. Although this is less than the 10:1 distance/height ratio criterion, the 10:1 distance/height ratio criterion is based on rectangular structures. A tall and aerodynamically smooth structure such as the existing HCGS cooling tower produces a downwind wake influence smaller than predicted by the 10:1 ratio. In addition, the terrain at the PSEG Site is generally flat with little relief. Therefore, the HCGS cooling tower does not have an adverse aerodynamic effect on tower wind measurements.

The containments for the new plant are located 5470 ft. northwest of the meteorological towers (measuring from the nearest point at the southeast corner of the new plant power block area). The new plant cooling towers are located 6800 ft. northwest of the meteorological towers (measuring from the nearest point at the southeast corner of the new plant cooling tower area). As shown in SSAR Table 1.3-1, the bounding plant parameter envelope values for the new plant containment heights and cooling tower heights are 234 ft. and 590 ft., respectively. These values yield distance/height ratios of 23.3:1 for the containments and 11.5:1 for the cooling towers. Both of these ratios meet the 10:1 distance/height ratio criterion in RG 1.23.

Generally, the local topography is quite flat. There are no significant groups of trees in the vicinity. Therefore, topographic features and trees do not affect meteorological tower wind measurements.

The maximum height of influence of a structure wake generally does not exceed 2.5 times the structure height for a squat building (width greater than height), such as the meteorological building at the base of the primary meteorological tower. The meteorological building is 12 ft. high. Based on the building height, the upper limit of the meteorological building aerodynamic wake does not exceed a height of 30 feet. The building aerodynamic wake height is below the lowest wind instrument (33 ft.) on the primary tower. Therefore, the meteorological building aerodynamic wake does not affect meteorological tower wind measurements. Additionally, the 10:1 distance/height ratio criterion does not apply to the meteorological building because its height (12 ft.) does not exceed one-half the height of the lowest wind measurement (33 ft.).

In summary, the topography, including raising the grade for a portion of the site, and existing and new plant structures in the vicinity of the on-site meteorological towers do not adversely affect meteorological measurements. Similarly, vegetation and minor structures in the vicinity of the meteorological towers, such as the meteorological building, do not adversely affect meteorological measurements.

In addition to the on-site meteorological data, NOAA regional meteorological datasets for the January 1, 2006, through December 31, 2008, period of record were used to supplement evaluations of atmospheric dispersion. The following datasets were used: Wilmington, Delaware (DE), hourly surface observations; and Sterling, Virginia (VA) Dulles Airport upper-air soundings and twice-daily mixing heights. The representativeness of Wilmington surface data is described in SSAR Subsection 2.3.1.5.6. Upper-air and mixing height data from Sterling VA Dulles Airport are appropriate because that station is the closest representative upper-air station, as described in Subsection 5.3.3.1.2.

6.4.1.3 Instrumentation Maintenance

Meteorological instrumentation is inspected and serviced regularly. Channel checks are made daily via data downloads and data reviews for inoperable sensors. Sensor and system repairs are made as needed. Site maintenance visits are made weekly. Indicator checks are made once per month. Surveillance and data and system backups are done at six month intervals. Channel calibrations are conducted semiannually. System calibrations encompass entire data channels, including recorders and displays. Calibration of instruments checks from the sensors to the computer displays in the meteorological building. Guyed towers are inspected annually and anchors are inspected every 3 yr.

6.4.1.4 Data Collection and Analysis

The on-site meteorological monitoring system includes display, processing, and communication components. A meteorological building at the base of the primary meteorological tower houses the equipment for processing, recording, display, and transmission of data measured at the primary and backup towers.

Measurements are digitally sampled once per second. Measurements are compiled as 15-minute averages for real-time display at the tower base meteorological building, HCGS and SGS Control Rooms and Technical Support Centers via fiber optic cable or modem. Fifteen minute averages are compiled as hourly values for historical and dispersion analyses. Precipitation values are hourly totals. Daily, meteorological data are downloaded, and reviewed via software and manual checks for reasonableness. Data are reviewed and validated for archive.

Archived on-site meteorological data collected by the monitoring system during the three year period from January 1, 2006 through December 31, 2008 were used to describe local meteorology in Section 2.7 and to evaluate atmospheric dispersion in other sections. Table 6.4-2 presents year-by-year values of percent data recovery for the measured meteorological parameters during those three years. Composite recovery values for joint frequency tables (JFTs) (of 33-ft. wind direction and 33-ft. wind speed, versus Pasquill stability class based on 150-33 ft. delta-T) of 95 percent or greater were achieved during each of the three years. The

only instrument with annual data recovery values less than the 90 percent target was the 33-ft. dew point temperature sensor during 2006 and 2008.

The 33-ft. dew point temperature sensor failed on October 19, 2008, which caused a 90 percent data recovery goal to not be met for the dew point parameter during the year 2008. However, that dew point sensor failure occurred after the June 2008 equipment upgrade which included installation of a 33-ft. relative humidity sensor. Because regulatory guidance requires atmospheric moisture measurement (for example, dew point or relative humidity), the 90 percent data recovery goal was effectively met during that year. The 33-ft. dew point sensor was subsequently replaced during 2009.

Atmospheric moisture measurements are used for predictions of cooling tower atmospheric impacts. Those predictions, described in Subsections 5.3.3.1 and 5.3.3.2, used the Seasonal/Annual Cooling Tower Impact (SACTI) computer code with the available valid dew point temperature measurements.

6.4.2 CONSTRUCTION AND PREOPERATIONAL MONITORING

Because the new plant is colocated with the HCGS and SGS, the construction and preoperational meteorological monitoring program is the existing HCGS and SGS program described above in Subsection 6.4.1.

6.4.3 OPERATIONAL MONITORING

Because the new plant is colocated with the HCGS and SGS, the operational meteorological monitoring program is the existing HCGS and SGS program described above in Subsection 6.4.1.

6.4.4 AIR QUALITY AND EMISSIONS MONITORING

A NJDEP Air Operating Permit, under Title V of the Clean Air Act will be obtained for the new plant. This permit addresses compliance with state and federal air pollution regulations. Requirements for monitoring air emissions and air quality are included in the Title V Operating Permit in accordance with the NJDEP regulations and permitting policies in effect at the time of permitting. These may include periodic stack tests for combustion sources and other monitoring such as fuel use measurements. The specific terms and conditions of any permitting will follow reactor technology selection and detail design, because the specification of auxiliary boilers and other combustion equipment is necessary to define the appropriate limitations. Based upon modeling and prior studies as discussed in Subsection 5.3.3.2, deposition monitoring for cooling tower particulate emissions is not anticipated.

Table 6.4-1 (Sheet 1 of 3)
Meteorological Instrumentation Descriptions and Accuracies for the On-Site Meteorological Monitoring System[a, b]

Measured Parameter	Primary Tower 300 ft. Wind Direction	Primary Tower 300 ft. Wind Speed	Primary Tower 300 ft. Sigma Theta	Primary Tower 300-33 ft. Delta-T	Primary Tower 150 ft. Wind Direction	Primary Tower 150 ft. Wind Speed	Primary Tower 150 ft. Sigma Theta	Primary Tower 150-33 ft. Delta-T
Manufacturer	Met One	Met One	Met One	Met One	Met One	Met One	Met One	Met One
Model	Model 50.5H Sonic Wind Sensor	Model 50.5H Sonic Wind Sensor	Model 50.5H Sonic Wind Sensor	Model 062MP (matched pair)	Model 50.5H Sonic Wind Sensor	Model 50.5H Sonic Wind Sensor	Model 50.5H Sonic Wind Sensor	Model 062MP (matched pair)
Units	degrees azimuth	mph	degrees azimuth	°C per 267 ft.	degrees azimuth	mph	degrees	°C per 117 ft.
Precision	to nearest degree	to 0.1 mph	to nearest degree (to 0.1 degree)	to 0.1°C (to 0.01°C)	to nearest degree	to 0.1 mph	to nearest degree (to 0.1 degree)	to 0.1°C (to 0.01°C)
Range	0 to 360	0.0 to 111.8 mph		-5.0 to 10.0°C	0 to 360	0.0 to 111.8 mph		-5.0 to 10.0°C
System Accuracy	+/- 5 degrees	+/- 0.45 mph or 5 percent of observed speed		+/- 0.1°C	+/- 5 degrees	+/- 0.45 mph or 5 percent of observed speed		+/- 0.1°C
Starting Threshold	0.1 m/s (0.22 mph)	0.1 m/s (0.22 mph)			0.1 m/s (0.22 mph)	0.1 m/s (0.22 mph)		

Table 6.4-1 (Sheet 2 of 3)
Meteorological Instrumentation Descriptions and Accuracies for the On-Site Meteorological Monitoring System[a, b]

Measured Parameter	Primary Tower 33 ft. Wind Direction	Primary Tower 33 ft. Wind Speed	Primary Tower 33 ft. Sigma Theta	Primary Tower 33 ft. Temperature	Primary Tower 33 ft. Dew Point	Primary Tower Ground Barometric Pressure	Primary Tower Ground Precipitation	Primary Tower Ground Solar Radiation
Manufacturer	Met One	Met One	Met One	Met One	Edge Tech	Met One	Met One	Met One
Model	Model 50.5H Sonic Wind Sensor	Model 50.5H Sonic Wind Sensor	Model 50.5H Sonic Wind Sensor	Model 060A-2	200M Chilled Mirror Sensor	Model 090D	Model 375 Tipping Rain/Snow Gauge	Model 95
Units	degrees azimuth	mph	degrees	°F	°F or °C	inches Hg	inches	Langleys per minute
Precision	to nearest degree	to 0.1 mph	to nearest degree (to 0.1 deg)	to 0.1°F	to 0.1°F or °C	to 0.01 inch	to 0.01 inch	to 0.01 Langley
Range	0 to 360	0.0 to 111.8 mph		-50.0 to 50.0°C	-75.0 to 60.0°C	26 to 32 inches Hg	0.00 to 1.00 inch/hour	0.00 to 2.00 Langleys
System Accuracy	+/- 5 degrees	+/- 0.45 mph or 5 percent of observed speed		+/- 0.5°C	+/- 1.5°C		+/- 10 percent of volume or 0.1 inches precipitation for rates < 2 inches per hour	
Starting Threshold	0.1 m/s (0.22 mph)	0.1 m/s (0.22 mph)						

Table 6.4-1 (Sheet 3 of 3)
Meteorological Instrumentation Descriptions and Accuracies for the On-Site Meteorological Monitoring System[a, b]

Measured Parameter	Backup Tower 33 ft. Wind Direction	Backup Tower 33 ft. Wind Speed	Backup Tower 33 ft. Sigma Theta	Time (recorded by data logger and work stations)
Manufacturer	Met One	Met One	Met One	Met One
Model	Model 50.5H Sonic Wind Sensor	Model 50.5H Sonic Wind Sensor	Model 50.5H Sonic Wind Sensor	Model 0455A
Units	degrees azimuth	mph	degrees	
Precision	to nearest degree	to 0.1 mph	to nearest degree (to 0.1 degree)	1 min.
Range	0 to 360	0.0 to 111.8 mph		
System Accuracy	+/- 5 degrees	+/- 0.45 mph or 5 percent of observed speed		+/- 5 min.
Starting Threshold	0.1 m/s (0.22 mph)	0.1 m/s (0.22 mph)		

a) Upgrades implemented as of July 1, 2008 to meet RG 1.23 Revision 1 include the following:

- Relative humidity sensors (0.1% precision) added at the 300-ft. and 33-ft. levels.
- Dry bulb temperature sensor added at the 300-ft. level.
- Wind direction, wind speed, sigma theta, and 197-33-ft. delta-temperature (0.01 ºC precision) sensors added at the 197-ft. level.
- All vertical temperature difference resolutions upgraded to 0.01 °C.

b) Precisions and accuracies in parentheses are values for upgraded equipment, if different.

Hg = mercury
mph = miles per hour
m/s = meters per second

Table 6.4-2
Annual Data Recovery Statistics for the On-Site Meteorological Monitoring System

		Year		
Tower	**Parameter**	**2006**	**2007**	**2008**
Primary	300-ft. Wind Direction	99.1	97.8	94.11
Primary	300-ft. Wind Speed	99.1	97.8	94.11
Primary	300-33-ft. Delta-T	99.9	98.7	99.23
Primary	150-ft. Wind Direction	97.8	99.9	98.44
Primary	150-ft. Wind Speed	97.8	99.9	98.44
Primary	150-33-ft. Delta-T	99.9	97.8	99.11
Primary	33-ft. Wind Direction	99.5	98.1	98.7
Primary	33-ft. Wind Speed	99.5	98.1	98.7
Primary	33-ft. Temperature	99.9	99.6	99.74
Primary	33-ft. Dew Point Temperature	83.9	99.6	79.19
Primary	Ground Barometric Pressure	100.0	99.98	99.86
Primary	Ground Precipitation	91.7	97.4	99.35
Primary	Ground Solar Radiation	100.0	99.98	99.84
Backup	33-ft. Wind Direction	97.3	98.0	98.5
Backup	33-ft. Wind Speed	97.3	98.0	98.5
Not applicable	JFT (150-33-ft. frequency using delta-T based stability class, and 33-ft. wind direction and speed on primary tower)	99.44	95.98	97.93

6.5 ECOLOGICAL MONITORING

This section addresses ecological monitoring for terrestrial ecology, land cover, and aquatic ecology of the areas likely to be affected by new plant site preparation, construction, and operation. The ecological monitoring programs are based on the anticipated environmental impacts due to the new plant implementation and expectations of permitting requirements.

The ongoing ecological monitoring programs are designed to establish baseline conditions, facilitate impact assessment, and detect changes, if present, in the site ecology during new plant site preparation, construction, and operation. In addition, these monitoring programs help guide the development of future permit conditions, mitigation measures, and effectiveness or success of such measures.

6.5.1 PREAPPLICATION MONITORING

6.5.1.1 Terrestrial Ecology and Land Use

Subsequent subsections describe the ecological monitoring for terrestrial ecology during site preparation, construction, and operation of the new plant. The ecological monitoring is designed based on anticipated environmental impacts through the various project phases.

Section 2.2 and Figure 2.2-1 describe the PSEG Site land use. Subsection 2.4.1 describes the preapplication field studies performed to establish baseline conditions, including the major plant communities, resident wildlife, and important species and habitats. This section also includes information on the distribution and abundance of important species and habitats, and life history information such as feeding/foraging areas, wintering areas and breeding.

Preapplication field studies coupled with agency consultation are used to determine if a suitable habitat for federal and state listed species of concern exists and to aid in identifying important species on-site. Baseline conditions, established through preapplication field studies, are used in the planning stages to avoid and minimize impacts to terrestrial natural resources. These studies are used to identify and quantify new plant construction-related and operational impacts as described in Section 4.3 and Subsections 5.3.3.3 and 5.6.1.

Preapplication studies included wetland delineation activities and wetland mitigation monitoring plan development, as described in Subsection 6.5.2. Wetlands are described in Subsection 2.4.1 and mapped wetland boundaries are depicted in Figure 2.4-5.

6.5.1.2 Aquatic Ecology

Aquatic ecosystem monitoring at the PSEG Site has been conducted for over 30 years (since the preoperational baseline studies of SGS) (Subsection 2.4.2). Since 1995, this has included comprehensive aquatic ecological monitoring performed as a condition of the Salem NJPDES permit. This inclusive program integrates impingement and entrainment sampling at the SGS with surveys of the Delaware River and marsh creeks in the vicinity of the PSEG Site. Subsection 2.4.2 summarizes the methods (e.g., locations, gear types) and results of the aquatic ecology aspects of this program, which includes quarterly sampling for fish in on-site and adjacent habitats, and a spring and fall sampling program for benthic invertebrates. PSEG publishes annual monitoring reports. These data provide a basis for describing the aquatic

resources found in the vicinity of the new plant. Other important aquatic species occurring near SGS, such as those of commercial and/or recreational importance, are generally abundant in the Delaware River. Subsection 2.4.2 provides life history information for fish and invertebrate species considered important for this study (Table 2.4-24).

6.5.2 CONSTRUCTION AND PREOPERATIONAL MONITORING

6.5.2.1 Terrestrial Ecology and Land Use

Mitigation is required for wetland impacts resulting from the new plant and potential off-site transmission line construction. This mitigation will begin prior to or concurrent with project construction. Mitigation for the unavoidable loss of wetland resources will be guided by the USACE and NJDEP permit requirements, in accordance with current regulations under Sections 401 and 404 of the CWA, and other regulatory requirements as listed in Section 1.3.

As discussed in Section 4.3, it is expected that mitigation for unavoidable wetlands impacts resulting from new plant and causeway construction will entail wetland restoration of coastal marshes degraded by hydrologic alteration and by invasive species (notably *Phragmites australis,* the invasive strain of common reed). PSEG has extensive knowledge, experience and demonstrated success in restoring coastal wetlands as part of its Estuary Enhancement Program (EEP). Any monitoring required during site preparation, construction, and preoperation will follow guidelines developed by the USACE and NJDEP, in accordance with conditions specified in required permits. Specific monitoring requirements are established in the project compensatory wetland mitigation plan and submitted to the USACE and NJDEP. As specified in future permit conditions, monitoring reports will be developed and sent to the USACE and/or NJDEP to demonstrate compliance with performance standards.

Additional monitoring programs are not proposed for impacts to important species and habitats (Subsection 4.3.1). Construction phase monitoring of ecosystems potentially affected by off-site transmission will be determined subsequent to future routing studies and permitting.

6.5.2.2 Aquatic Ecology

Subsection 4.3.2 describes the proposed construction activities (e.g., dredging, stream bank clearing, and filling of wetlands) and their potential effect on the existing condition of aquatic communities at the site. Detention ponds collect stormwater runoff from areas disturbed during construction. This stormwater is discharged in accordance with applicable stormwater management plans and future permits.

Construction phase monitoring may be required to monitor the effects of dredging activities (related to intake, discharge, and barge facility construction) on benthic invertebrates of the Delaware River. Section 10/404 permit conditions from the USACE and Section 401 permit conditions from NJDEP determines the methodology, location, and duration of this monitoring. Because of the robust nature of the ongoing monitoring associated with the Salem NJPDES permit, additional monitoring of aquatic ecosystems is not proposed during the construction and preoperational phase.

6.5.3 OPERATIONAL MONITORING

6.5.3.1 Terrestrial Ecology and Land Use

Additional terrestrial monitoring programs are not proposed for the operational phase of the new plant. The location of a potential off-site transmission line has not been determined. However, a general discussion of anticipated impacts associated with the operation and maintenance of a typical off-site transmission line is provided in Subsection 5.6.1. If an off-site transmission line is required, monitoring will be developed in accordance with appropriate state and/or federal requirements.

There are no continuous monitoring programs proposed for terrestrial ecology and land use in this phase of the project.

6.5.3.2 Aquatic Ecology

The new plant will be designed to meet the Phase I new facility requirements specified in 40 CFR 125.84. PSEG is required to perform monitoring at the new plant to demonstrate compliance with USEPA requirements specified in 40 CFR 125.84. With regard to aquatic ecology, the two elements of this proposed monitoring program are impingement sampling and entrainment sampling at the new intake for a minimum of two yr. Once per month, in accordance with Phase I rules, impingement samples will be collected for a 24-hour period while the cooling water intake structure is in operation. Fish and shellfish species from these samples are enumerated, measured (total length in millimeters) and weighed (in grams). During operation, 24-hour entrainment samples are collected once every two weeks during the primary period of reproduction, larval recruitment, and peak abundance identified in the Source Water Baseline Biological Characterization. Species are enumerated, and the life stage of each specimen is recorded.

In terms of statistical validity, sampling methodologies are similar to those used in the ongoing studies required by PSEG’s NJPDES permit for SGS. Thus, data collected for the new plant will be comparable to other PSEG data sets. Records are kept of all data used to demonstrate compliance with these monitoring requirements. Appropriate reporting will summarize the biological monitoring data.

Impingement and entrainment programs include monitoring of head loss across the surface intake screen systems and correlation with the design intake velocity, and visual/remote inspections of design and construction technologies (Section 6.3). While not strictly related to aquatic ecology, these activities provide information used to interpret impingement and entrainment monitoring data.

There are no monitoring programs proposed other than the NJPDES required impingement and entrainment monitoring programs.

6.6 CHEMICAL MONITORING

The following subsections describe the chemical monitoring program for surface water and groundwater quality and include the following topics:

- Preapplication monitoring that supports the water quality and baseline environmental water quality descriptions in Chapter 2.
- Construction and preoperational monitoring to evaluate potential changes in baseline conditions that are attributable to site preparation, construction, and preoperational activities associated with the new plant. Anticipated impacts to surface water and groundwater are discussed in Section 4.2.
- Operational monitoring to identify potential effects attributable to the new plant operation. Anticipated impacts to surface water and groundwater are discussed in Section 5.2.

6.6.1 PREAPPLICATION MONITORING

The purpose of the preapplication monitoring program is to provide data to support the assessment of potential impacts that result from the construction and operation of the new plant. The program includes ongoing surface water monitoring per the requirements of the HCGS and SGS NJPDES permits, routine monitoring of the potable groundwater wells, and sampling of surface water systems performed in conjunction with the preparation of the ESP application.

6.6.1.1 Surface Water

PSEG currently conducts routine surface water monitoring of HCGS and SGS intake and discharges in accordance with CWA requirements, as specified in the NJPDES permits for each facility. The HCGS NJPDES Permit (NJ0025411) and SGS NJPDES Permit (NJ0005622) both require monitoring and reporting of intake and discharge water chemical characteristics. Sampling program parameters, frequency, and methodology are summarized in Table 6.6-1 (References 6.6-2 and 6.6-3) (Figure 6.3-1 for locations). Limited surface water monitoring has been completed for this ESP ER, including periodic sample collection at a limited number of locations along tidal marsh creeks. Surface water quality parameters evaluated as part of the ER are consistent with NUREG-1555, *Standard Review Plans for Environmental Reviews for Nuclear Power Plants: Environmental Standard Review Plan*, requirements and are discussed in Subsection 2.3.3. This program has characterized current site conditions and provides baseline data for evaluating potential impacts of plant construction and operations.

6.6.1.2 Groundwater

Two groundwater programs (diesel fuel remediation and routine monitoring of potable water wells) require chemical monitoring at the existing HCGS and SGS. NUREG-1555 calls for a discussion of chemical groundwater monitoring programs that are conducted within the area, or at HCGS or SGS. A historic discharge of fuel oil to the SGS environment is currently being remediated. The location and distribution of fuel oil impacted groundwater does not indicate any impacts to the new plant location on the PSEG Site. The diesel fuel oil remediation program is associated with a release at SGS that has been characterized, including remedial actions approved by NJDEP, demonstrating that the impacted area is defined and that the remediation

is appropriate to prevent further migration of any impacted water. Groundwater monitoring associated with this program is ongoing and has demonstrated that the fuel oil-impacted groundwater is contained in a localized area well south (and down-gradient) of the new plant location. Groundwater from this area is not anticipated to reach the new plant location, even as a result of dewatering activities (Section 4.2). Therefore, additional monitoring programs are not needed.

In addition to the groundwater monitoring, PSEG withdraws groundwater for potable water and plant makeup water. The NJDEP and DRBC regulate water withdrawals, and NJDEP requires routine monitoring of the potable water supply. Additional quarterly sampling for chlorides is required by PSEG’s Water Allocation Permit (Reference 6.6-4). The groundwater monitoring program is summarized in Table 6.6-2.

In addition to required monitoring programs, groundwater samples were collected to support ESP development. Groundwater quality parameters evaluated as part of the ESP are consistent with NUREG-1555 requirements and are listed in Subsection 2.3.3. This program is used to characterize current site conditions and is used as a baseline for evaluating potential impacts from plant construction and operations.

6.6.2 CONSTRUCTION AND PREOPERATIONAL MONITORING

Surface water and groundwater monitoring will be conducted during the construction and preoperational stages to evaluate potential impacts.

Surface water discharges during construction include stormwater runoff and construction dewatering discharges. These construction phase discharges will be monitored in accordance with NJPDES permit requirements. Delaware River monitoring, performed in accordance with HCGS and SGS permit requirements, provides data regarding receiving water quality throughout the construction period.

Groundwater monitoring of the existing potable wells will continue during construction and plant operations. Wells installed in the shallow river bed alluvium and the underlying Vincentown Aquifers will be used to assess the potential changes in groundwater quality associated with construction of the new plant.

6.6.3 OPERATIONAL MONITORING

After construction, surface water and groundwater monitoring will continue in accordance with state and federal requirements.

Surface water quality monitoring during plant operation will be conducted in accordance with NJPDES permit and the DRBC docket requirements. It is anticipated that monitoring requirements will be similar to those of the existing HCGS water quality monitoring programs.

Two new groundwater withdrawal wells are anticipated to support the new plant. Operational groundwater monitoring will be conducted in accordance with NJDEP permit requirements and will be similar to the program described in Table 6.6-2.

6.6.4 REFERENCES

6.6-1 New Jersey Department of Environmental Protection, Division of Water Supply, Website, http://www.state.nj.us/dep/watersupply/monitoring.htm, accessed on August 27, 2009.

6.6-2 New Jersey Department of Environmental Protection, Final Surface Water Renewal Permit Action, Hope Creek Generating Station, NJPDES Permit Number NJ0025411, December 31, 2002.

6.6-3 New Jersey Department of Environmental Protection, Final Surface Water Renewal Permit Action, Salem Generating Station, NJPDES Permit Number NJ0005622, June 29, 2001.

6.6-4 New Jersey Department of Environmental Protection, Water Allocation Permit WAP040001, Program Interest ID: 2216P, January 1, 2005.

Table 6.6-1
Surface Water Quality Monitoring Program

Monitoring Location	Constituents	Frequency	Sample Type
Salem Generating Station			
48C	TSS, Ammonia, Petroleum Hydrocarbons, TOC	Twice per month	TSS, Ammonia and TOC: Composite. Petroleum hydrocarbons: Grab.
481A	pH, chlorine produced oxidants	pH measured once per week; chlorine produced oxidants measured three times per week.	Grab
482A	pH, chlorine produced oxidants	pH measured once per week; chlorine produced oxidants measured three times per week.	Grab
483A	pH, chlorine produced oxidants	pH measured once per week; chlorine produced oxidants measured three times per week.	Grab
484A	pH, chlorine produced oxidants	pH measured once per week; chlorine produced oxidants measured three times per week.	Grab
485A	pH, chlorine produced oxidants	pH measured once per week; chlorine produced measured three times per week	Grab
486A	pH, chlorine produced oxidants	pH measured once per week; chlorine produced measured three times per week	Grab
487B	pH, TSS, petroleum hydrocarbons, TOC	Once per batch	Grab
489A	pH, petroleum hydrocarbons, TOC	Once per month	Grab
Hope Creek Generating Station			
461A	pH, TOC, chlorine produced oxidants	pH measured at 1/week; chlorine produced oxidants measured continuously; TOC at 1/month.	pH and TOC: Grab. Chlorine produced oxidants is measured continuously via meter.
461C	TSS, TOC, and petroleum hydrocarbons	TSS and TOC once per month; petroleum hydrocarbons measured twice per month.	TSS and TOC: Composite. Petroleum hydrocarbons: Grab.
462B	BOD, TSS, oil and grease, fecal coliform	Once per month	BOD Composite and Calculated. TSS: Composite Oil and Grease and fecal coliform: Grab.

TSS – Total Suspended Solids
BOD – Biological Oxygen Demand
TOC – Total Organic Carbon

Reference 6.6-2 and 6.6-3

Table 6.6-2
Groundwater Monitoring Program

HCGS and SGS Wells	Chlorides	Total Coliform	Volatile Organic Compounds	Nitrate	Lead	Copper	Inorganics
Wells: PW-2, PW-5, PW-6, Well J, Well I, and Well G	Quarterly[(a)]	NA	NA	NA	NA	NA	NA
Well HC-1	Quarterly[(a)]	NA	Triennial[(b)]	Annual[(c)]	NA	NA	Triennial[(b)]
Well HC-2	Quarterly[(a)]	NA	Triennial[(b)]	Annual[(c)]	NA	NA	Triennial[(b)]
Hope Creek Distribution System	NA	Monthly[(d)]	NA	NA	Triennial[(e)]	Triennial[(e)]	NA
Salem Common Header 1	NA	NA	Triennial[(b)]	Annual[(c)]	NA	NA	Triennial[(b)]
Salem Distribution System	NA	Quarterly[(f)]	NA	NA	Triennial[(e)]	Triennial[(e)]	NA

a) Reference 6.6-4.
b) One sample to be collected anytime during 2010 (Reference 6.6-1).
c) One sample to be collected anytime during 2009 (Reference 6.6-1).
d) Two samples collected per month during 2009 (Reference 6.6-1).
e) Ten samples collected between June 1 2009 and September 30 2009 (Reference 6.6-1).
f) One sample collected per quarter for 2009 (Reference 6.6-1).
NA = not applicable
Well pumping rates, water levels, and locations are discussed in Section 2.3

6.7 SUMMARY OF MONITORING PROGRAMS

This section summarizes the environmental monitoring programs described in the preceding sections of Chapter 6 (Table 6.7-1). The summary is divided into three sections:

- Preapplication monitoring.
- Construction and preoperational monitoring.
- Operational monitoring.

6.7.1 PREAPPLICATION MONITORING

Preapplication monitoring requirements for the new plant are fulfilled in part by the ongoing thermal, radiological, hydrological, meteorological, ecological, and chemical monitoring programs for the existing HCGS and SGS. In addition to pre-existing hydrological monitoring, additional observation wells were installed and monitored, as discussed in Subsection 6.3.1, in and around the proposed project footprint to better characterize the site hydrologically. Hydrologic monitoring also included a slug test and a tidal response study. Surface water monitoring was performed at an array of locations to document hydrologic characteristics of marsh creeks, on-site water bodies, and the Delaware River.

Preapplication ecological monitoring was performed on terrestrial and aquatic ecosystems on-site and off-site to determine the current characteristics of these systems. Information collected historically and from ongoing programs form a basis to assess the new plant impacts.

6.7.2 CONSTRUCTION AND PREOPERATIONAL MONITORING

The current thermal, radiological, hydrological, meteorological, ecological, and chemical monitoring programs for the existing HCGS and SGS will continue through the new plant construction and preoperational phases.

Additional monitoring during construction and preoperation will be conducted in accordance with applicable permit requirements. Parameters to be monitored include hydrological, chemical and ecological. Data collected will be evaluated and impacts assessed and mitigated as required.

6.7.3 OPERATIONAL MONITORING

The purpose of the operational monitoring program is to identify and assess impacts resulting from new plant operation. Operational monitoring programs are prescribed by the various permits required for new plant operation (e.g., air permit, NJPDES permit) or by federal regulations.

The existing SGS and HCGS operational monitoring programs will serve as the basis for development of programs for the new plant. These programs may be modified as a result of future consultations with regulatory agencies. The need for modifications to existing monitoring programs, including locations, parameters, collection techniques, or analytical procedures, will be established prior to new plant operation. Data collected will be evaluated and impacts assessed and mitigated as required.

Table 6.7-1 (Sheet 1 of 4)
Summary of Monitoring Programs

Resource	Program	Scope/Content	Status
Preapplication			
Water	Thermal Monitoring	Thermal monitoring performed as part of routine NJPDES permitting requirements for HCGS and SGS. This monitoring is ongoing and has served as baseline.	Ongoing
		Supplemental thermal monitoring performed for the new plant as part of baseline quarterly water quality sampling at surface water sampling locations.	Complete
	Hydrological Monitoring	Groundwater monitoring performed to provide monthly water level data for baseline analysis.	Complete
		Delaware River monitoring through ongoing requirements for HCGS and SGS NJPDES permits.	Ongoing
		Monitoring performed during groundwater pumping tests in the new plant area to establish design level criteria.	Complete
	Chemical Monitoring	Chemical monitoring performed quarterly as part of baseline monitoring of surface water and groundwater resources.	Complete
Ecology	Ecological Monitoring	Quarterly baseline monitoring performed to characterize plant communities and seasonal use of birds, mammals and herpetofauna for the site and off-site areas.	Complete
		Aquatic ecological monitoring performed as part of the ongoing Salem NJPDES impingement and entrainment monitoring. This monitoring is ongoing and has served as baseline.	Ongoing
		Supplemental quarterly baseline monitoring performed within the on-site marsh creek system and within perched water bodies potentially affected by the new plant (including the USACE CDF facility).	Complete
		Supplemental seasonal (spring and fall) monitoring of benthic invertebrates performed to establish baselines of marsh creeks, the Delaware River, and perched water bodies.	Complete

Table 6.7-1 (Sheet 2 of 4)
Summary of Monitoring Programs

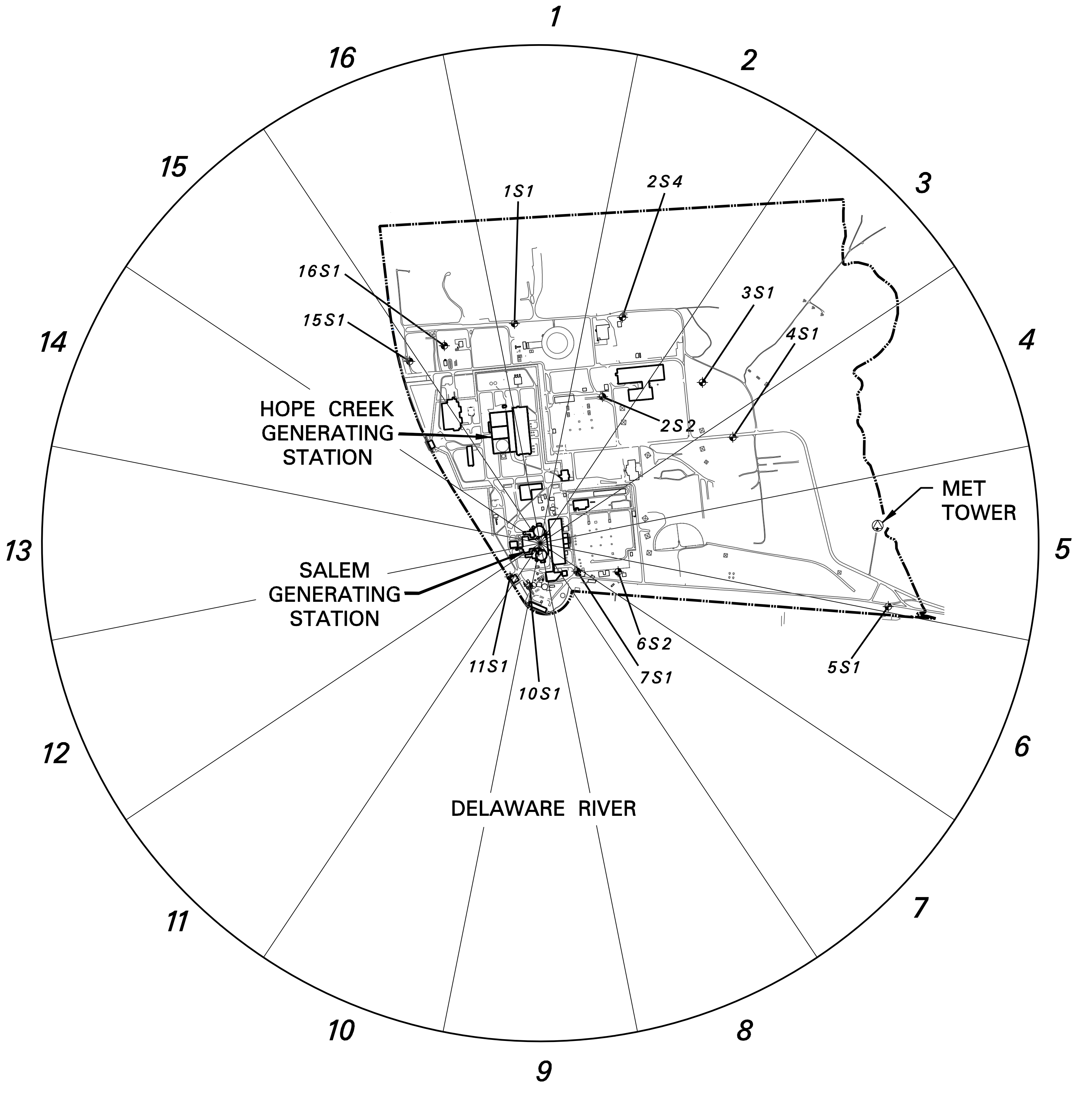
Resource	Program	Scope/Content	Status
Human Health	Radiological Monitoring	No additional radiological monitoring performed.	NA
Air Quality and Meteorology	Meteorological Monitoring	The existing meteorological monitoring program for HCGS and SGS was used for preapplication analyses. Air quality/emissions monitoring in accordance with applicable NJDEP permits.	Existing
Construction and Preoperational			
Water	Thermal Monitoring	Thermal monitoring to be performed as part of routine NJPDES permitting requirements for HCGS and SGS. This monitoring is ongoing and has served as baseline.	Ongoing
	Hydrological Monitoring	Groundwater and surface water monitoring to be performed during dewatering activities at the power block. Specific monitoring as part of the NJPDES permit process for construction activities occurring off-site (e.g., causeway construction, transmission line development, etc.) as applicable. Surface water monitoring in vicinity of dredging of intake/discharge/barge area to monitor for applicable hydrologic parameters including turbidity, as required. Stormwater discharges will be monitored in accordance with NJDEP permits, as applicable.	To be developed
	Chemical Monitoring	Chemical monitoring to be performed at stormwater outfall and/or release points in accordance with NJDEP permits, as applicable. Groundwater monitoring will continue during portions of construction and preoperation to ascertain the chemical effects of construction and/or dewatering on local groundwater.	To be developed

Table 6.7-1 (Sheet 3 of 4)
Summary of Monitoring Programs

Resource	Program	Scope/Content	Status
Ecology	Ecological Monitoring	Aquatic ecological monitoring to be performed as part of the ongoing impingement and entrainment monitoring at SGS.	Ongoing
		Monitoring of wetland mitigation to be performed in accordance with NJDEP and USACE permitting requirements, as applicable.	To be developed
		Supplemental monitoring of benthic invertebrates is required to support NJDEP/USACE permit application for dredging of intake/barge areas.	To be developed
Human Health	Radiological Monitoring	Existing REMP for HCGS and SGS to encompass needs of new plant.	Existing
Air Quality and Meteorology	Meteorological Monitoring	The existing meteorological monitoring program for HCGS and SGS will be used during these phases. Air quality / emissions monitoring in accordance with applicable NJDEP permits	Existing
Operational			
Water	Thermal Monitoring	Thermal monitoring to be performed as part of routine NJPDES permitting requirements at intake structure and discharge of new plant.	To be developed
	Hydrological Monitoring	Intake structure head loss measurements to be conducted in accordance with NJPDES permit requirements. Groundwater monitoring to be performed for on-site wells in accordance with NJDEP permit requirements.	To be developed
	Chemical Monitoring	Chemical monitoring to be performed as part of routine NJPDES permitting requirements at discharge of new plant. Monitoring of stormwater outfalls will be performed in accordance with permit requirements, as applicable.	To be developed

**Table 6.7-1 (Sheet 4 of 4)
Summary of Monitoring Programs**

Resource	Program	Scope/Content	Status
Ecology	Ecological Monitoring	Impingement and entrainment studies to be performed at intake structure in accordance with NJPDES permit requirements. Monitoring of wetland mitigation performance parameters to be performed in accordance with NJDEP and USACE permitting requirements, as applicable.	To be developed
Human Health	Radiological	The monitoring program specified in Section 6.2 will be conducted.	Existing/ modified
Air Quality and Meteorology	Meteorological Monitoring	The existing meteorological monitoring program for SGS and HCGS will be used during this phase. Air quality/emissions monitoring in accordance with applicable NJDEP permits	Existing

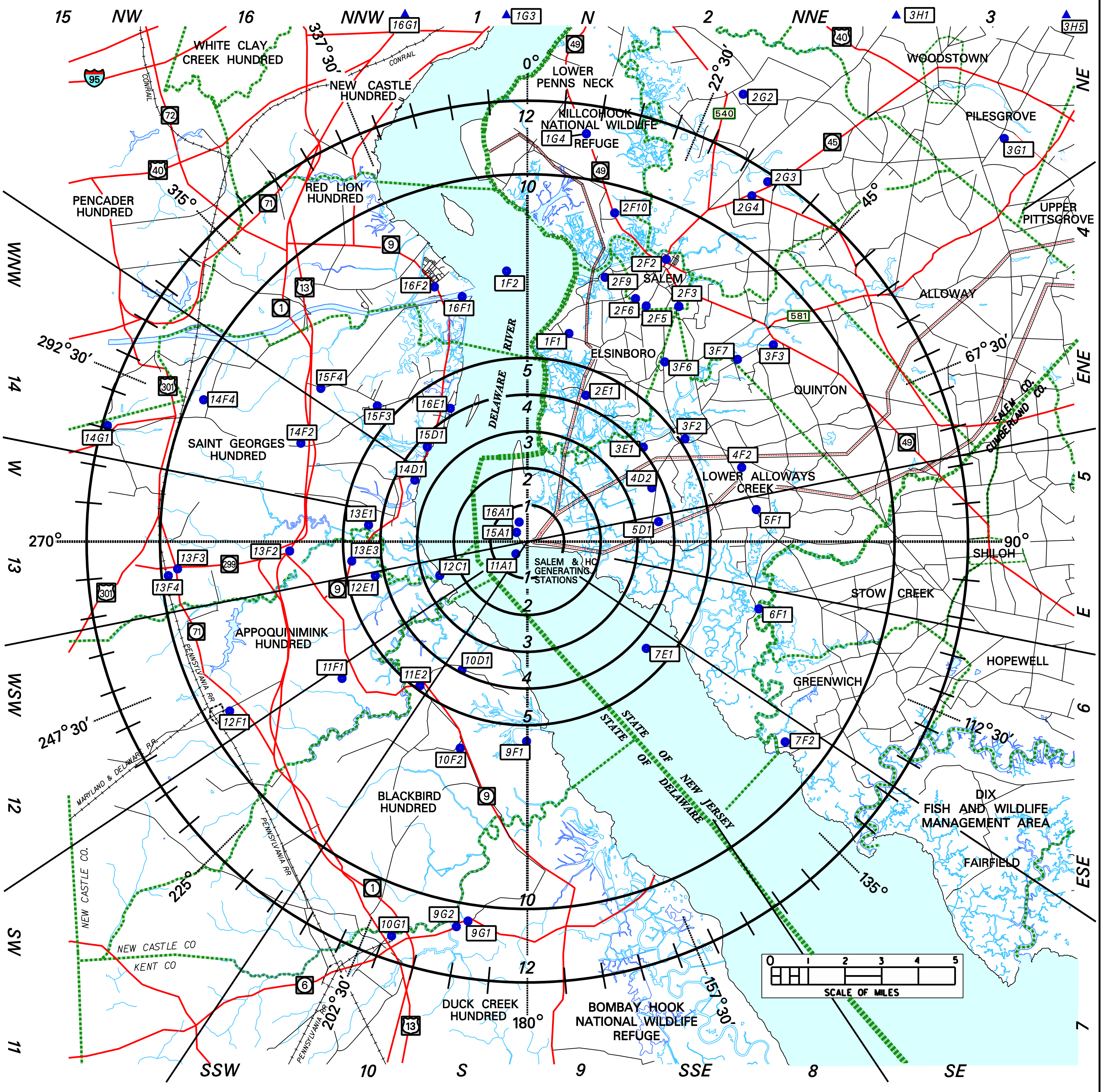


PSEG Power, LLC
PSEG Site ESPA
Part 3, Environmental Report

On-Site Sampling Locations

Figure 6.2-1

Rev. 0

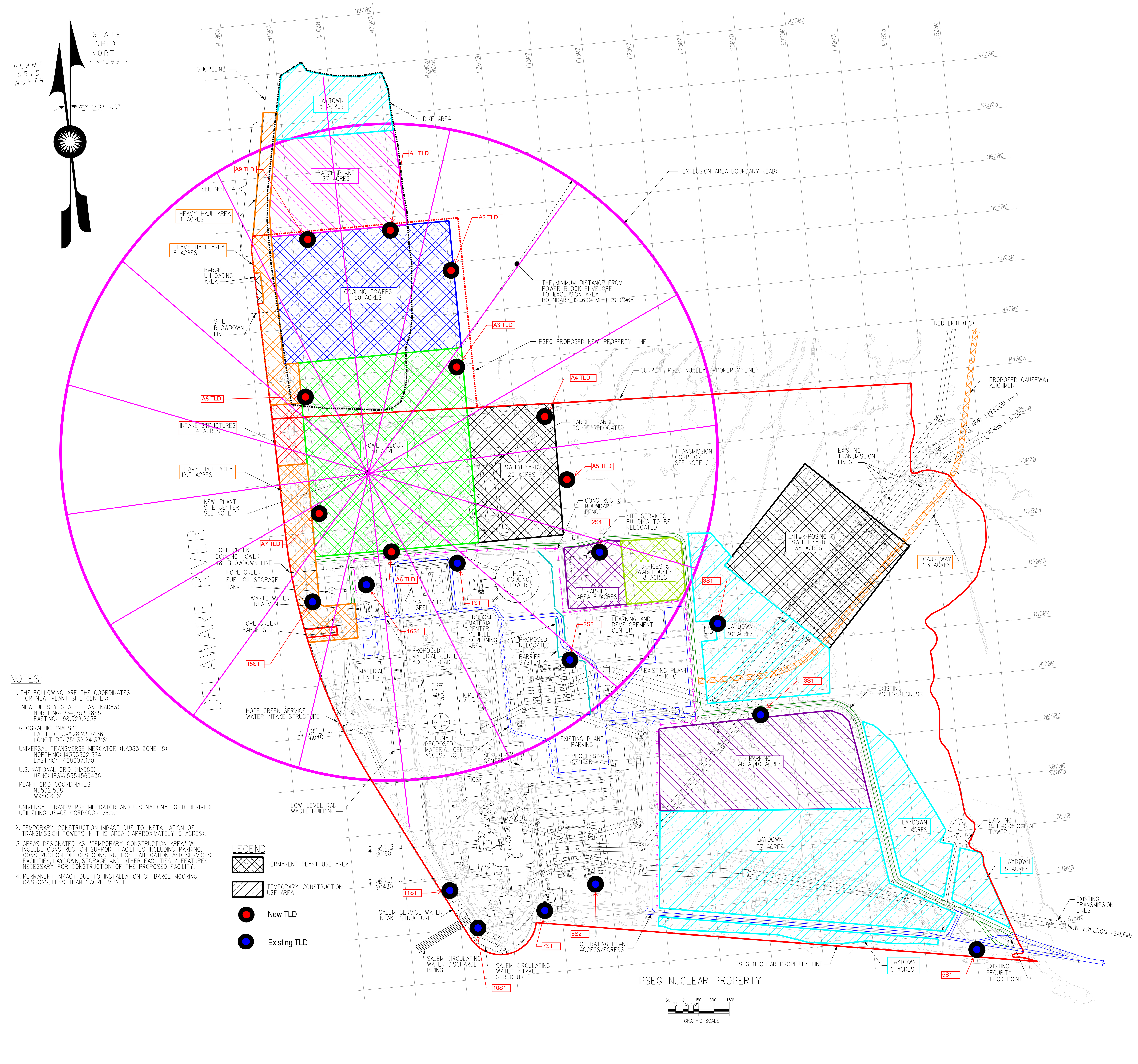


PSEG Power, LLC
PSEG Site ESPA
Part 3, Environmental Report

Off-Site Sampling Locations

Figure 6.2-2

Rev. 0



NOTES:

1. THE FOLLOWING ARE THE COORDINATES FOR NEW PLANT SITE CENTER:

   NEW JERSEY STATE PLAN (NAD83)
   NORTHING: 234,753.9885
   EASTING: 198,529.2938

   GEOGRAPHIC (NAD83)
   LATITUDE: 39° 28'23.7436"
   LONGITUDE: 75° 32'24.3316"

   UNIVERSAL TRANSVERSE MERCATOR (NAD83 ZONE 18)
   NORTHING: 14335392.324
   EASTING: 1488007.170

   U.S. NATIONAL GRID (NAD83)
   USNG: 18SVJ5354569436

   PLANT GRID COORDINATES
   N3532.538'
   W980.666'

   UNIVERSAL TRANSVERSE MERCATOR AND U.S. NATIONAL GRID DERIVED UTILIZLING USACE CORPSCON v6.0.1.

2. TEMPORARY CONSTRUCTION IMPACT DUE TO INSTALLATION OF TRANSMISSION TOWERS IN THIS AREA (APPROXIMATELY 5 ACRES).
3. AREAS DESIGNATED AS "TEMPORARY CONSTRUCTION AREA" WILL INCLUDE CONSTRUCTION SUPPORT FACILITIES INCLUDING PARKING, CONSTRUCTION OFFICES, CONSTRUCTION FABRICATION AND SERVICES FACILITIES, LAYDOWN, STORAGE AND OTHER FACILITIES / FEATURES NECESSARY FOR CONSTRUCTION OF THE PROPOSED FACILITY.
4. PERMANENT IMPACT DUE TO INSTALLATION OF BARGE MOORING CAISSONS, LESS THAN 1 ACRE IMPACT.

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New Sample Locations

FIGURE 6.2-3

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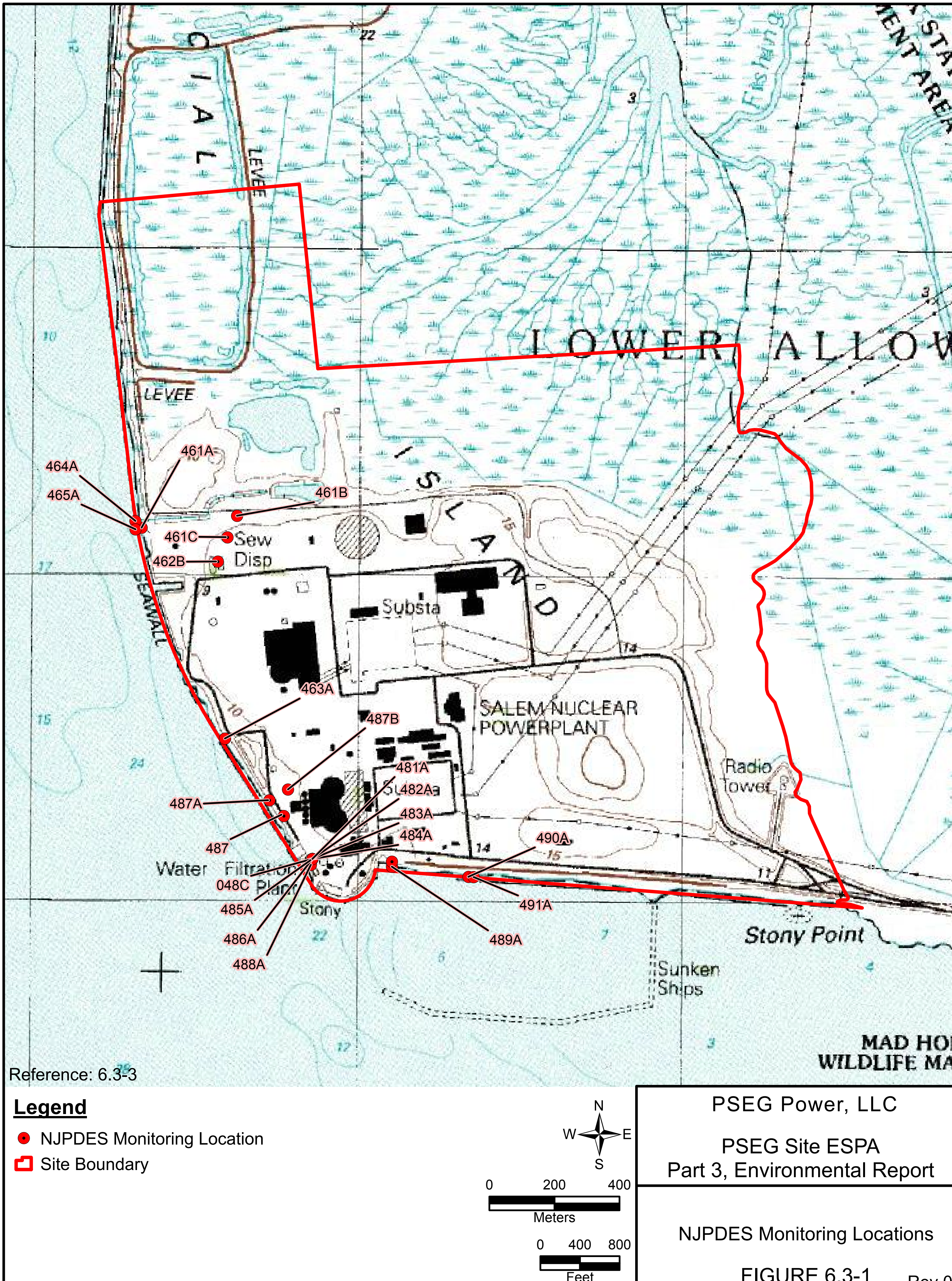

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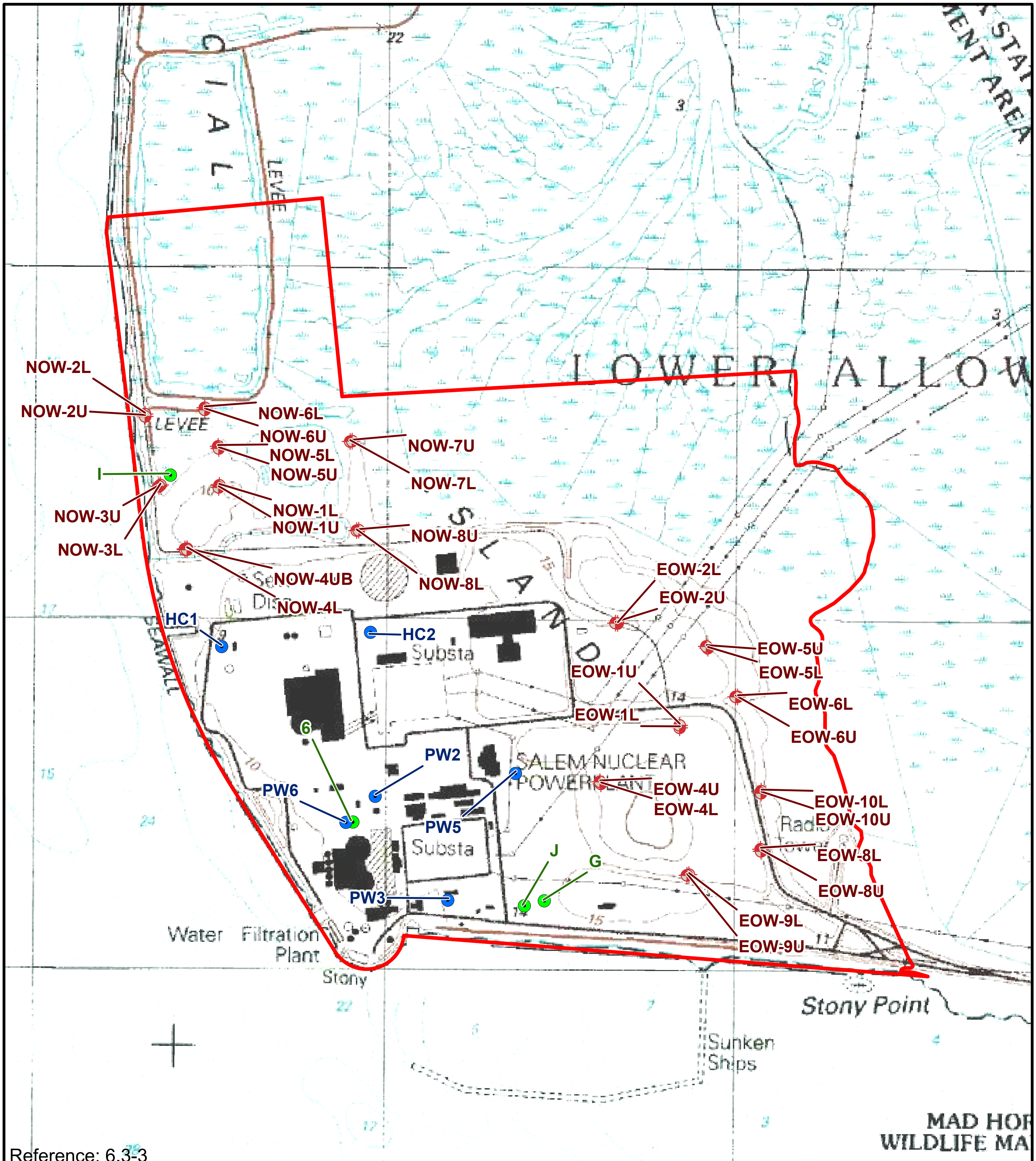
NJPDES Monitoring Locations

FIGURE 6.3-1

Rev 0



Reference: 6.3-3

Legend

- HCGS/SGS Production Well
- HCGS/SGS Observation Well
- ESP Observation Well
- Site Boundary

N W E S

0 200 400 Meters

0 400 800 Feet

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HCGS and SGS
Production/Observation Wells
and ESP Observation Wells

FIGURE 6.3-2

Rev 0

CHAPTER 7

ENVIRONMENTAL IMPACTS OF POSTULATED ACCIDENTS INVOLVING RADIOACTIVE MATERIALS

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ACRONYMS AND ABBREVIATIONS

Acronyms	Definitions
ABWR	Advanced Boiling Water Reactor
AP1000	Advanced Passive 1000
AST	Alternative Source Term
BWR	boiling water reactor
CDF	Core Damage Frequency
Ci	curie
Ci/yr	curies per year
COL	combined license
DBA	design basis accident
DCD	Design Certification Document
DOE	U. S. Department of Energy
ESP	early site permit
ESPA	early site permit application
ft.	feet
ft^3	cubic feet
ft^3/yr	cubic feet per year
gpd	gallons per day
HCGS	Hope Creek Generating Station
HIC	high integrity container
hr.	hour
HRCQ	highway route controlled quantity
km	kilometer
lb.	pound
LOCA	Loss of Coolant Accident
LPGS	Liquid Pathway Generic Study
LPZ	Low Population Zone
LWR	light water reactor
m	meter
m^3	cubic meter
MBq	megabecquerel
mi.	Miles

ACRONYMS AND ABBREVIATIONS (CONTINUED)

Acronyms	Definitions
MTU	metric ton of uranium
MW	megawatt
MWd/MTU	megawattdays per metric ton of uranium
MWe	megawatts electric
MWt	megawatts thermal
NRC	U.S. Nuclear Regulatory Commission
PPE	plant parameter envelope
PSEG	PSEG Power, LLC and PSEG Nuclear, LLC
PWR	pressurized water reactor
sec.	second(s)
SSAR	Site Safety Analysis Report
Sv	sievert
TEDE	Total Effective Dose Equivalent
U.S. EPR	U.S. Evolutionary Power Reactor
U-235	uranium-235
US-APWR	U.S. Advanced Pressurized Water Reactor
yr	year

CHAPTER 7

ENVIRONMENTAL IMPACTS OF POSTULATED ACCIDENTS INVOLVING RADIOACTIVE MATERIALS

This chapter evaluates the environmental impacts of postulated accidents involving radioactive materials. Section 7.1 discusses design basis accidents (DBAs). Section 7.2 discusses the impacts of severe accidents. Section 7.3 discusses severe accident mitigation alternatives. Section 7.4 discusses transportation accidents.

7.1 DESIGN BASIS ACCIDENTS

PSEG is considering constructing a new plant at the PSEG Site. The designs under consideration include an Advanced Boiling Water Reactor (ABWR), an Advanced Passive 1000 Reactor (AP1000) (dual unit), a U.S. Evolutionary Power Reactor (U.S. EPR), or a U.S. Advanced Pressurized Water Reactor (US-APWR). All of these designs are light water reactors (LWR). This section evaluates the radiological consequences of DBAs for the four reactor technologies.

7.1.1 SELECTION OF DESIGN BASIS ACCIDENTS

NUREG-1555*, Standard Review Plans for Environmental Reviews for Nuclear Power Plants: Environmental Standard Review Plan,* Section 7.1 Appendix A states that all DBAs having the potential to release activity to the environment must be identified. Due to differences in reactor technologies, not all accidents identified in NUREG-1555 apply to each reactor design. Tables 7.1-1 through 7.1-4 provide lists of applicable accidents corresponding to the different reactor technologies.

7.1.2 EVALUATION METHODOLOGY

Doses for selected accidents involving possible fission product release are evaluated at the exclusion area boundary (EAB) and at the outer boundary of the low population zone (LPZ) to demonstrate the new plant's capabilities to mitigate the radiological consequences of an accident. Although the emergency safeguard features are expected to prevent core damage and mitigate the radioactivity release, the bounding Loss of Coolant Accident (LOCA) analysis presumes substantial core damage with fission product release. Other DBAs of lesser magnitude, but greater frequencies of occurrence, are not expected to approach the 10 CFR 50.34, *Contents of Applications; Technical Information,* or 10 CFR 100, *Reactor Site Criteria,* limits as closely as a LOCA. For these accidents, the more restrictive dose limits in Regulatory Guide (RG) 1.183, *Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors*, Revision 0, 2000, and NUREG-0800, *Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition,* are invoked to determine if the accidents are acceptable from an overall risk perspective. Accident doses to an individual are evaluated at any point on the EAB and at any point on the outer boundary of the LPZ to meet limits specified in 10 CFR 50.34 and 10 CFR 100. Radiological consequences related to control room personnel are evaluated as part of the combined license (COL) review.

The dose to an individual located on the EAB or the outer boundary of the LPZ is calculated based on the amount of activity released to the environment through multiple pathways, the atmospheric dispersion of the activity during transport from the release point to the dose point,the breathing rate of the individual at the dose point location and the activity-to-dose conversion factors. The atmospheric dispersion factor (χ/Q) is the only site-specific parameter required for determining the dose to an individual. The Design Certification Documents (DCDs) have developed χ/Q values that are not expected to be exceeded at most reactor sites. For this evaluation, the accident doses at the EAB and the outer boundary of the LPZ are calculated using the ratio of the site-specific and design certified χ/Q values for each respective reactor technology and then compared to the acceptance criteria in RG 1.183 and NUREG-0800. Site-specific χ/Q values are based on on-site meteorology and described in Site Safety Analysis Report (SSAR) Section 2.3. Site-specific short-term directional dependent 50th percentile χ/Q values are calculated for the PSEG Site using on-site meteorological data and the RG 1.145, *Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants,* Revision 1, 1983, methodology.

The accident dose evaluations are performed using χ/Qs and activity releases for the following intervals.

EAB	LPZ
0 to 2 hr.	0 to 8 hr.
	8 to 24 hr.
	24 to 96 hr.
	96 to 720 hr.

The zero to two hour χ/Q value is used for the two hour release duration with the greatest dose consequence at the EAB. Accident doses for the ABWR are expressed as whole body and thyroid doses consistent with 10 CFR 100. Accident doses for the other reactor technologies evaluated are expressed in total effective dose equivalent (TEDE) consistent with 10 CFR 50.34.

Note that SSAR Chapter 15 uses conservative assumptions to perform bounding safety analyses. One such assumption is the use of the 95th percentile χ/Q values. These analyses overstate the environmental impact of the DBAs. Consistent with NUREG-1555, this section uses 50th percentile χ/Q values that better reflect probable accident conditions.

7.1.3 SOURCE TERMS

Dose estimates are calculated using time-dependent activities released to the environment for each DBA. The activities are based on the analyses used to support the reactor standard safety analysis reports submitted with the DCD. Each reactor technology uses different source terms and approaches in defining the activity releases.

The US-APWR source terms are calculated using the guidance in NUREG-0800 and RG 1.183. US-APWR source terms are listed in Tables 7.1-5 through 7.1-13, and are obtained from the US-APWR DCD (Reference 7.1-3). LOCA activity releases are calculated for a reactor power level of 4555 megawatts thermal (MWt) (102 percent of rated NSSS power of 4466 MWt).

Activity releases for other accidents are calculated for a reactor power level equal to or less than that of the LOCA.

The ABWR source terms are calculated using the guidance in RG 1.3, *Assumptions Used for Evaluating the Potential Radiological Consequences of a Loss of Coolant Accident for Boiling Water Reactors*, Revision 2, 1974; RG 1.25, *Assumptions Used for Evaluating the Potential Radiological Consequences of a Fuel Handling Accident in the Fuel Handling and Storage Facility for Boiling and Pressurized Water Reactors*, Revision 0, 1972; and TID-14844, *Calculation of Distance Factors for Power and Test Reactor Sites*, 1962. The ABWR DCD source terms are given for a reactor power level of 4005 MWt. An uprated, 4300 MWt version of the ABWR is being considered for the PSEG Site. Source terms are calculated for a reactor power level of 4386 MWt (102 percent of the uprated 4300 MWt) by multiplying the source terms in the ABWR DCD (Reference 7.1-2) by a factor of 1.095 (4386/4005), because activity releases scale directly with power. This approach is used for accidents that involve postulated fuel damage (LOCA and fuel handling accidents). The source terms for the ABWR are listed in Tables 7.1-14 through 7.1-18, and are obtained from the ABWR DCD (Reference 7.1-2).

The AP1000 source terms and approaches to assessing accidents are based on the Alternative Source Term (AST) methods as described in NUREG-1465, *Accident Source Terms for Light-Water Nuclear Power Plants,* 1995, and are in accordance with RG 1.183. Activity releases are calculated at a power level of 3468 MWt (102 percent of rated core power of 3400 MWt). The source terms for the AP1000 are listed in Tables 7.1-19 through 7.1-27.

The U.S. EPR source terms and approaches to assessing accidents are calculated in accordance with NUREG-0800 and RG 1.183. Activity releases are calculated for a reactor power level of 4612 MWt (4590 MWt rated core power + 22 MWt heat balance measurement uncertainty). The source terms for the U.S. EPR are listed in Tables 7.1-28 through 7.1-37.

7.1.4 DOSE CONSEQUENCES

PSEG Site-specific radiation doses at EAB and LPZ are calculated for the applicable postulated DBAs for the four reactor technologies. These PSEG Site-specific doses are calculated by multiplying the reactor DCD dose by the ratio of the site 50th percentile χ/Q value to the DCD χ/Q value. All PSEG Site-specific 50th percentile χ/Q values are bounded by the DCD χ/Q values, therefore all site-specific doses are bounded by DCD doses. The site-specific analysis results demonstrate that all US-APWR, AP1000, and U.S. EPR accident doses meet the site acceptance criteria of 10 CFR 50.34. The results also demonstrate that all ABWR accident doses meet the site acceptance criteria of 10 CFR 100.

The ABWR DCD doses are calculated for a reactor power level of 4005 MWt. An uprated, 4300 MWt version of the ABWR is being considered at the PSEG Site. The power uprate only affects doses of accidents that involve fuel damage (LOCA and fuel handling accidents). Doses for these two accidents are calculated for a reactor power level of 4386 MWt (102 percent of the uprated 4300 MWt) by multiplying the site-specific doses by a factor of 1.095 (4386/4005), since activity releases and thus doses are proportional to power. Reactor technology data table locations are listed below:

Reactor Technology	χ/Q Data Table	Dose Data Table
US-APWR	Table 7.1-38	Table 7.1-39
ABWR	Table 7.1-40	Tables 7.1-41 through 45
AP1000	Table 7.1-46	Tables 7.1-47 through 7.1-54
U.S. EPR	Table 7.1-55	Table 7.1-56

7.1.5 REFERENCES

7.1-1 AREVA, Design Certification Document for the U.S. Evolutionary Power Reactor (U.S. EPR), Revision 0.

7.1-2 GE, Design Certification Document for the Advanced Boiling Water Reactor (ABWR), Revision 4.

7.1-3 Mitsubishi, Design Certification Document for the U.S. Advanced Pressurized Water Reactor (US-APWR), Revision 1.

7.1-4 Westinghouse, Design Certification Document (DCD) for the Advanced Passive 1000 (AP1000) Reactor, Revision 17.

Table 7.1-1
US-APWR Design Basis Accident List

NUREG-1555 DBA Descriptions	Consequences Tabulated	Remarks
15.1.5A - Main Steam Line Failures Outside Containment of a PWR	Yes	
15.2.8 - Feedwater System Pipe Breaks Inside and Outside Containment (PWR)	No	Bounded by the main steam line break accident, as discussed in US-APWR DCD Subsection 15.2.8.5 (Reference 7.1-3).
15.3.3 - Reactor Coolant Pump Rotor Seizure	Yes	
15.3.4 - Reactor Coolant Pump Shaft Break	No	Bounded by the RCP rotor seizure accident, as discussed in US-APWR DCD Subsection 15.3.4 (Reference 7.1-3).
15.4.9A - Control Rod Drop Accident (BWR)	No	N/A
15.6.2 - Failure of Small Lines Carrying Primary Coolant Outside Containment	Yes	
15.6.3 - Steam Generator Tube Failure (PWR)	Yes	
15.6.5A - Design Basis Loss of Coolant Accident Including Containment Leakage Contribution	Yes	Included in LOCA analysis
15.6.5B - Design Basis Loss of Coolant Accident: Leakage From Engineered Safety Feature Components Outside Containment	Yes	Included in LOCA analysis
15.6.5D - Design Basis Loss of Coolant Accident: Leakage From Main Steam Isolation Valve Leakage Control System (BWR)	No	N/A
15.7.4 - Fuel Handling Accidents	Yes	

Other Accident Descriptions	Consequences Tabulated	Remarks
Spectrum of Rod Ejection Accidents (PWR)	Yes	

Table 7.1-2
ABWR Design Basis Accident List

NUREG-1555 DBA Descriptions	Consequences Tabulated	Remarks
15.1.5A - Main Steam Line Failures Outside Containment of a PWR	No	N/A
15.2.8 - Feedwater System Pipe Breaks Inside and Outside Containment (PWR)	No	N/A
15.3.3 - Reactor Coolant Pump Rotor Seizure	No	Accident does not result in any fuel failures, thus has no radiological consequences as discussed in ABWR DCD Subsection 15.3.4.5 (Reference 7.1-2).
15.3.4 - Reactor Coolant Pump Shaft Break	No	Accident does not result in any fuel failures, thus has no radiological consequences as discussed in ABWR DCD Subsection 15.3.4.5 (Reference 7.1-2).
15.4.9A - Control Rod Drop Accident (BWR)	No	There is no basis for this accident to occur, as discussed in ABWR DCD 15.4.10.3 (Reference 7.1-2).
15.6.2 - Failure of Small Lines Carrying Primary Coolant Outside Containment	Yes	
15.6.3 - Steam Generator Tube Failure (PWR)	No	N/A
15.6.5A - Design Basis Loss of Coolant Accident Including Containment Leakage Contribution	Yes	Included in LOCA analysis
15.6.5B - Design Basis Loss of Coolant Accident: Leakage From Engineered Safety Feature Components Outside Containment	Yes	Included in LOCA analysis
15.6.5D - Design Basis Loss of Coolant Accident: Leakage From Main Steam Isolation Valve Leakage Control System (BWR)	Yes	Included in LOCA analysis
15.7.4 - Fuel Handling Accidents	Yes	

Other Accident Descriptions	Consequences Tabulated	Remarks
Main Steam Line Break	Yes	

Table 7.1-3
AP1000 Design Basis Accident List

NUREG-1555 DBA Descriptions	Consequences Tabulated	Remarks
15.1.5A - Main Steam Line Failures Outside Containment of a PWR	Yes	
15.2.8 - Feedwater System Pipe Breaks Inside and Outside Containment (PWR)	No	Bounded by steam system piping failures, as discussed in AP1000 DCD Subsection 15.1.5 (Reference 7.1-4).
15.3.3 - Reactor Coolant Pump Rotor Seizure	Yes	
15.3.4 - Reactor Coolant Pump Shaft Break	No	Bounded by RCP rotor seizure accident, as discussed in AP1000 DCD Subsection 15.3.3 (Reference 7.1-4).
15.4.9A - Control Rod Drop Accident (BWR)	No	N/A
15.6.2 - Failure of Small Lines Carrying Primary Coolant Outside Containment	Yes	
15.6.3 - Steam Generator Tube Failure (PWR)	Yes	
15.6.5A - Design Basis Loss of Coolant Accident Including Containment Leakage Contribution	Yes	Included in LOCA analysis
15.6.5B - Design Basis Loss of Coolant Accident: Leakage From Engineered Safety Feature Components Outside Containment	Yes	Included in LOCA analysis
15.6.5D - Design Basis Loss of Coolant Accident: Leakage From Main Steam Isolation Valve Leakage Control System (BWR)	No	N/A
15.7.4 - Fuel Handling Accidents	Yes	

Other Accident Descriptions	Consequences Tabulated	Remarks
Spectrum of Rod Cluster Control Assembly Ejection Accidents	Yes	

Table 7.1-4
U.S. EPR Design Basis Accident List

NUREG-1555 DBA Descriptions	Consequences Tabulated	Remarks
15.1.5A - Main Steam Line Failures Outside Containment of a PWR	Yes	
15.2.8 - Feedwater System Pipe Breaks Inside and Outside Containment (PWR)	No	Bounded by steam system piping failures, as discussed in U.S. EPR DCD Subsection 15.1.5 (Reference 7.1-1).
15.3.3 - Reactor Coolant Pump Rotor Seizure	Yes	
15.3.4 - Reactor Coolant Pump Shaft Break	No	Bounded by RCP rotor seizure accident, as discussed in U.S. EPR DCD Subsection15.3.4 (Reference 7.1-1).
15.4.9A - Control Rod Drop Accident (BWR)	No	N/A
15.6.2 - Failure of Small Lines Carrying Primary Coolant Outside Containment	Yes	
15.6.3 - Steam Generator Tube Failure (PWR)	Yes	
15.6.5A - Design Basis Loss of Coolant Accident Including Containment Leakage Contribution	Yes	Included in LOCA analysis
15.6.5B - Design Basis Loss of Coolant Accident: Leakage From Engineered Safety Feature Components Outside Containment	Yes	Included in LOCA analysis
15.6.5D - Design Basis Loss of Coolant Accident: Leakage From Main Steam Isolation Valve Leakage Control System (BWR)	No	N/A
15.7.4 - Fuel Handling Accidents	Yes	

Other Accident Descriptions	Consequences Tabulated	Remarks
Rod Ejection Accident	Yes	

**Table 7.1-5 (Sheet 1 of 2)
US-APWR Source Terms
Time Dependent Released Activity during LOCA (Ci)[a]**

Nuclide	0.5 to 2.5 hr.[b]	0 to 8 hr.	8 to 24 hr.	24 to 96 hr.	96 to 720 hr.	Total 0 to 720 hr.
Noble Gases						
Kr-85	1.97E+02	7.75E+0	1.74E+03	3.92E+03	3.35E+04	3.99E+04
Kr-85m	3.03E+03	9.16E+0	4.37E+03	1.99E+02	0.00E+00	1.37E+04
Kr-87	2.00E+03	3.54E+0	7.83E+01	0.00E+00	0.00E+00	3.62E+03
Kr-88	6.55E+03	1.68E+0	3.68E+03	3.70E+01	0.00E+00	2.05E+04
Xe-133	2.97E+04	1.26E+0	2.76E+05	4.93E+05	9.77E+05	1.87E+06
Xe-135	1.04E+04	3.79E+0	4.05E+04	9.60E+03	4.41E+01	8.80E+04
Iodines						
I-131	8.72E+02	1.42E+0	5.61E+02	1.85E+03	5.60E+03	9.43E+03
I-132	1.09E+03	1.50E+0	1.01E+02	2.22E+02	2.48E+02	2.07E+03
I-133	1.68E+03	2.67E+0	7.37E+02	8.09E+02	8.07E+01	4.30E+03
I-134	3.09E+02	4.22E+0	1.84E-01	0.00E+00	0.00E+00	4.22E+02
I-135	1.30E+03	1.95E+0	2.44E+02	4.67E+01	1.20E-01	2.24E+03
Alkali Metals						
Rb-86	1.13E+00	1.44E+0	1.60E-02	0.00E+00	0.00E+00	1.45E+00
Cs-134	1.13E+02	1.44E+0	1.62E+00	0.00E+00	0.00E+00	1.46E+02
Cs-136	3.07E+01	3.90E+0	4.31E-01	0.00E+00	0.00E+00	3.94E+01
Cs-137	6.44E+01	8.19E+0	9.21E-01	1.00E-03	0.00E+00	8.28E+01
Tellurium Group						
Sb-127	8.55E+00	1.04E+0	1.26E-01	1.00E-05	0.00E+00	1.05E+01
Sb-129	1.74E+01	1.99E+0	6.87E-02	0.00E+00	0.00E+00	2.00E+01
Te-127	8.56E+00	1.04E+0	1.30E-01	0.00E+00	0.00E+00	1.05E+01
Te-127m	1.14E+00	1.39E+0	1.80E-02	0.00E+00	0.00E+00	1.40E+00
Te-129	1.99E+01	2.30E+0	1.12E-01	0.00E+00	0.00E+00	2.31E+01
Te-129m	3.90E+00	4.75E+0	6.13E-02	0.00E+00	0.00E+00	4.81E+00
Te-131m	1.13E+01	1.36E+0	1.44E-01	0.00E+00	0.00E+00	1.37E+01
Te-132	1.17E+02	1.41E+0	1.71E+00	1.00E-04	0.00E+00	1.43E+02
Strontium and Barium						
Sr-89	3.89E+01	4.74E+0	6.12E-01	0.00E+00	0.00E+00	4.80E+01
Sr-90	3.23E+00	3.93E+0	5.10E-02	0.00E+00	0.00E+00	3.98E+00
Sr-91	4.25E+01	5.01E+0	3.54E-01	1.00E-03	0.00E+00	5.05E+01
Sr-92	2.79E+01	3.11E+0	4.95E-02	0.00E+00	0.00E+00	3.11E+01
Ba-139	1.83E+01	1.96E+0	5.04E-03	0.00E+00	0.00E+00	1.96E+01
Ba-140	6.16E+01	7.49E+0	9.53E-01	0.00E+00	0.00E+00	7.59E+1

Table 7.1-5 (Sheet 2 of 2)
US-APWR Source Terms
Time Dependent Released Activity during LOCA (Ci)[a]

Nuclide	0.5 to 2.5 hr.[b]	0 to 8 hr.	8 to 24 hr.	24 to 96 hr.	96 to 720 hr.	Total 0 to 720 hr.
Noble Metals						
Co-58	3.36E-03	3.36E-03	4.50E-08	0.00E+00	0.00E+00	3.36E-03
Co-60	1.32E-02	1.59E-02	2.00E-04	1.01E-06	0.00E+00	1.61E-02
Mo-99	7.94E+00	9.57E+00	1.11E-01	1.00E-04	0.00E+00	9.68E+00
Tc-99m	7.01E+00	8.50E+00	1.04E-01	1.00E-04	0.00E+00	8.60E+00
Ru-103	6.26E+00	7.62E+00	9.83E-02	1.01E-04	0.00E+00	7.72E+00
Ru-105	2.74E+00	3.14E+00	1.12E-02	0.00E+00	0.00E+00	3.15E+00
Ru-106	2.19E+00	2.67E+00	3.46E-02	0.00E+00	0.00E+00	2.70E+00
Rh-105	3.80E+00	4.61E+00	5.41E-02	0.00E+00	0.00E+00	4.67E+00
Lanthanides						
Y-90	4.79E-02	7.44E-02	5.12E-03	6.06E-06	0.00E+00	7.96E-02
Y-91	4.90E-01	6.00E-01	8.54E-03	0.00E+00	0.00E+00	6.09E-01
Y-92	2.57E+00	4.13E+00	1.04E-01	0.00E+00	0.00E+00	4.24E+00
Y-93	4.99E-01	5.90E-01	4.32E-03	0.00E+00	0.00E+00	5.94E-01
Zr-95	6.20E-01	7.55E-01	9.76E-03	0.00E+00	0.00E+00	7.65E-01
Zr-97	5.56E-01	6.65E-01	6.12E-03	0.00E+00	0.00E+00	6.71E-01
Nb-95	6.24E-01	7.60E-01	9.85E-03	1.01E-05	0.00E+00	7.69E-01
La-140	1.05E+00	1.76E+00	1.43E-01	2.02E-04	0.00E+00	1.90E+00
La-141	3.74E-01	4.25E-01	1.29E-03	0.00E+00	0.00E+00	4.27E-01
La-142	1.87E-01	2.01E-01	7.07E-05	0.00E+00	0.00E+00	2.01E-01
Pr-143	5.53E-01	6.74E-01	8.91E-03	1.00E-05	0.00E+00	6.83E-01
Nd-147	2.30E-01	2.80E-01	3.55E-03	0.00E+00	0.00E+00	2.83E-01
Am-241	6.17E-05	7.51E-05	9.77E-07	0.00E+00	0.00E+00	7.60E-05
Cm-242	1.52E-02	1.86E-02	2.41E-04	0.00E+00	0.00E+00	1.88E-02
Cm-244	1.85E-03	2.26E-03	2.93E-05	0.00E+00	0.00E+00	2.29E-03
Cerium Group						
Ce-141	1.46E+00	1.78E+00	2.29E-02	0.00E+00	0.00E+00	1.80E+00
Ce-143	1.35E+00	1.63E+00	1.78E-02	0.00E+00	0.00E+00	1.65E+00
Ce-144	1.11E+00	1.35E+00	1.75E-02	0.00E+00	0.00E+00	1.36E+00
Np-239	1.53E+01	1.85E+01	2.16E-01	1.00E-05	0.00E+00	1.87E+01
Pu-238	4.35E-03	5.30E-03	6.88E-05	0.00E+00	0.00E+00	5.37E-03
Pu-239	3.29E-04	4.00E-04	5.19E-06	0.00E+00	0.00E+00	4.05E-04
Pu-240	5.15E-04	6.28E-04	8.14E-06	1.01E-08	0.00E+00	6.36E-04
Pu-241	1.14E-01	1.39E-01	1.81E-03	0.00E+00	0.00E+00	1.41E-01
Total	5.78E+04	2.03E+05	3.28E+05	5.09E+05	1.02E+06	2.06E+06

a) LOCA is calculated at a reactor power level of 4555 MWt (102% of 4466 MWt NSSS)
b) This release corresponds to the 2-hour period that yields the maximum dose at the EAB for this accident scenario.

Table 7.1-6
US-APWR Source Terms
Time Dependent Released Activity during Steam System Piping Failure (Ci)
(Transient-Initiated Iodine Spike)[a]

Nuclide	0 to 2 hr.[b]	0 to 8 hr.	8 to 24 hr.	24 to 96 hr.	96 to 720 hr.	Total 0 to 720 hr.
Noble Gases						
Kr-85	8.04E+00	3.21E+01	2.40E+01	0.00E+00	0.00E+00	5.61E+01
Kr-85m	1.33E-01	3.56E-01	8.77E-02	0.00E+00	0.00E+00	4.43E-01
Kr-87	6.14E-02	9.12E-02	1.13E-03	0.00E+00	0.00E+00	9.23E-02
Kr-88	2.30E-01	5.10E-01	6.46E-02	0.00E+00	0.00E+00	5.74E-01
Xe-133	2.78E+01	1.08E+02	8.03E+01	0.00E+00	0.00E+00	1.88E+02
Xe-135	3.57E+00	7.61E+00	1.33E+01	0.00E+00	0.00E+00	2.09E+01
Iodines						
I-131	2.76E+01	5.05E+01	6.50E+01	0.00E+00	0.00E+00	1.16E+02
I-132	5.61E+00	9.89E+00	1.49E+00	0.00E+00	0.00E+00	1.14E+01
I-133	4.10E+01	7.65E+01	8.09E+01	0.00E+00	0.00E+00	1.57E+02
I-134	3.03E+00	3.77E+00	9.11E-03	0.00E+00	0.00E+00	3.78E+00
I-135	1.97E+01	3.77E+01	2.45E+01	0.00E+00	0.00E+00	6.21E+01
Alkali Metals						
Rb-86	8.49E-02	8.64E-02	1.62E-03	0.00E+00	0.00E+00	8.80E-02
Cs-134	8.65E+00	8.80E+00	1.68E-01	0.00E+00	0.00E+00	8.97E+00
Cs-136	2.28E+00	2.32E+00	4.33E-02	0.00E+00	0.00E+00	2.37E+00
Cs-137	4.92E+00	5.01E+00	9.56E-02	0.00E+00	0.00E+00	5.11E+00
Total	1.53E+02	3.43E+02	2.90E+02	0.00E+00	0.00E+00	6.33E+02

a) Steam system piping failure is calculated at a reactor power level of 4540 MWt (102 percent of 4451 MWt core thermal power).

b) This release corresponds to the 2-hour period that yields the maximum dose at the EAB for this accident scenario.

Table 7.1-7
US-APWR Source Terms
Time Dependent Released Activity during Steam System Piping Failure (Ci)
(Pre-Transient Iodine Spike)[(a)]

Nuclide	0 to 2 hr.[(b)]	0 to 8 hr.	8 to 24 hr.	24 to 96 hr.	96 to 720 hr.	Total 0 to 720 hr.
Noble Gases						
Kr-85	8.04E+00	3.21E+01	2.40E+01	0.00E+00	0.00E+00	5.61E+01
Kr-85m	1.33E-01	3.56E-01	8.77E-02	0.00E+00	0.00E+00	4.43E-01
Kr-87	6.14E-02	9.12E-02	1.13E-03	0.00E+00	0.00E+00	9.23E-02
Kr-88	2.30E-01	5.10E-01	6.46E-02	0.00E+00	0.00E+00	5.74E-01
Xe-133	2.72E+01	1.07E+02	7.75E+01	0.00E+00	0.00E+00	1.85E+02
Xe-135	1.05E+00	4.38E+00	3.39E+00	0.00E+00	0.00E+00	7.78E+00
Iodines						
I-131	1.06E+01	1.72E+01	7.25E+00	0.00E+00	0.00E+00	2.44E+01
I-132	5.24E+00	6.18E+00	1.66E-01	0.00E+00	0.00E+00	6.35E+00
I-133	1.80E+01	2.79E+01	9.03E+00	0.00E+00	0.00E+00	3.69E+01
I-134	3.38E+00	3.49E+00	1.01E-03	0.00E+00	0.00E+00	3.49E+00
I-135	1.15E+01	1.62E+01	2.73E+00	0.00E+00	0.00E+00	1.89E+01
Alkali Metals						
Rb-86	8.49E-02	8.64E-02	1.62E-03	0.00E+00	0.00E+00	8.80E-02
Cs-134	8.65E+00	8.80E+00	1.68E-01	0.00E+00	0.00E+00	8.97E+00
Cs-136	2.28E+00	2.32E+00	4.33E-02	0.00E+00	0.00E+00	2.37E+00
Cs-137	4.92E+00	5.01E+00	9.56E-02	0.00E+00	0.00E+00	5.11E+00
Total	1.01E+02	2.32E+02	1.25E+02	0.00E+00	0.00E+00	3.56E+02

a) Steam system piping failure is calculated at a reactor power level of 4540 MWt (102 percent of 4451 MWt core thermal power).
b) This release corresponds to the 2-hour period that yields the maximum dose at the EAB for this accident scenario.

Table 7.1-8
US-APWR Source Terms
Time Dependent Released Activity during Steam Generator Tube Rupture (Ci)
(Transient-Initiated Iodine Spike)[a]

Nuclide	0 to 2 hr.[b]	0 to 8 hr.	8 to 24 hr.	24 to 96 hr.	96 to 720 hr.	Total 0 to 720 hr.
Noble Gases						
Kr-85	3.41E+03	3.43E+03	4.64E+01	2.06E+02	1.59E+03	5.27E+03
Kr-85m	6.16E+01	6.17E+01	9.70E-02	8.00E-03	0.00E+00	6.18E+01
Kr-87	3.40E+01	3.40E+01	0.00E+00	0.00E+00	0.00E+00	3.40E+01
Kr-88	1.11E+02	1.11E+02	6.00E-02	1.00E-02	0.00E+00	1.11E+02
Xe-133	1.16E+04	1.16E+04	1.45E+02	5.06E+02	9.44E+02	1.32E+04
Xe-135	3.68E+02	3.70E+02	3.82E+00	6.70E-01	0.00E+00	3.74E+02
Iodines						
I-131	1.07E+02	1.10E+02	1.03E+01	0.00E+00	0.00E+00	1.20E+02
I-132	5.21E+01	5.24E+01	2.12E-01	0.00E+00	0.00E+00	5.26E+01
I-133	1.83E+02	1.87E+02	1.27E+01	0.00E+00	0.00E+00	2.00E+02
I-134	3.05E+01	3.05E+01	1.06E-03	0.00E+00	0.00E+00	3.05E+01
I-135	1.17E+02	1.19E+02	3.74E+00	0.00E+00	0.00E+00	1.23E+02
Alkali Metals						
Rb-86	4.07E-03	4.54E-03	5.44E-04	0.00E+00	0.00E+00	5.09E-03
Cs-134	4.15E-01	4.63E-01	5.63E-02	0.00E+00	0.00E+00	5.19E-01
Cs-136	1.09E-01	1.22E-01	1.45E-02	0.00E+00	0.00E+00	1.37E-01
Cs-137	2.36E-01	2.64E-01	3.21E-02	0.00E+00	0.00E+00	2.96E-01
Total	1.60E+04	1.61E+04	2.22E+02	7.12 E+02	2.53E+03	1.96E+04

a) SGTR is calculated at a reactor power level of 4555 MWt (102 percent of 4466 MWt NSSS)
b) This release corresponds to the 2-hour period that yields the maximum does at the EAB for this accident scenario.

Table 7.1-9
US-APWR Source Terms
Time Dependent Released Activity during Steam Generator Tube Rupture (Ci)
(Pre-Transient Iodine Spike)[a]

Nuclide	0 to 2 hr.[b]	0 to 8 hr.	8 to 24 hr.	24 to 96 hr.	96 to 720 hr.	Total 0 to 720 hr.
Noble Gases						
Kr-85	3.41E+03	3.43E+03	4.64E+01	2.06E+02	1.59E+03	5.27E+03
Kr-85m	6.16E+01	6.17E+01	9.70E-02	8.00E-03	0.00E+00	6.18E+01
Kr-87	3.40E+01	3.40E+01	0.00E+00	0.00E+00	0.00E+00	3.40E+01
Kr-88	1.11E+02	1.11E+02	6.00E-02	1.00E-02	0.00E+00	1.11E+02
Xe-133	1.16E+04	1.16E+04	1.44E+02	5.06E+02	9.44E+02	1.32E+04
Xe-135	3.74E+02	3.75E+02	2.18E+00	6.70E-01	0.00E+00	3.78E+02
Iodines						
I-131	4.17E+02	4.18E+02	1.81E+00	0.00E+00	0.00E+00	4.20E+02
I-132	2.08E+02	2.09E+02	3.92E-02	0.00E+00	0.00E+00	2.09E+02
I-133	7.14E+02	7.16E+02	2.24E+00	0.00E+00	0.00E+00	7.18E+02
I-134	1.28E+02	1.28E+02	6.00E-05	0.00E+00	0.00E+00	1.28E+02
I-135	4.60E+02	4.61E+02	6.70E-01	0.00E+00	0.00E+00	4.62E+02
Alkali Metals						
Rb-86	4.07E-03	4.54E-03	5.44E-04	0.00E+00	0.00E+00	5.09E-03
Cs-134	4.15E-01	4.63E-01	5.63E-02	0.00E+00	0.00E+00	5.19E-01
Cs-136	1.09E-01	1.22E-01	1.45E-02	0.00E+00	0.00E+00	1.37E-01
Cs-137	2.36E-01	2.64E-01	3.21E-02	0.00E+00	0.00E+00	2.96E-01
Total	1.75E+04	1.76E+04	1.98E+02	7.12E+02	2.53E+03	2.10E+04

a) SGTR is calculated at a reactor power level of 4555 MWt (102 percent of 4466 MWt NSSS)
b) This release corresponds to the 2-hour period that yields the maximum dose at the EAB for this accident scenario.

Table 7.1-10
US-APWR Source Terms
Time Dependent Released Activity during RCP Rotor Seizure (Ci)[a]

Nuclide	10 to 12 hr.[b]	0 to 8 hr.	8 to 24 hr.	24 to 96 hr.	96 to 720 hr.	Total 0 to 720 hr.
Noble Gases						
Kr-85	2.81E+01	1.12E+02	8.40E+01	0.00E+00	0.00E+00	1.96E+02
Kr-85m	2.40E+02	6.40E+02	1.58E+02	0.00E+00	0.00E+00	7.98E+02
Kr-87	3.38E+02	5.02E+02	6.21E+00	0.00E+00	0.00E+00	5.08E+02
Kr-88	6.19E+02	1.37E+03	1.74E+02	0.00E+00	0.00E+00	1.55E+03
Xe-133	1.75E+03	6.87E+03	4.96E+03	0.00E+00	0.00E+00	1.18E+04
Xe-135	5.18E+02	1.61E+03	7.67E+02	0.00E+00	0.00E+00	2.37E+03
Iodines						
I-131	7.93E+01	8.81E+01	2.32E+02	0.00E+00	0.00E+00	3.20E+02
I-132	2.54E+00	1.94E+01	8.35E+00	0.00E+00	0.00E+00	2.77E+01
I-133	7.40E+01	9.85E+01	2.17E+02	0.00E+00	0.00E+00	3.15E+02
I-134	4.08E-02	6.46E+00	1.10E-01	0.00E+00	0.00E+00	6.57E+00
I-135	3.08E+01	6.38E+01	9.16E+01	0.00E+00	0.00E+00	1.55E+02
Alkali Metals						
Rb-86	2.96E-02	3.23E-02	8.66E-02	0.00E+00	0.00E+00	1.19E-01
Cs-134	3.00E+00	3.24E+00	8.78E+00	0.00E+00	0.00E+00	1.20E+01
Cs-136	7.98E-01	8.72E-01	2.33E+00	0.00E+00	0.00E+00	3.21E+00
Cs-137	1.71E+00	1.84E+00	5.00E+00	0.00E+00	0.00E+00	6.84E+00
Total	3.69E+03	1.14E+04	6.71E+03	0.00E+00	0.00E+00	1.81E+04

a) RCP rotor seizure is calculated at a reactor power level of 4555 MWt (102 percent of 4466 MWt NSSS).
b) This release corresponds to the 2-hour period that yields the maximum dose at the EAB for this accident scenario.

Table 7.1-11
US-APWR Source Terms
Time Dependent Released Activity during Rod Ejection Accident (Ci)[a]

Nuclide	0 to 2 hr.[b]	0 to 8 hr.	8 to 24 hr.	24 to 96 hr.	96 to 720 hr.	Total 0 to 720 hr.
Noble Gases						
Kr-85	6.73E+01	2.63E+02	2.50E+02	1.90E+02	1.63E+03	2.33E+03
Kr-85m	1.37E+03	3.59E+03	9.58E+02	9.86E+00	0.00E+00	4.56E+03
Kr-87	1.91E+03	2.81E+03	3.50E+01	0.00E+00	0.00E+00	2.85E+03
Kr-88	3.52E+03	7.70E+03	1.02E+03	2.05E+00	0.00E+00	8.72E+03
Xe-133	9.92E+03	3.81E+04	3.46E+04	2.11E+04	4.22E+04	1.36E+05
Xe-135	3.02E+03	9.31E+03	5.32E+03	5.40E+02	2.81E+00	1.52E+04
Iodines						
I-131	5.36E+02	5.82E+02	7.17E+02	2.58E+02	7.79E+02	2.34E+03
I-132	3.62E+02	4.62E+02	3.93E+01	1.40E-02	0.00E+00	5.01E+02
I-133	9.42E+02	1.12E+03	1.06E+03	1.13E+02	1.13E+01	2.30E+03
I-134	4.59E+02	4.95E+02	5.15E-01	0.00E+00	0.00E+00	4.95E+02
I-135	6.57E+02	8.75E+02	4.39E+02	6.60E+00	4.00E-03	1.32E+03
Alkali Metals						
Rb-86	4.02E-01	4.16E-01	9.65E-02	0.00E+00	0.00E+00	5.13E-01
Cs-134	4.02E+01	4.15E+01	9.79E+00	1.01E-03	0.00E+00	5.13E+01
Cs-136	1.09E+01	1.13E+01	2.60E+00	1.00E-06	0.00E+00	1.39E+01
Cs-137	2.29E+01	2.36E+01	5.57E+00	0.00E+00	0.00E+00	2.92E+01
Total	2.28E+04	6.53E+04	4.45E+04	2.22E+04	4.46E+04	1.77E+05

a) Rod ejection accident is calculated at a reactor power level of 4540 MWt (102 percent of 4451 MWt core thermal power).
b) This release corresponds to the 2-hour period that yields the maximum dose at the EAB for this accident scenario.

Table 7.1-12
US-APWR Source Terms
Time Dependent Released Activity during Fuel Handling Accident (Ci)

Nuclide	0 to 2 hr.[a]	0 to 8 hr.	8 to 24 hr.	24 to 96 hr.	96 to 720 hr.	Total 0 to 720 hr.
Noble Gases						
Kr-85	1.20E+03	1.20E+03	0.00E+00	0.00E+00	0.00E+00	1.20E+03
Kr-85m	3.90E+02	3.90E+02	0.00E+00	0.00E+00	0.00E+00	3.90E+02
Kr-87	5.98E-02	5.98E-02	0.00E+00	0.00E+00	0.00E+00	5.98E-02
Kr-88	1.25E+02	1.25E+02	0.00E+00	0.00E+00	0.00E+00	1.25E+02
Xe-133	9.90E+04	9.90E+04	0.00E+00	0.00E+00	0.00E+00	9.90E+04
Xe-135	2.21E+04	2.21E+04	0.00E+00	0.00E+00	0.00E+00	2.21E+04
Iodines						
I-131	3.67E+02	3.67E+02	0.00E+00	0.00E+00	0.00E+00	3.67E+02
I-132	2.75E+02	2.75E+02	0.00E+00	0.00E+00	0.00E+00	2.75E+02
I-133	2.31E+02	2.31E+02	0.00E+00	0.00E+00	0.00E+00	2.31E+02
I-134	2.71E-06	2.71E-06	0.00E+00	0.00E+00	0.00E+00	2.71E-06
I-135	3.80E+01	3.80E+01	0.00E+00	0.00E+00	0.00E+00	3.80E+01
Total	1.24E+05	1.24E+05	0.00E+00	0.00E+00	0.00E+00	1.24E+05

a) This release corresponds to the 2-hour period that yields the maximum dose at the EAB for this accident scenario.

Table 7.1-13
US-APWR Source Terms
Time Dependent Released Activity during Failure of Small Lines Carrying Primary Coolant Outside Containment (Ci)[a]

Nuclide	0 to 2 hr.[b]	0 to 8 hr.	8 to 24 hr.	24 to 96 hr.	96 to 720 hr.	Total 0 to 720 hr.
Noble Gases						
Kr-85	6.84E+02	6.84E+02	0.00E+00	0.00E+00	0.00E+00	6.84E+02
Kr-85m	1.25E+01	1.25E+01	0.00E+00	0.00E+00	0.00E+00	1.25E+01
Kr-87	7.05E+00	7.05E+00	0.00E+00	0.00E+00	0.00E+00	7.05E+00
Kr-88	2.26E+01	2.26E+01	0.00E+00	0.00E+00	0.00E+00	2.26E+01
Xe-133	2.32E+03	2.32E+03	0.00E+00	0.00E+00	0.00E+00	2.32E+03
Xe-135	7.70E+01	7.70E+01	0.00E+00	0.00E+00	0.00E+00	7.70E+01
Iodines						
I-131	1.72E+02	1.72E+02	0.00E+00	0.00E+00	0.00E+00	1.72E+02
I-132	7.98E+01	7.98E+01	0.00E+00	0.00E+00	0.00E+00	7.98E+01
I-133	2.93E+02	2.93E+02	0.00E+00	0.00E+00	0.00E+00	2.93E+02
I-134	4.33E+01	4.33E+01	0.00E+00	0.00E+00	0.00E+00	4.33E+01
I-135	1.85E+02	1.85E+02	0.00E+00	0.00E+00	0.00E+00	1.85E+02
Total	3.90E+03	3.90E+03	0.00E+00	0.00E+00	0.00E+00	3.90E+03

a) Source terms are calculated for 4540 MWt (102 percent of core thermal power 4451 MWt).
b) This release corresponds to the 2-hour period that yields the maximum dose at the EAB for this accident scenario.

**Table 7.1-14 (Sheet 1 of 2)
ABWR Source Terms
Iodine Activity Release to the Environment during a LOCA**

Isotope	1 min	10 min	1 hr.	2 hr.	4 hr.
A. Release from Reactor Building to Environment (MBq)					
I-131	3.2E+04	2.9E+06	1.1E+07	1.1E+07	1.1E+07
I-132	4.5E+04	4.1E+06	1.4E+07	1.4E+07	1.5E+07
I-133	6.5E+04	6.1E+06	2.2E+07	2.2E+07	2.3E+07
I-134	7.3E+04	6.1E+06	2.1E+07	2.1E+07	2.1E+07
I-135	6.1E+04	5.7E+06	2.1E+07	2.1E+07	2.2E+07
Total	2.8E+05	2.5E+07	8.9E+07	8.9E+07	9.2E+07
B.1 MSIV Pathway Release to Environment—Elemental (MBq)					
I-131	0.0E+00	0.0E+00	6.1E+01	1.0E+03	1.0E+04
I-132	0.0E+00	0.0E+00	6.9E+01	9.3E+02	6.1E+03
I-133	0.0E+00	0.0E+00	1.2E+02	2.1E+03	1.9E+04
I-134	0.0E+00	0.0E+00	6.9E+01	6.9E+02	2.5E+03
I-135	0.0E+00	0.0E+00	1.1E+02	1.8E+03	1.4E+04
Total	0.0E+00	0.0E+00	4.3E+02	6.5E+03	5.2E+04
B.2 MSIV Pathway Release to Environment—Organic (MBq)					
I-131	0.0E+00	0.0E+00	7.3E+02	1.2E+04	1.2E+05
I-132	0.0E+00	0.0E+00	8.1E+02	1.1E+04	7.3E+04
I-133	0.0E+00	0.0E+00	1.4E+03	2.5E+04	2.3E+05
I-134	0.0E+00	0.0E+00	8.5E+02	8.5E+03	3.1E+04
I-135	0.0E+00	0.0E+00	1.3E+03	2.1E+04	1.8E+05
Total	0.0E+00	0.0E+00	5.1E+03	7.8E+04	6.3E+05
B.3 MSIV Pathway Release to Environment—Resuspended Organic (MBq)					
I-131	0.0E+00	0.0E+00	7.3E+00	3.0E+01	2.4E+02
I-132	0.0E+00	0.0E+00	6.1E+00	2.3E+01	8.9E+01
I-133	0.0E+00	0.0E+00	1.4E+01	5.7E+01	4.5E+02
I-134	0.0E+00	0.0E+00	4.5E+00	1.4E+01	3.1E+01
I-135	0.0E+00	0.0E+00	1.2E+01	4.5E+01	2.9E+02
Total	0.0E+00	0.0E+00	4.4E+01	1.7E+02	1.1E+03
B.4 Release from Condenser to Environment—Sum of B.1+B.2+B.3 (MBq)					
I-131	0.0E+00	0.0E+00	7.7E+02	1.3E+04	1.3E+05
I-132	0.0E+00	0.0E+00	8.9E+02	1.2E+04	7.7E+04
I-133	0.0E+00	0.0E+00	1.6E+03	2.6E+04	2.5E+05
I-134	0.0E+00	0.0E+00	9.3E+02	9.3E+03	3.3E+04
I-135	0.0E+00	0.0E+00	1.4E+03	2.3E+04	1.9E+05
Total	0.0E+00	0.0E+00	5.6E+03	8.3E+04	6.8E+05

Table 7.1-14 (Sheet 2 of 2)
ABWR Source Terms
Iodine Activity Release to the Environment during a LOCA

Isotope	8 hr.	12 hr.	1 day	4 days	30 days
A. Release from Reactor Building to Environment (MBq)					
I-131	1.4E+07	1.9E+07	3.9E+07	2.1E+08	7.3E+08
I-132	1.5E+07	1.6E+07	1.6E+07	1.6E+07	1.6E+07
I-133	2.9E+07	3.6E+07	6.1E+07	1.3E+08	1.4E+08
I-134	2.1E+07	2.1E+07	2.1E+07	2.1E+07	2.1E+07
I-135	2.5E+07	2.9E+07	3.4E+07	3.8E+07	3.8E+07
Total	1.0E+08	1.2E+08	1.7E+08	7.7E+08	9.5E+08
B.1 MSIV Pathway Release to Environment—Elemental (MBq)					
I-131	6.9E+04	2.0E+05	9.8E+05	1.1E+07	3.3E+07
I-132	2.0E+04	3.0E+04	3.6E+04	3.7E+04	3.7E+04
I-133	1.2E+05	3.3E+05	1.2E+06	5.3E+06	6.1E+06
I-134	3.9E+03	4.1E+03	4.1E+03	1.4E+02	4.1E+03
I-135	7.7E+04	1.8E+05	4.1E+05	6.1E+05	6.1E+05
Total	2.9E+05	7.4E+05	2.6E+06	1.7E+07	4.0E+07
B.2 MSIV Pathway Release to Environment—Organic (MBq)					
I-131	8.5E+05	2.4E+06	1.2E+07	1.8E+08	1.5E+09
I-132	2.4E+05	3.6E+05	4.5E+05	4.5E+05	4.5E+05
I-133	1.5E+06	3.9E+06	1.5E+07	7.7E+07	8.9E+07
I-134	4.8E+04	4.8E+04	4.8E+04	4.8E+04	4.8E+04
I-135	9.3E+05	2.1E+06	4.8E+06	7.7E+06	7.7E+06
Total	3.6E+06	8.8E+06	3.2E+07	2.7E+08	1.6E+09
B.3 MSIV Pathway Release to Environment—Resuspended Organic (MBq)					
I-131	1.5E+03	5.3E+03	4.1E+04	6.9E+06	5.7E+08
I-132	3.2E+02	4.8E+02	7.3E+02	7.7E+02	7.7E+02
I-133	2.6E+03	8.1E+03	4.8E+04	1.5E+06	3.6E+06
I-134	5.3E+01	6.1E+01	6.1E+01	6.1E+01	6.1E+01
I-135	1.5E+03	3.5E+03	1.2E+04	3.7E+04	3.8E+04
Total	6.0E+03	1.7E+04	1.0E+05	8.4E+06	5.7E+08
B.4 Release from Condenser to Environment—Sum of B.1+B.2+B.3 (MBq)					
I-131	9.3E+05	2.6E+06	1.3E+07	2.0E+08	2.2E+09
I-132	2.6E+05	3.8E+05	4.8E+05	4.8E+05	4.8E+05
I-133	1.6E+06	4.1E+06	1.6E+07	8.1E+07	9.8E+07
I-134	5.3E+04	5.3E+04	5.3E+04	5.3E+04	5.3E+04
I-135	1.0E+06	2.2E+06	5.7E+06	8.1E+06	8.1E+06
Total	3.8E+06	9.3E+06	3.5E+07	2.9E+08	2.3E+09

Table 7.1-15 (Sheet 1 of 2)
ABWR Source Terms
Noble Gas Activity Release to the Environment during a LOCA

Isotope	1 min	10 min	1 hr.	2 hr.	4 hr.
A. Reactor Building Release to Environment (MBq)					
Kr-83m	3.0E+04	2.5E+06	1.0E+07	1.3E+07	2.1E+07
Kr-85	2.8E+03	2.5E+05	1.1E+06	1.6E+06	3.9E+06
Kr-85m	6.1E+04	5.7E+06	2.3E+07	3.4E+07	6.5E+07
Kr-87	1.2E+05	1.0E+07	3.9E+07	4.8E+07	6.9E+07
Kr-88	1.8E+05	1.5E+07	6.1E+07	8.5E+07	1.5E+08
Kr-89	1.9E+05	5.3E+06	7.3E+06	7.3E+06	7.3E+06
Xe-131m	1.4E+03	1.3E+05	5.7E+05	8.5E+05	2.1E+06
Xe-133	5.3E+05	4.5E+07	2.0E+08	3.1E+08	7.3E+08
Xe-133m	2.2E+04	2.0E+06	8.1E+06	1.2E+07	3.0E+07
Xe-135	6.5E+04	6.1E+06	2.5E+07	3.7E+07	8.1E+07
Xe-135m	9.3E+04	6.5E+06	1.9E+07	2.0E+07	2.0E+07
Xe-137	4.1E+05	1.4E+07	2.1E+07	2.1E+07	2.1E+07
Xe-138	4.1E+05	2.8E+07	8.1E+07	8.1E+07	8.1E+07
Total	2.1E+06	1.4E+08	4.7E+08	6.2E+08	1.3E+09
B. Condenser Release to Environment (MBq)					
Kr-83m	0.0E+00	0.0E+00	6.5E+03	8.5E+04	4.8E+05
Kr-85	0.0E+00	0.0E+00	8.1E+02	1.4E+04	1.4E+05
Kr-85m	0.0E+00	0.0E+00	1.6E+04	2.5E+05	2.0E+06
Kr-87	0.0E+00	0.0E+00	2.2E+04	2.6E+05	1.2E+06
Kr-88	0.0E+00	0.0E+00	4.1E+04	6.1E+05	4.1E+06
Kr-89	0.0E+00	0.0E+00	4.5E+00	4.5E+00	4.5E+00
Xe-131m	0.0E+00	0.0E+00	4.5E+02	7.3E+03	7.3E+04
Xe-133	0.0E+00	0.0E+00	1.5E+05	2.6E+06	2.5E+07
Xe-133m	0.0E+00	0.0E+00	6.1E+03	1.1E+05	1.0E+06
Xe-135	0.0E+00	0.0E+00	1.9E+04	3.0E+05	2.6E+06
Xe-135m	0.0E+00	0.0E+00	3.2E+03	1.1E+04	1.4E+04
Xe-137	0.0E+00	0.0E+00	3.7E+01	3.8E+01	3.8E+01
Xe-138	0.0E+00	0.0E+00	1.1E+04	3.5E+04	4.1E+04
Total	0.0E+00	0.0E+00	2.7E+05	4.3E+06	3.7E+07

Table 7.1-15 (Sheet 2 of 2)
ABWR Source Terms
Noble Gas Activity Release to the Environment during a LOCA

Isotope	8 hr.	12 hr.	1 day	4 days	30 days
A. Reactor Building Release to Environment (MBq)					
Kr-83m	3.1E+07	3.5E+07	3.6E+07	3.6E+07	3.6E+07
Kr-85	1.3E+07	2.6E+07	8.9E+07	7.3E+08	6.1E+09
Kr-85m	1.4E+08	2.1E+08	3.0E+08	3.2E+08	3.2E+08
Kr-87	8.5E+07	8.9E+07	8.9E+07	8.9E+07	8.9E+07
Kr-88	2.7E+08	3.4E+08	3.9E+08	4.1E+08	4.1E+08
Kr-89	7.3E+06	7.3E+06	7.3E+06	7.3E+06	7.3E+06
Xe-131m	6.5E+06	1.4E+07	4.5E+07	3.3E+08	1.5E+09
Xe-133	2.3E+09	4.8E+09	1.5E+10	9.7E+10	2.7E+11
Xe-133m	9.3E+07	1.9E+08	5.7E+08	2.8E+09	4.5E+09
Xe-135	2.1E+08	3.6E+08	7.3E+08	1.1E+09	1.1E+09
Xe-135m	2.0E+07	2.0E+07	2.0E+07	2.0E+07	2.0E+07
Xe-137	2.1E+07	2.1E+07	2.1E+07	2.1E+07	2.1E+07
Xe-138	8.1E+07	8.1E+07	8.1E+07	8.1E+07	8.1E+07
Total	3.3E+09	6.2E+09	1.8E+10	1.0E+11	2.8E+11
B. Condenser Release to Environment (MBq)					
Kr-83m	1.4E+06	1.9E+06	2.1E+06	2.1E+06	2.1E+06
Kr-85	1.0E+06	2.8E+06	1.4E+07	2.5E+08	6.5E+09
Kr-85m	9.3E+06	1.8E+07	3.3E+07	3.9E+07	3.9E+07
Kr-87	2.6E+06	3.0E+06	3.1E+06	3.1E+06	3.1E+06
Kr-88	1.5E+07	2.5E+07	3.4E+07	3.5E+07	3.5E+07
Kr-89	4.5E+00	4.5E+00	4.5E+00	4.5E+00	4.5E+00
Xe-131m	5.3E+05	1.4E+06	7.3E+06	1.1E+08	1.4E+09
Xe-133	1.8E+08	4.8E+08	2.4E+09	3.3E+10	2.0E+11
Xe-133m	7.3E+06	2.0E+07	8.9E+07	8.9E+08	2.2E+09
Xe-135	1.5E+07	3.6E+07	1.1E+08	2.2E+08	2.2E+08
Xe-135m	1.4E+04	1.4E+04	1.4E+04	1.4E+04	1.4E+04
Xe-137	3.8E+01	3.8E+01	3.8E+01	3.8E+01	3.8E+01
Xe-138	4.1E+04	4.1E+04	4.1E+04	4.1E+04	4.1E+04
Total	2.3E+08	5.9E+08	2.7E+09	3.5E+10	2.1E+11

Table 7.1-16
ABWR Source Terms
Activity Released to Environment during a Main Steamline Break Accident (MBq)

Isotope	Case 1[(a)]	Case 2[(a)]
I-131	7.29E+04	1.46E+06
I-132	7.10E+05	1.42E+07
I-133	5.00E+05	9.99E+06
I-134	1.40E+06	2.79E+07
I-135	7.29E+05	1.46E+07
Total Halogens	3.41E+06	6.81E+07
Kr-83m	4.07E+02	2.44E+03
Kr-85m	7.18E+02	4.29E+03
Kr-85	2.26E+00	1.36E+01
Kr-87	2.44E+03	1.47E+04
Kr-88	2.46E+03	1.48E+04
Kr-89	9.88E+03	5.92E+04
Kr-90	2.55E+03	1.55E+04
Xe-131m	1.76E+00	1.06E+01
Xe-133m	3.39E+01	2.04E+02
Xe-133	9.47E+02	5.70E+03
Xe-135m	2.89E+03	1.74E+04
Xe-135	2.70E+03	1.62E+04
Xe-137	1.23E+04	7.40E+04
Xe-138	9.44E+03	5.66E+04
Xe-139	4.33E+03	2.59E+04
Total Noble Gases	5.11E+04	3.07E+05

a) The level of activity is consistent with an offgas release rate of 3.7 GBq/s for Case 1 and 14.8 GBq/s for Case 2 referenced to a 30 minute decay. The iodine concentrations in the reactor coolant are tabulated below for each case.

	MBq/g	
Isotope	**Case 1**	**Case 2**
I-131	0.001739	0.03515
I-132	0.01536	0.30747
I-133	0.01206	0.24161
I-134	0.02634	0.52688
I-135	0.01647	0.3293

Table 7.1-17
ABWR Source Terms
Isotopic Releases during an Instrument Line Break Accident (MBq)

Isotope	1 min	10 min	1 hr.	2 hr.	4 hr.	8 hr.
Reactor Building Inventory						
I-131	3.77E+01	3.27E+02	2.60E+04	1.73E+04	1.38E+04	4.59E+00
I-132	3.68E+02	3.11E+03	2.31E+05	1.44E+05	1.17E+05	1.17E+01
I-133	2.59E+02	2.24E+03	1.75E+05	1.16E+05	9.29E+04	2.72E+01
I-134	7.22E+02	5.92E+03	3.89E+05	2.26E+05	1.86E+05	2.65E+00
I-135	3.77E+02	3.25E+03	2.52E+05	1.64E+05	1.32E+05	2.90E+01
Total	1.76E+03	1.48E+04	1.07E+06	6.68E+05	5.41E+05	7.52E+01
Isotopic Releases to Environment						
I-131	6.36E-01	5.77E+01	2.77E+04	6.81E+04	1.27E+05	1.41E+05
I-132	6.18E+00	5.51E+02	2.52E+05	5.96E+05	1.09E+06	1.19E+06
I-133	4.37E+00	3.96E+02	1.87E+05	4.59E+05	8.51E+05	9.44E+05
I-134	1.21E+01	1.06E+03	4.44E+05	9.92E+05	1.76E+06	1.90E+06
I-135	6.36E+00	5.74E+02	2.71E+05	6.59E+05	1.21E+06	1.34E+06
Total	2.97E+01	2.64E+03	1.18E+06	2.77E+06	5.04E+06	5.51E+06

Table 7.1-18
ABWR Source Terms
Isotopic Release to Environment during a Fuel Handling Accident (MBq)

Isotope	1 min	10 min	1 hr.	2 hr.
I-131	3.12E+05	2.80E+06	4.98E+06	4.98E+06
I-132	4.02E+05	3.53E+06	6.15E+06	6.15E+06
I-133	3.23E+05	2.89E+06	5.15E+06	5.15E+06
I-134	1.75E-02	1.49E-01	2.50E-01	2.50E-01
I-135	5.31E+04	4.70E+05	8.34E+05	8.34E+05
Total	1.09E+06	9.69E+06	1.71E+07	1.71E+07
Kr-83m	1.66E+04	1.45E+05	2.55E+05	2.61E+05
Kr-85m	2.12E+05	1.88E+06	3.37E+06	3.46E+06
Kr-85	1.15E+06	1.04E+07	1.88E+07	1.94E+07
Kr-87	3.29E+01	2.84E+02	4.94E+02	4.98E+02
Kr-88	6.15E+04	5.39E+05	9.65E+05	9.85E+05
Kr-89	7.17E-07	3.03E-06	3.30E-06	3.30E-06
Xe-131m	2.02E+05	1.81E+06	3.29E+06	3.38E+06
Xe-133m	2.67E+06	2.39E+07	4.34E+07	4.46E+07
Xe-133	6.81E+07	6.12E+08	1.11E+09	1.14E+09
Xe-135m	7.94E+05	5.96E+06	8.96E+06	8.96E+06
Xe-135	1.56E+07	1.39E+08	2.51E+08	2.58E+08
Xe-137	1.59E-06	7.41E-06	8.39E-06	8.39E-06
Xe-138	1.60E-06	1.17E-05	1.74E-05	1.74E-05
Total	8.88E+07	7.95E+08	1.45E+09	1.48E+09

Table 7.1-19
AP1000 Source Terms
Activity Releases for Steam System Piping Failure with Pre-Existing Iodine Spike (Ci)

Isotope	0 to 2 hr.	2 to 8 hr.	8 to 24 hr.	24 to 72 hr.	Total
Kr-85m	6.86E-02	1.14E-01	6.80E-02	6.18E-03	2.57E-01
Kr-85	2.82E-01	8.46E-01	2.25E+00	6.69E+00	1.01E+01
Kr-87	2.76E-02	1.34E-02	5.29E-04	8.60E-08	4.15E-02
Kr-88	1.12E-01	1.37E-01	4.04E-02	8.27E-04	2.91E-01
Xe-131m	1.28E-01	3.79E-01	9.81E-01	2.70E+00	4.19E+00
Xe-133m	1.59E-01	4.51E-01	1.04E+00	2.05E+00	3.70E+00
Xe-133	1.18E+01	3.45E+01	8.64E+01	2.16E+02	3.49E+02
Xe-135m	3.04E-03	1.33E-05	0.00E+00	0.00E+00	3.06E-03
Xe-135	3.10E-01	6.90E-01	8.35E-01	3.38E-01	2.17E+00
Xe-138	3.99E-03	1.14E-05	0.00E+00	0.00E+00	4.00E-03
I-130	3.59E-01	1.42E-01	2.09E-01	1.33E-01	8.44E-01
I-131	2.40E+01	1.21E+01	3.10E+01	8.22E+01	1.49E+02
I-132	3.05E+01	4.14E+00	8.06E-01	6.55E-03	3.55E+01
I-133	4.34E+01	1.90E+01	3.53E+01	3.98E+01	1.37E+02
I-134	6.74E+00	1.63E-01	1.43E-03	4.54E-09	6.91E+00
I-135	2.60E+01	8.16E+00	7.54E+00	1.71E+00	4.34E+01
Cs-134	1.90E+01	1.95E-01	5.19E-01	1.54E+00	2.12E+01
Cs-136	2.82E+01	2.86E-01	7.43E-01	2.06E+00	3.13E+01
Cs-137	1.37E+01	1.41E-01	3.74E-01	1.11E+00	1.53E+01
Cs-138	1.01E+01	1.02E-03	4.42E-07	0.00E+00	1.01E+01
Total	2.15E+02	8.15E+01	1.68E+02	3.56E+02	8.21E+02

Table 7.1-20
AP1000 Source Terms
Activity Releases for Steam System Piping Failure with Accident-Initiated Iodine Spike (Ci)

Isotope	0 to 2 hr.	2 to 8 hr.	8 to 24 hr.	24 to 72 hr.	Total
Kr-85m	6.86E-02	1.14E-01	6.80E-02	6.18E-03	2.57E-01
Kr-85	2.82E-01	8.46E-01	2.25E+00	6.69E+00	1.01E+01
Kr-87	2.76E-02	1.34E-02	5.29E-04	8.60E-08	4.15E-02
Kr-88	1.12E-01	1.37E-01	4.04E-02	8.27E-04	2.91E-01
Xe-131m	1.28E-01	3.79E-01	9.81E-01	2.70E+00	4.19E+00
Xe-133m	1.59E-01	4.51E-01	1.04E+00	2.05E+00	3.70E+00
Xe-133	1.18E+01	3.45E+01	8.64E+01	2.16E+02	3.49E+02
Xe-135m	3.04E-03	1.33E-05	0.00E+00	0.00E+00	3.06E-03
Xe-135	3.10E-01	6.90E-01	8.35E-01	3.38E-01	2.17E+00
Xe-138	3.99E-03	1.14E-05	0.00E+00	0.00E+00	4.00E-03
I-130	4.20E-01	9.95E-01	1.58E+00	1.01E+00	4.01E+00
I-131	2.60E+01	5.73E+01	1.56E+02	4.13E+02	6.53E+02
I-132	4.62E+01	9.74E+01	2.24E+01	1.82E-01	1.66E+02
I-133	4.91E+01	1.14E+02	2.27E+02	2.55E+02	6.45E+02
I-134	1.34E+01	1.86E+01	2.65E-01	8.42E-07	3.23E+01
I-135	3.24E+01	7.74E+01	7.83E+01	1.77E+01	2.06E+02
Cs-134	1.90E+01	1.95E-01	5.19E-01	1.54E+00	2.12E+01
Cs-136	2.82E+01	2.86E-01	7.43E-01	2.06E+00	3.13E+01
Cs-137	1.37E+01	1.41E-01	3.74E-01	1.11E+00	1.53E+01
Cs-138	1.01E+01	1.02E-03	4.42E-07	0.00E+00	1.01E+01
Total	2.51E+02	4.03E+02	5.78E+02	9.20E+02	2.15E+03

Table 7.1-21
AP1000 Source Terms
Activity Releases for Reactor Coolant Pump Shaft Seizure (Ci)

Isotope	No Feedwater 0 to 1.5 hr.	Feedwater Available 0 to 2 hr.	2 to 8 hr.	6 to 8 hr.	Total
Kr-85m	8.16E+01	1.05E+02	1.74E+02	4.13E+01	2.79E+02
Kr-85	7.58E+00	1.01E+01	3.03E+01	1.01E+01	4.04E+01
Kr-87	1.20E+02	1.43E+02	6.97E+01	5.43E+00	2.13E+02
Kr-88	2.08E+02	2.62E+02	3.20E+02	6.05E+01	5.82E+02
Xe-131m	3.77E+00	5.03E+00	1.49E+01	4.95E+00	1.99E+01
Xe-133m	2.02E+01	2.69E+01	7.64E+01	2.48E+01	1.03E+02
Xe-133	6.66E+02	8.87E+02	2.60E+03	8.57E+02	3.49E+03
Xe-135m	3.24E+01	3.28E+01	1.43E-01	2.68E-06	3.30E+01
Xe-135	1.59E+02	2.08E+02	4.64E+02	1.32E+02	6.72E+02
Xe-138	1.29E+02	1.30E+02	3.72E-01	3.01E-06	1.30E+02
I-130	8.45E-01	1.17E-01	1.33E+00	5.65E-01	1.45E+00
I-131	3.77E+01	5.39E+00	7.51E+01	3.46E+01	8.05E+01
I-132	2.79E+01	3.45E+00	1.48E+01	3.95E+00	1.83E+01
I-133	4.86E+01	6.86E+00	8.29E+01	3.64E+01	8.98E+01
I-134	2.88E+01	2.76E+00	2.98E+00	2.09E-01	5.74E+00
I-135	4.19E+01	5.68E+00	5.22E+01	2.05E+01	5.79E+01
Cs-134	1.29E+00	1.82E-01	2.40E+00	1.11E+00	2.59E+00
Cs-136	5.63E-01	8.45E-02	7.79E-01	3.47E-01	8.63E-01
Cs-137	7.74E-01	1.10E-01	1.41E+00	6.51E-01	1.52E+00
Cs-138	6.08E+00	7.29E-01	3.35E+00	1.13E+00	4.08E+00
Rb-86	1.33E-02	1.83E-03	2.73E-02	1.27E-02	2.91E-02
Total	1.62E+03	1.84E+03	3.99E+03	1.23E+03	5.82E+03

Table 7.1-22
AP1000 Source Terms
Activity Releases for Spectrum of Rod Cluster Control Assembly Ejection Accidents (Ci)

Isotope	0 to 2 hr.	2 to 8 hr.	8 to 24 hr.	24 to 96 hr.	96 to 720 hr.	Total
Kr-85m	1.12E+02	6.48E+01	3.87E+01	1.77E+00	2.51E-05	2.18E+02
Kr-85	5.01E+00	5.60E+00	1.49E+01	3.35E+01	2.88E+02	3.47E+02
Kr-87	1.82E+02	2.60E+01	1.03E+00	8.37E-05	0.00E+00	2.09E+02
Kr-88	2.91E+02	1.18E+02	3.49E+01	3.59E-01	8.41E-09	4.45E+02
Xe-131m	4.94E+00	5.46E+00	1.42E+01	2.86E+01	1.16E+02	1.69E+02
Xe-133m	2.67E+01	2.81E+01	6.49E+01	8.45E+01	5.31E+01	2.57E+02
Xe-133	8.79E+02	9.58E+02	2.40E+03	4.27E+03	8.45E+03	1.70E+04
Xe-135m	7.34E+01	5.30E-02	4.33E-09	0.00E+00	0.00E+00	7.35E+01
Xe-135	2.15E+02	1.72E+02	2.09E+02	4.35E+01	1.79E-01	6.39E+02
Xe-138	2.99E+02	1.38E-01	3.19E-09	0.00E+00	0.00E+00	2.99E+02
I-130	4.90E+00	7.28E+00	4.32E+00	2.03E-01	2.95E-04	1.67E+01
I-131	1.36E+02	2.45E+02	2.31E+02	3.10E+01	1.68E+01	6.60E+02
I-132	1.53E+02	9.94E+01	9.85E+00	8.24E-03	0.00E+00	2.62E+02
I-133	2.72E+02	4.40E+02	3.18E+02	2.28E+01	2.41E-01	1.05E+03
I-134	1.66E+02	2.85E+01	1.37E-01	4.48E-08	0.00E+00	1.95E+02
I-135	2.39E+02	2.97E+02	1.19E+02	2.39E+00	7.32E-05	6.57E+02
Cs-134	3.08E+01	6.22E+01	6.03E+01	7.76E+00	5.16E+00	1.66E+02
Cs-136	8.79E+00	1.75E+01	1.67E+01	2.05E+00	6.58E-01	4.57E+01
Cs-137	1.79E+01	3.62E+01	3.51E+01	4.52E+00	3.05E+00	9.68E+01
Cs-138	1.09E+02	7.05E+00	1.68E-03	0.00E+00	0.00E+00	1.16E+02
Rb-86	3.62E-01	7.27E-01	6.96E-01	8.67E-02	3.42E-02	1.91E+00
Total	3.23E+03	2.62E+03	3.58E+03	4.53E+03	8.93E+03	2.29E+04

Table 7.1-23
AP1000 Source Terms
Activity Releases for Failure of Small Lines Carrying Primary Coolant Outside Containment (Ci)

Isotope	0-2 hr.
Kr-85m	1.24E+01
Kr-85	4.40E+01
Kr-87	7.05E+00
Kr-88	2.21E+01
Xe-131m	1.99E+01
Xe-133m	2.50E+01
Xe-133	1.84E+03
Xe-135m	2.59E+00
Xe-135	5.20E+01
Xe-138	3.65E+00
I-130	1.89E+00
I-131	9.26E+01
I-132	3.49E+02
I-133	2.01E+02
I-134	1.58E+02
I-135	1.68E+02
Cs-134	4.16E+00
Cs-136	6.16E+00
Cs-137	3.00E+00
Cs-138	2.21E+00
Total	3.02E+03

Table 7.1-24
AP1000 Source Terms
Activity Releases for Steam Generator Tube Rupture with Pre-Existing Iodine Spike (Ci)

Isotope	0 to 2 hr.	2 to 8 hr.	8 to 24 hr.	Total
Kr-85m	5.53E+01	1.93E+01	7.53E-03	7.46E+01
Kr-85	2.20E+02	1.09E+02	1.34E-01	3.29E+02
Kr-87	2.39E+01	3.61E+00	9.12E-05	2.75E+01
Kr-88	9.22E+01	2.65E+01	5.43E-03	1.19E+02
Xe-131m	9.96E+01	4.88E+01	5.91E-02	1.48E+02
Xe-133m	1.24E+02	5.91E+01	6.61E-02	1.83E+02
Xe-133	9.19E+03	4.47E+03	5.29E+00	1.37E+04
Xe-135m	3.44E+00	5.86E-03	0.00E+00	3.45E+00
Xe-135	2.46E+02	1.02E+02	7.10E-02	3.47E+02
Xe-138	4.56E+00	5.07E-03	0.00E+00	4.57E+00
I-130	1.79E+00	5.39E-02	2.68E-01	2.12E+00
I-131	1.21E+02	5.27E+00	3.06E+01	1.56E+02
I-132	1.42E+02	7.43E-01	1.92E+00	1.44E+02
I-133	2.16E+02	7.63E+00	4.06E+01	2.64E+02
I-134	2.74E+01	4.40E-03	4.23E-03	2.74E+01
I-135	1.27E+02	2.70E+00	1.17E+01	1.42E+02
Cs-134	1.63E+00	6.05E-02	2.16E-01	1.90E+00
Cs-136	2.42E+00	8.86E-02	3.14E-01	2.82E+00
Cs-137	1.17E+00	4.37E-02	1.56E-01	1.37E+00
Cs-138	5.64E-01	2.91E-06	5.73E-07	5.64E-01
Total	1.07E+04	4.85E+03	9.14E+01	1.56E+04

Table 7.1-25
AP1000 Source Terms
Activity Releases for Steam Generator Tube Rupture with Accident-Initiated Iodine Spike (Ci)

Isotope	0 to 2 hr.	2 to 8 hr.	8 to 24 hr.	Total
Kr-85m	5.53E+01	1.93E+01	7.53E-03	7.46E+01
Kr-85	2.20E+02	1.09E+02	1.34E-01	3.29E+02
Kr-87	2.39E+01	3.61E+00	9.12E-05	2.75E+01
Kr-88	9.22E+01	2.65E+01	5.43E-03	1.19E+02
Xe-131m	9.96E+01	4.88E+01	5.91E-02	1.48E+02
Xe-133m	1.24E+02	5.91E+01	6.61E-02	1.83E+02
Xe-133	9.19E+03	4.47E+03	5.29E+00	1.37E+04
Xe-135m	3.44E+00	5.86E-03	0.00E+00	3.45E+00
Xe-135	2.46E+02	1.02E+02	7.10E-02	3.47E+02
Xe-138	4.56E+00	5.07E-03	0.00E+00	4.57E+00
I-130	8.87E-01	1.62E-01	8.24E-01	1.87E+00
I-131	4.36E+01	1.14E+01	6.76E+01	1.23E+02
I-132	1.47E+02	4.86E+00	1.29E+01	1.65E+02
I-133	9.33E+01	2.00E+01	1.08E+02	2.22E+02
I-134	5.59E+01	6.04E-02	5.94E-02	5.60E+01
I-135	7.61E+01	9.88E+00	4.38E+01	1.30E+02
Cs-134	1.63E+00	6.05E-02	2.16E-01	1.90E+00
Cs-136	2.42E+00	8.86E-02	3.14E-01	2.82E+00
Cs-137	1.17E+00	4.37E-02	1.56E-01	1.37E+00
Cs-138	5.64E-01	2.91E-06	5.73E-07	5.64E-01
Total	1.05E+04	4.88E+03	2.40E+02	1.56E+04

Table 7.1-26 (Sheet 1 of 2)
AP1000 Source Terms
Activity Releases for LOCA Resulting from a Spectrum of Postulated Piping Breaks Within the Reactor Coolant Pressure Boundary (Ci)

Isotope	1.4 to 3.4 hr.	0 to 8 hr.	8 to 24 hr.	24 to 96 hr.	96 to 720 hr.	Total
I-130	5.64E+01	1.12E+02	5.37E+00	7.10E-01	1.27E-02	1.18E+02
I-131	1.68E+03	3.49E+03	2.66E+02	2.39E+02	7.19E+02	4.71E+03
I-132	1.23E+03	2.14E+03	1.64E+01	1.46E-02	0.00E+00	2.15E+03
I-133	3.23E+03	6.54E+03	3.83E+02	1.04E+02	1.04E+01	7.04E+03
I-134	6.60E+02	1.14E+03	2.96E-01	6.79E-08	0.00E+00	1.14E+03
I-135	2.56E+03	4.89E+03	1.58E+02	6.09E+00	3.16E-03	5.06E+03
Kr-85m	1.42E+03	3.77E+03	1.87E+03	8.56E+01	1.22E-03	5.73E+03
Kr-85	8.31E+01	2.97E+02	7.06E+02	1.59E+03	1.36E+04	1.62E+04
Kr-87	1.10E+03	1.95E+03	4.97E+01	4.05E-03	0.00E+00	1.99E+03
Kr-88	3.11E+03	7.26E+03	1.70E+03	1.75E+01	4.09E-07	8.97E+03
Xe-131m	8.26E+01	2.94E+02	6.79E+02	1.37E+03	5.57E+03	7.91E+03
Xe-133m	4.43E+02	1.54E+03	3.15E+03	4.11E+03	2.58E+03	1.14E+04
Xe-133	1.47E+04	5.19E+04	1.16E+05	2.06E+05	4.07E+05	7.80E+05
Xe-135m	1.06E+01	3.59E+01	2.14E-07	0.00E+00	0.00E+00	3.59E+01
Xe-135	3.15E+03	9.64E+03	1.01E+04	2.11E+03	8.68E+00	2.19E+04
Xe-138	3.11E+01	1.20E+02	1.58E-07	0.00E+00	0.00E+00	1.20E+02
Rb-86	3.04E+00	6.32E+00	2.99E-01	9.83E-02	5.13E-01	7.23E+00
Cs-134	2.58E+02	5.38E+02	2.57E+01	9.11E+00	7.74E+01	6.50E+02
Cs-136	7.33E+01	1.52E+02	7.16E+00	2.28E+00	9.88E+00	1.72E+02
Cs-137	1.51E+02	3.13E+02	1.50E+01	5.32E+00	4.57E+01	3.79E+02
Cs-138	1.50E+02	3.30E+02	2.18E-03	0.00E+00	0.00E+00	3.30E+02
Sb-127	2.42E+01	4.80E+01	2.29E+00	5.67E-01	7.82E-01	5.16E+01
Sb-129	5.10E+01	8.94E+01	1.51E+00	4.95E-03	4.90E-08	9.09E+01
Te-127m	3.15E+00	6.30E+00	3.16E-01	1.11E-01	8.71E-01	7.60E+00
Te-127	2.05E+01	3.83E+01	1.15E+00	2.75E-02	1.33E-04	3.94E+01
Te-129m	1.07E+01	2.15E+01	1.07E+00	3.65E-01	2.36E+00	2.52E+01
Te-129	1.88E+01	2.83E+01	2.69E-02	3.54E-08	0.00E+00	2.84E+01
Te-131m	3.17E+01	6.20E+01	2.64E+00	3.35E-01	7.81E-02	6.50E+01
Te-132	3.23E+02	6.40E+02	3.02E+01	7.04E+00	7.83E+00	6.85E+02
Sr-89	9.23E+01	1.85E+02	9.24E+00	3.19E+00	2.26E+01	2.20E+02
Sr-90	7.95E+00	1.59E+01	7.99E-01	2.84E-01	2.44E+00	1.94E+01
Sr-91	9.68E+01	1.81E+02	5.46E+00	1.35E-01	7.06E-04	1.87E+02
Sr-92	6.83E+01	1.13E+02	1.01E+00	5.15E-04	0.00E+00	1.14E+02
Ba-139	5.44E+01	8.30E+01	1.49E-01	9.91E-07	0.00E+00	8.32E+01
Ba-140	1.63E+02	3.25E+02	1.61E+01	5.11E+00	2.17E+01	3.68E+02

Table 7.1-26 (Sheet 2 of 2)
AP1000 Source Terms
Activity Releases for LOCA Resulting from a Spectrum of Postulated Piping Breaks Within the Reactor Coolant Pressure Boundary (Ci)

Isotope	1.4 to 3.4 hr.	0 to 8 hr.	8 to 24 hr.	24 to 96 hr.	96 to 720 hr.	Total
Mo-99	2.15E+01	4.25E+01	1.98E+00	4.29E-01	3.78E-01	4.53E+01
Tc-99m	1.47E+01	2.66E+01	6.05E-01	5.27E-03	1.33E-06	2.72E+01
Ru-103	1.73E+01	3.46E+01	1.73E+00	5.93E-01	3.99E+00	4.09E+01
Ru-105	8.18E+00	1.44E+01	2.48E-01	8.86E-04	1.17E-08	1.46E+01
Ru-106	5.70E+00	1.14E+01	5.73E-01	2.03E-01	1.70E+00	1.39E+01
Rh-105	1.03E+01	2.02E+01	8.81E-01	1.29E-01	4.14E-02	2.12E+01
Ce-141	3.89E+00	7.78E+00	3.88E-01	1.32E-01	8.45E-01	9.15E+00
Ce-143	3.46E+00	6.78E+00	2.93E-01	4.05E-02	1.14E-02	7.13E+00
Ce-144	2.94E+00	5.89E+00	2.96E-01	1.05E-01	8.68E-01	7.15E+00
Pu-238	9.16E-03	1.83E-02	9.21E-04	3.27E-04	2.82E-03	2.24E-02
Pu-239	8.06E-04	1.61E-03	8.10E-05	2.88E-05	2.48E-04	1.97E-03
Pu-240	1.18E-03	2.37E-03	1.19E-04	4.22E-05	3.63E-04	2.89E-03
Pu-241	2.66E-01	5.31E-01	2.67E-02	9.48E-03	8.14E-02	6.49E-01
Np-239	4.48E+01	8.87E+01	4.08E+00	8.15E-01	5.70E-01	9.41E+01
Y-90	8.08E-02	1.60E-01	7.44E-03	1.59E-03	1.35E-03	1.70E-01
Y-91	1.19E+00	2.37E+00	1.19E-01	4.12E-02	3.00E-01	2.83E+00
Y-92	7.89E-01	1.35E+00	1.80E-02	2.86E-05	0.00E+00	1.37E+00
Y-93	1.21E+00	2.28E+00	7.08E-02	1.98E-03	1.42E-05	2.35E+00
Nb-95	1.60E+00	3.19E+00	1.59E-01	5.44E-02	3.55E-01	3.76E+00
Zr-95	1.59E+00	3.18E+00	1.59E-01	5.52E-02	4.08E-01	3.80E+00
Zr-97	1.43E+00	2.74E+00	1.03E-01	6.73E-03	3.71E-04	2.85E+00
La-140	1.67E+00	3.29E+00	1.46E-01	2.36E-02	9.62E-03	3.47E+00
La-141	1.03E+00	1.79E+00	2.71E-02	6.41E-05	2.01E-10	1.81E+00
La-142	5.38E-01	8.31E-01	2.09E-03	3.39E-08	0.00E+00	8.33E-01
Nd-147	6.16E-01	1.23E+00	6.06E-02	1.90E-02	7.29E-02	1.38E+00
Pr-143	1.39E+00	2.78E+00	1.37E-01	4.40E-02	1.94E-01	3.15E+00
Am-241	1.20E-04	2.39E-04	1.20E-05	4.27E-06	3.68E-05	2.92E-04
Cm-242	2.82E-02	5.65E-02	2.83E-03	9.98E-04	8.08E-03	6.84E-02
Cm-244	3.46E-03	6.93E-03	3.48E-04	1.24E-04	1.06E-03	8.47E-03
Total	3.53E+04	9.85E+04	1.35E+05	2.15E+05	4.30E+05	8.79E+05

Table 7.1-27
AP1000 Source Terms
Activity Releases for Fuel Handling Accident (Ci)

Isotope	0 to 2 hr.
Kr-85m	3.42E+02
Kr-85	1.11E+03
Kr-87	6.00E-02
Kr-88	1.07E+02
Xe-131m	5.54E+02
Xe-133m	2.80E+03
Xe-133	9.66E+04
Xe-135m	1.26E+03
Xe-135	2.49E+04
I-130	2.51E+00
I-131	3.76E+02
I-132	3.01E+02
I-133	2.40E+02
I-135	3.94E+01
Total	1.29E+05

Table 7.1-28
U.S. EPR Source Terms
Radionuclide Releases to Atmosphere for Main Steamline Break with Pre-Accident Iodine Spike (Ci)

Isotope	0 to 2 hr.	2 to 8 hr.	8 to 24 hr.	Total
Kr-83m	2.167E-02	2.145E-02	3.182E-04	4.344E-02
Kr-85m	1.115E-01	1.858E-01	4.350E-03	3.016E-01
Kr-85	1.205E+00	3.613E+00	1.505E-01	4.969E+00
Kr-87	4.505E-02	2.194E-02	9.099E-05	6.709E-02
Kr-88	1.849E-01	2.258E-01	3.674E-03	4.144E-01
Kr-89	2.093E-04	8.419E-16	1.370E-50	2.093E-04
Xe-131m	2.446E-01	7.271E-01	3.027E-02	1.002E+00
Xe-133m	3.042E-01	8.850E-01	3.985E-02	1.229E+00
Xe-133	2.140E+01	6.307E+01	2.646E+00	8.711E+01
Xe-135m	3.843E-01	8.821E-01	8.834E-02	1.355E+00
Xe-135	9.137E-01	3.733E+00	4.540E-01	5.100E+00
Xe-137	4.777E-04	1.767E-13	2.237E-42	4.777E-04
Xe-138	6.324E-03	1.790E-05	9.525E-14	6.341E-03
Br-83	2.522E-01	4.130E-03	7.641E-05	2.564E-01
Br-84	4.771E-02	4.524E-05	7.550E-09	4.775E-02
Br-85	6.133E-04	1.092E-18	1.546E-56	6.133E-04
I-129	7.539E-07	3.757E-08	1.301E-09	7.928E-07
I-130	6.787E-01	2.685E-02	8.749E-04	7.064E-01
I-131	1.516E+01	8.621E+00	1.226E+00	2.501E+01
I-132	4.788E+00	1.069E+00	4.889E-02	5.906E+00
I-133	2.350E+01	1.244E+01	1.602E+00	3.754E+01
I-134	1.620E+00	1.135E-01	5.052E-04	1.734E+00
I-135	1.246E+01	5.510E+00	5.515E-01	1.852E+01
Rb-86m	1.353E-09	1.255E-45	0.000E+00	1.353E-09
Rb-86	1.398E-03	7.207E-04	1.024E-04	2.221E-03
Rb-88	1.915E-01	2.517E-01	4.103E-03	4.474E-01
Rb-89	1.838E-03	3.266E-06	1.619E-13	1.841E-03
Cs-134	1.609E-01	8.300E-02	1.185E-02	2.557E-01
Cs-136	3.808E-02	1.963E-02	2.782E-03	6.048E-02
Cs-137	6.160E-02	3.177E-02	4.536E-03	9.791E-02
Cs-138	2.051E-02	1.254E-03	1.886E-07	2.177E-02
Sr-89	7.189E-07	2.557E-06	3.082E-07	3.584E-06
Ba-137m	5.786E-02	3.006E-02	4.291E-03	9.220E-02
Total	8.386E+01	1.016E+02	6.875E+00	1.923E+02

Table 7.1-29
U.S. EPR Source Terms
Radionuclide Releases to Atmosphere for Main Steamline Break with Accident-Induced (Coincident) Iodine Spike (Ci)

Isotope	0 to 2 hr.	2 to 8 hr.	8 to 24 hr.	Total
Kr-83m	2.167E-02	2.145E-02	3.182E-04	4.344E-02
Kr-85m	1.115E-01	1.858E-01	4.350E-03	3.016E-01
Kr-85	1.205E+00	3.613E+00	1.505E-01	4.969E+00
Kr-87	4.505E-02	2.194E-02	9.099E-05	6.709E-02
Kr-88	1.849E-01	2.258E-01	3.674E-03	4.144E-01
Kr-89	2.093E-04	8.419E-16	1.370E-50	2.093E-04
Xe-131m	2.446E-01	7.308E-01	3.188E-02	1.007E+00
Xe-133m	3.045E-01	9.837E-01	8.092E-02	1.369E+00
Xe-133	2.140E+01	6.448E+01	3.237E+00	8.912E+01
Xe-135m	7.205E-01	1.136E+01	2.616E+00	1.470E+01
Xe-135	1.023E+00	1.721E+01	5.434E+00	2.367E+01
Xe-137	4.777E-04	1.767E-13	2.237E-42	4.777E-04
Xe-138	6.324E-03	1.790E-05	9.525E-14	6.341E-03
Br-83	2.522E-01	4.130E-03	7.641E-05	2.564E-01
Br-84	4.771E-02	4.524E-05	7.550E-09	4.775E-02
Br-85	6.133E-04	1.092E-18	1.546E-56	6.133E-04
I-129	7.539E-07	3.757E-08	1.301E-09	7.928E-07
I-130	6.787E-01	2.685E-02	8.749E-04	7.064E-01
I-131	1.627E+01	6.254E+01	1.557E+01	9.438E+01
I-132	8.145E+00	3.962E+01	6.683E+00	5.445E+01
I-133	2.653E+01	1.129E+02	2.685E+01	1.663E+02
I-134	5.642E+00	2.468E+01	2.899E+00	3.322E+01
I-135	1.595E+01	7.814E+01	1.675E+01	1.108E+02
Rb-86m	1.353E-09	1.255E-45	0.000E+00	1.353E-09
Rb-86	1.398E-03	7.207E-04	1.024E-04	2.221E-03
Rb-88	1.915E-01	2.517E-01	4.103E-03	4.474E-01
Rb-89	1.838E-03	3.266E-06	1.619E-13	1.841E-03
Cs-134	1.609E-01	8.300E-02	1.185E-02	2.557E-01
Cs-136	3.808E-02	1.963E-02	2.782E-03	6.048E-02
Cs-137	6.160E-02	3.177E-02	4.536E-03	9.791E-02
Cs-138	2.051E-02	1.254E-03	1.886E-07	2.177E-02
Sr-89	7.189E-07	2.557E-06	3.082E-07	3.584E-06
Ba-137m	5.786E-02	3.006E-02	4.291E-03	9.220E-02
Total	9.932E+01	4.172E+02	8.034E+01	5.968E+02

Table 7.1-30A
U.S. EPR Source Terms
Radionuclide Releases to Atmosphere for Main Steamline Break with Accident-Induced 3.3% Clad Failure (Ci)

Isotope	0 to 2 hr.	2 to 8 hr.	8 to 24 hr.	Total
Kr-83m	3.280E+01	3.559E+01	1.238E+00	6.963E+01
Kr-85m	8.444E+01	1.407E+02	3.320E+00	2.285E+02
Kr-85	1.031E+01	3.093E+01	1.288E+00	4.253E+01
Kr-87	1.192E+02	5.806E+01	2.408E-01	1.775E+02
Kr-88	2.202E+02	2.688E+02	4.376E+00	4.934E+02
Kr-89	1.332E+01	5.359E-11	8.719E-46	1.332E+01
Xe-131m	3.583E+00	1.068E+01	4.523E-01	1.472E+01
Xe-133m	1.946E+01	5.604E+01	2.403E+00	7.790E+01
Xe-133	6.466E+02	1.908E+03	8.055E+01	2.635E+03
Xe-135m	4.150E+01	4.615E+01	4.800E+00	9.245E+01
Xe-135	1.998E+02	5.351E+02	3.532E+01	7.702E+02
Xe-137	2.515E+01	9.302E-09	1.178E-37	2.515E+01
Xe-138	9.017E+01	2.552E-01	1.358E-09	9.042E+01
Br-83	1.094E+01	9.155E+00	4.542E-01	2.055E+01
Br-84	1.069E+01	5.777E-01	1.566E-04	1.126E+01
Br-85	1.663E+00	2.161E-13	3.269E-51	1.663E+00
I-129	6.476E-06	1.488E-05	2.258E-06	2.362E-05
I-130	9.312E+00	1.780E+01	2.217E+00	2.933E+01
I-131	1.643E+02	3.897E+02	5.846E+01	6.125E+02
I-132	1.121E+02	8.941E+01	4.225E+00	2.057E+02
I-133	2.124E+02	4.391E+02	5.933E+01	7.109E+02
I-134	1.242E+02	2.356E+01	1.065E-01	1.479E+02
I-135	1.789E+02	2.877E+02	2.996E+01	4.966E+02
Rb-86m	1.764E-03	2.996E-39	0.000E+00	1.764E-03
Rb-86	9.539E-01	2.456E+00	3.714E-01	3.781E+00
Rb-88	2.406E+02	2.999E+02	4.885E+00	5.454E+02
Rb-89	8.269E+01	2.451E-01	1.281E-08	8.293E+01
Cs-134	1.069E+02	2.768E+02	4.209E+01	4.258E+02
Cs-136	2.650E+01	6.805E+01	1.026E+01	1.048E+02
Cs-137	4.081E+01	1.057E+02	1.607E+01	1.626E+02
Cs-138	2.696E+02	2.276E+01	4.151E-03	2.923E+02
Sr-89	5.497E-02	1.946E-01	2.451E-02	2.741E-01
Ba-137m	3.860E+01	1.000E+02	1.520E+01	1.538E+02
Total	3.138E+03	5.224E+03	3.776E+02	8.739E+03

Table 7.1-30B
U.S. EPR Source Terms
Radionuclide Releases to Atmosphere for Main Steam Line Break with Accident-Induced 0.58% Fuel Overheat (Ci)

Isotope	0 to 2 hr	2 to 8 hr	8 to 24 hr	Total
Kr-83m	1.098E+02	1.038E+02	2.549E+00	2.162E+02
Kr-85m	2.957E+02	4.928E+02	1.158E+01	8.001E+02
Kr-85	1.721E+01	5.163E+01	2.150E+00	7.099E+01
Kr-87	4.179E+02	2.035E+02	8.440E-01	6.223E+02
Kr-88	7.737E+02	9.445E+02	1.537E+01	1.733E+03
Kr-89	4.684E+01	1.884E-10	3.065E-45	4.684E+01
Xe-131m	1.197E+01	3.560E+01	1.483E+00	4.905E+01
Xe-133m	6.769E+01	1.938E+02	8.011E+00	2.695E+02
Xe-133	2.213E+03	6.514E+03	2.708E+02	8.997E+03
Xe-135m	1.112E+02	8.124E+01	8.435E+00	2.008E+02
Xe-135	6.807E+02	1.677E+03	8.537E+01	2.443E+03
Xe-137	8.839E+01	3.271E-08	4.140E-37	8.839E+01
Xe-138	3.178E+02	8.992E-01	4.786E-09	3.187E+02
Br-83	1.904E+01	1.609E+01	7.982E-01	3.592E+01
Br-84	1.875E+01	1.015E+00	2.752E-04	1.976E+01
Br-85	2.922E+00	3.798E-13	5.745E-51	2.922E+00
I-129	1.081E-05	2.613E-05	3.967E-06	4.091E-05
I-130	1.585E+01	3.127E+01	3.897E+00	5.102E+01
I-131	1.792E+02	4.277E+02	6.411E+01	6.709E+02
I-132	1.943E+02	1.571E+02	7.425E+00	3.588E+02
I-133	3.595E+02	7.712E+02	1.043E+02	1.235E+03
I-134	2.175E+02	4.141E+01	1.872E-01	2.591E+02
I-135	3.073E+02	5.054E+02	5.265E+01	8.654E+02
Rb-86m	1.290E-03	2.191E-39	0.000E+00	1.290E-03
Rb-86	7.010E-01	1.804E+00	2.727E-01	2.777E+00
Rb-88	6.770E+02	1.053E+03	1.716E+01	1.747E+03
Rb-89	9.740E+01	3.763E-01	1.278E-08	9.778E+01
Cs-134	7.845E+01	2.031E+02	3.087E+01	3.124E+02
Cs-136	1.947E+01	4.995E+01	7.537E+00	7.696E+01
Cs-137	2.990E+01	7.740E+01	1.177E+01	1.191E+02
Cs-138	4.164E+02	5.014E+01	5.701E-03	4.666E+02
Sr-89	7.331E-02	2.692E-01	2.321E-02	3.657E-01
Ba-137m	2.829E+01	7.327E+01	1.113E+01	1.127E+02
Total	7.814E+03	1.376E+04	7.187E+02	2.229E+04

Table 7.1-31
U.S. EPR Source Terms
Radionuclide Releases to Atmosphere for Pump Locked Rotor Accident (LRA) with Accident-Induced 9.5% Clad Failure (Ci)

Isotope	0 to 2 hr.	2 to 8 hr.	Total
Kr-83m	6.864E+01	5.405E+01	1.227E+02
Kr-85m	1.905E+02	3.030E+02	4.935E+02
Kr-85	2.146E+01	6.173E+01	8.319E+01
Kr-87	2.742E+02	1.254E+02	3.996E+02
Kr-88	5.001E+02	5.806E+02	1.081E+03
Kr-89	3.803E+01	1.158E-10	3.803E+01
Xe-131m	7.701E+00	2.195E+01	2.966E+01
Xe-133m	4.324E+01	1.182E+02	1.615E+02
Xe-133	1.423E+03	4.010E+03	5.433E+03
Xe-135m	5.836E+01	1.167E+01	7.003E+01
Xe-135	4.279E+02	9.442E+02	1.372E+03
Xe-137	7.127E+01	2.011E-08	7.127E+01
Xe-138	2.288E+02	5.516E-01	2.293E+02
Br-83	4.263E+00	2.041E+00	6.304E+00
Br-84	6.306E+00	8.774E-02	6.394E+00
Br-85	2.332E+00	2.497E-14	2.332E+00
I-129	2.293E-06	3.969E-06	6.262E-06
I-130	3.307E+00	4.570E+00	7.877E+00
I-131	5.682E+01	1.029E+02	1.597E+02
I-132	4.404E+01	1.982E+01	6.386E+01
I-133	7.514E+01	1.144E+02	1.896E+02
I-134	6.060E+01	4.122E+00	6.472E+01
I-135	6.439E+01	7.163E+01	1.360E+02
Rb-86m	2.540E-03	3.391E-40	2.540E-03
Rb-86	3.151E-01	6.410E-01	9.561E-01
Rb-88	4.415E+02	6.471E+02	1.089E+03
Rb-89	8.974E+01	1.757E-01	8.992E+01
Cs-134	3.527E+01	7.231E+01	1.076E+02
Cs-136	8.757E+00	1.775E+01	2.651E+01
Cs-137	1.347E+01	2.761E+01	4.108E+01
Cs-138	2.872E+02	2.755E+01	3.147E+02
Sr-89	3.289E-02	1.374E-01	1.702E-01
Ba-137m	1.008E+01	2.612E+01	3.620E+01
Total	4.557E+03	7.371E+03	1.193E+04

Table 7.1-32
U.S. EPR Source Terms
Radionuclide Releases to Atmosphere for Design Basis Small Line Break (Ci)

Isotope	0 to 2 hr.
Kr-83m	1.653E+00
Kr-85m	7.066E+00
Kr-85	6.827E+01
Kr-87	3.672E+00
Kr-88	1.247E+01
Kr-89	4.810E-02
Xe-131m	1.389E+01
Xe-133m	1.750E+01
Xe-133	1.219E+03
Xe-135m	1.652E+02
Xe-135	6.941E+01
Xe-137	1.093E-01
Xe-138	1.111E+00
Br-83	1.514E-01
Br-84	6.319E-02
Br-85	1.447E-03
I-129	2.360E-07
I-130	2.521E-01
I-131	9.400E+01
I-132	1.132E+02
I-133	1.828E+02
I-134	1.347E+02
I-135	1.502E+02
Rb-86	1.881E-02
Rb-88	5.174E+00
Rb-89	1.458E-01
Cs-134	2.150E+00
Cs-136	5.140E-01
Cs-137	8.228E-01
Cs-138	1.032E+00
Sr-89	2.485E-05
Ba-137m	7.775E-01
Total	2.27E+03

Table 7.1-33
U.S. EPR Source Terms
Radionuclide Releases to Atmosphere for Steam Generator Tube Rupture with Pre-Accident Spike (Ci)

Isotope	0 to 2 hr.	2 to 8 hr.	8 to 24 hr.	24 to 96 hr.	96 to 720 hr.	Total
Kr-83m	5.579E+01	5.208E+01	1.113E+01	1.110E-01	1.024E-10	1.191E+02
Kr-85m	2.745E+01	9.737E-02	5.647E-02	5.168E-03	7.391E-08	2.761E+01
Kr-85	2.693E+02	1.875E+00	4.878E+00	2.172E+01	1.734E+02	4.711E+02
Kr-87	1.365E+01	1.170E-02	4.390E-04	7.132E-08	6.326E-25	1.366E+01
Kr-88	4.786E+01	1.186E-01	3.368E-02	6.881E-04	1.565E-11	4.801E+01
Kr-89	1.260E-01	4.744E-16	2.768E-50	0.000E+00	0.000E+00	1.260E-01
Xe-131m	5.483E+01	7.018E-01	1.810E+00	7.458E+00	3.116E+01	9.596E+01
Xe-133m	7.072E+01	7.102E+00	1.379E+01	2.108E+01	4.983E+00	1.177E+02
Xe-133	4.829E+03	1.262E+02	2.600E+02	5.499E+02	6.459E+02	6.411E+03
Xe-135m	1.530E+03	3.263E+03	3.062E+03	7.187E+02	4.064E-01	8.574E+03
Xe-135	4.299E+02	5.069E+02	4.845E+02	1.206E+02	1.232E-01	1.542E+03
Xe-137	2.887E-01	9.932E-14	4.492E-42	0.000E+00	0.000E+00	2.887E-01
Xe-138	3.434E+00	9.959E-06	2.041E-13	8.199E-34	0.000E+00	3.434E+00
Br-83	2.004E+00	2.840E-03	7.849E-04	1.620E-05	4.395E-14	2.008E+00
Br-84	5.904E-01	4.270E-05	1.939E-08	4.027E-17	1.788E-57	5.904E-01
Br-85	6.852E-04	1.190E-18	2.448E-56	0.000E+00	0.000E+00	6.852E-04
I-129	3.454E-06	1.964E-08	8.140E-08	1.077E-06	4.192E-05	4.655E-05
I-130	3.616E+00	1.503E-02	3.374E-02	5.191E-02	2.304E-03	3.719E+00
I-131	5.578E+01	3.103E-01	1.236E+00	1.376E+01	1.542E+02	2.253E+02
I-132	2.339E+01	3.417E-02	8.312E-03	1.407E-04	1.667E-13	2.343E+01
I-133	9.220E+01	4.337E-01	1.242E+00	3.997E+00	9.448E-01	9.882E+01
I-134	1.140E+01	3.079E-03	3.155E-05	2.442E-10	1.584E-34	1.140E+01
I-135	5.584E+01	1.805E-01	2.463E-01	1.167E-01	1.685E-04	5.639E+01
Rb-86	4.589E-03	2.766E-05	1.086E-04	1.305E-03	2.814E-02	3.417E-02
Rb-88	1.105E+00	1.286E-03	6.410E-04	2.976E-05	2.261E-12	1.107E+00
Rb-89	1.257E-02	4.677E-08	4.331E-15	1.140E-33	0.000E+00	1.257E-02
Cs-134	5.246E-01	3.196E-03	1.275E-02	1.648E-01	6.259E+00	6.964E+00
Cs-136	1.253E-01	7.520E-04	2.931E-03	3.415E-02	5.875E-01	7.507E-01
Cs-137	2.008E-01	1.224E-03	4.884E-03	6.322E-02	2.436E+00	2.706E+00
Cs-138	1.397E-01	9.813E-06	5.129E-09	1.405E-17	2.046E-57	1.397E-01
Ba-137m	1.883E-01	1.148E-03	4.579E-03	5.927E-02	2.284E+00	2.537E+00
Total	7.580E+03	3.959E+03	3.841E+03	1.458E+03	1.023E+03	1.786E+04

Table 7.1-34
U.S. EPR Source Terms
Radionuclide Releases to Atmosphere for Steam Generator Tube Rupture with Accident-Induced (Coincident) Iodine Spike (Ci)

Isotope	0 to 2 hr.	2 to 8 hr.	8 to 24 hr.	24 to 96 hr.	96 to 720 hr.	Total
Kr-83m	5.286E+01	6.506E+01	2.614E+01	5.395E-01	1.229E-09	1.446E+02
Kr-85m	2.938E+01	2.475E-01	2.560E-01	2.342E-02	3.350E-07	2.990E+01
Kr-85	2.693E+02	1.875E+00	4.878E+00	2.172E+01	1.734E+02	4.711E+02
Kr-87	1.365E+01	1.170E-02	4.390E-04	7.132E-08	6.326E-25	1.366E+01
Kr-88	4.786E+01	1.186E-01	3.368E-02	6.881E-04	1.565E-11	4.801E+01
Kr-89	1.260E-01	4.744E-16	2.768E-50	0.000E+00	0.000E+00	1.260E-01
Xe-131m	5.476E+01	5.269E-01	1.550E+00	9.473E+00	8.667E+01	1.530E+02
Xe-133m	6.924E+01	4.025E+00	1.188E+01	4.107E+01	2.417E+01	1.504E+02
Xe-133	4.808E+03	8.294E+01	2.349E+02	9.134E+02	1.558E+03	7.597E+03
Xe-135m	9.009E+02	2.273E+03	2.859E+03	1.054E+03	1.262E+00	7.088E+03
Xe-135	3.154E+02	3.712E+02	6.204E+02	3.471E+02	1.427E+00	1.655E+03
Xe-137	2.887E-01	9.932E-14	4.492E-42	0.000E+00	0.000E+00	2.887E-01
Xe-138	3.434E+00	9.959E-06	2.041E-13	8.199E-34	0.000E+00	3.434E+00
Br-83	3.105E+00	2.064E-02	3.304E-02	1.187E-03	4.062E-12	3.159E+00
Br-84	3.844E+00	4.306E-03	7.921E-04	7.298E-12	4.404E-52	3.849E+00
Br-85	7.119E-01	4.381E-05	6.904E-07	0.000E+00	0.000E+00	7.120E-01
I-129	1.942E-06	3.838E-08	4.662E-07	9.049E-06	3.973E-04	4.088E-04
I-130	2.679E+00	3.998E-02	3.041E-01	6.765E-01	3.436E-02	3.734E+00
I-131	3.199E+01	6.194E-01	7.305E+00	1.192E+02	1.500E+03	1.659E+03
I-132	3.721E+01	2.421E-01	3.626E-01	1.103E-02	1.671E-11	3.782E+01
I-133	6.155E+01	1.022E+00	9.383E+00	4.389E+01	1.163E+01	1.275E+02
I-134	4.170E+01	9.438E-02	3.336E-02	7.756E-07	6.711E-31	4.183E+01
I-135	5.032E+01	6.126E-01	3.161E+00	2.185E+00	3.747E-03	5.629E+01
Rb-86	4.589E-03	2.766E-05	1.086E-04	1.305E-03	2.814E-02	3.417E-02
Rb-88	1.105E+00	1.286E-03	6.410E-04	2.976E-05	2.261E-12	1.107E+00
Rb-89	1.257E-02	4.677E-08	4.331E-15	1.140E-33	0.000E+00	1.257E-02
Cs-134	5.246E-01	3.196E-03	1.275E-02	1.648E-01	6.259E+00	6.964E+00
Cs-136	1.253E-01	7.520E-04	2.931E-03	3.415E-02	5.875E-01	7.507E-01
Cs-137	2.008E-01	1.224E-03	4.884E-03	6.322E-02	2.436E+00	2.706E+00
Cs-138	1.397E-01	9.813E-06	5.129E-09	1.405E-17	2.046E-57	1.397E-01
Ba-137m	1.883E-01	1.148E-03	4.579E-03	5.927E-02	2.284E+00	2.537E+00
Total	6.801E+03	2.802E+03	3.780E+03	2.554E+03	3.368E+03	1.930E+04

**Table 7.1-35 (Sheet 1 of 6)
U.S. EPR Source Terms
Radionuclide Releases to Atmosphere for Design Basis LOCA (Ci)**

Isotope	0 to 1.5 hr.	1.5 to 3.5 hr.	3.5 to 8 hr.
Kr-83m	7.297E+02	2.751E+03	4.641E+03
Kr-85m	1.709E+03	6.303E+03	8.876E+03
Kr-85	1.126E+02	4.307E+02	9.847E+02
Kr-87	2.224E+03	4.925E+03	2.337E+03
Kr-88	4.382E+03	1.434E+04	1.548E+04
Kr-89	9.523E+00	3.044E-06	1.461E-17
Xe-131m	7.277E+01	3.151E+02	7.225E+02
Xe-133m	4.023E+02	1.806E+03	4.148E+03
Xe-133	1.326E+04	5.898E+04	1.353E+05
Xe-135m	1.676E+03	1.283E+04	5.187E+04
Xe-135	4.390E+03	2.130E+04	5.958E+04
Xe-137	2.238E+01	1.730E-04	7.545E-14
Xe-138	6.229E+02	9.854E+01	3.005E-01
Br-83	3.714E+00	7.476E+00	5.922E+00
Br-84	3.206E+00	1.399E+00	1.010E-01
Br-85	7.005E-01	3.783E-10	1.011E-22
I-129	2.143E-06	6.460E-06	1.204E-05
I-130	3.160E+00	8.910E+00	1.395E+01
I-131	3.558E+01	1.070E+02	1.971E+02
I-132	3.928E+01	8.453E+01	8.515E+01
I-133	7.134E+01	2.071E+02	3.479E+02
I-134	4.192E+01	4.308E+01	1.043E+01
I-135	6.120E+01	1.615E+02	2.183E+02
Rb-86m	2.457E-04	8.331E-31	2.805E-66
Rb-86	1.268E-01	3.249E-01	5.175E-01
Rb-88	6.288E+01	1.545E+02	1.636E+02
Rb-89	1.126E+01	5.235E-01	1.960E-03
Cs-134	1.418E+01	3.636E+01	5.818E+01
Cs-136	3.511E+00	9.004E+00	1.431E+01
Cs-137	5.419E+00	1.389E+01	2.223E+01
Cs-138	4.511E+01	2.603E+01	1.839E+00
Sb-125	7.674E-02	3.605E-01	5.787E-01

Table 7.1-35 (Sheet 2 of 6)
U.S. EPR Source Terms
Radionuclide Releases to Atmosphere for Design Basis LOCA (Ci)

Isotope	8 to 24 hr.	24 to 96 hr.	96 to 720 hr.	Total
Kr-83m	4.187E+03	1.072E+02	3.150E-07	1.242E+04
Kr-85m	8.074E+03	3.703E+02	5.366E-03	2.533E+04
Kr-85	3.497E+03	7.845E+03	6.661E+04	7.948E+04
Kr-87	2.199E+02	1.791E-02	1.613E-19	9.706E+03
Kr-88	7.580E+03	7.766E+01	1.794E-06	4.186E+04
Kr-89	3.346E-43	0.000E+00	0.000E+00	9.523E+00
Xe-131m	2.650E+03	8.448E+03	8.304E+04	9.525E+04
Xe-133m	1.551E+04	3.840E+04	2.689E+04	8.716E+04
Xe-133	4.923E+05	1.172E+06	2.331E+06	4.202E+06
Xe-135m	1.495E+05	6.371E+04	8.257E+01	2.797E+05
Xe-135	2.402E+05	1.708E+05	9.095E+02	4.971E+05
Xe-137	4.529E-35	0.000E+00	0.000E+00	2.238E+01
Xe-138	5.518E-07	1.111E-27	0.000E+00	7.217E+02
Br-83	1.578E+00	9.943E-03	7.939E-12	1.870E+01
Br-84	2.106E-04	1.010E-13	1.200E-54	4.706E+00
Br-85	3.330E-51	0.000E+00	0.000E+00	7.005E-01
I-129	2.778E-05	8.971E-05	6.739E-04	8.120E-04
I-130	1.919E+01	9.181E+00	1.557E-01	5.455E+01
I-131	4.395E+02	1.216E+03	3.310E+03	5.305E+03
I-132	8.672E+01	1.646E+02	1.700E+02	6.303E+02
I-133	5.859E+02	5.389E+02	5.089E+01	1.802E+03
I-134	2.466E-01	4.949E-07	8.736E-32	9.568E+01
I-135	2.005E+02	3.195E+01	1.584E-02	6.735E+02
Rb-86m	0.000E+00	0.000E+00	0.000E+00	2.457E-04
Rb-86	6.158E-01	1.784E-01	3.473E-02	1.798E+00
Rb-88	8.009E+01	8.460E-01	1.980E-08	4.619E+02
Rb-89	4.966E-09	5.198E-29	0.000E+00	1.178E+01
Cs-134	7.012E+01	2.128E+01	5.202E+00	2.053E+02
Cs-136	1.694E+01	4.810E+00	8.548E-01	4.943E+01
Cs-137	2.679E+01	8.142E+00	2.002E+00	7.848E+01
Cs-138	3.106E-03	3.645E-13	3.186E-55	7.298E+01
Sb-125	6.973E-01	2.117E-01	5.185E-02	1.977E+00

Table 7.1-35 (Sheet 3 of 6)
U.S. EPR Source Terms
Radionuclide Releases to Atmosphere for Design Basis LOCA (Ci)

Isotope	0 to 1.5 hr.	1.5 to 3.5 hr.	3.5 to 8 hr.
Sb-127	3.566E-01	1.658E+00	2.602E+00
Sb-129	8.062E-01	3.074E+00	3.076E+00
Te-127m	5.087E-02	2.290E-01	3.677E-01
Te-127	3.679E-01	1.678E+00	2.678E+00
Te-129m	1.475E-01	6.643E-01	1.065E+00
Te-129	9.137E-01	3.758E+00	4.244E+00
Te-131m	4.117E-01	1.808E+00	2.706E+00
Te-131	4.731E-01	6.764E-01	6.180E-01
Te-132	4.076E+00	1.819E+01	2.841E+01
Te-134	1.637E+00	2.306E+00	2.992E-01
Sr-89	1.295E+00	6.070E+00	9.727E+00
Sr-90	1.352E-01	6.346E-01	1.019E+00
Sr-91	1.523E+00	6.489E+00	8.369E+00
Sr-92	1.273E+00	4.299E+00	3.300E+00
Ba-137m	4.246E+00	1.310E+01	2.103E+01
Ba-139	1.252E+00	2.933E+00	1.185E+00
Ba-140	2.011E+00	9.409E+00	1.500E+01
Mo-99	6.680E-01	1.185E+00	1.843E+00
Tc-99m	4.054E-01	1.062E+00	1.685E+00
Ru-103	2.419E-01	1.134E+00	1.816E+00
Ru-105	1.639E-01	6.263E-01	6.347E-01
Ru-106	1.433E-01	6.720E-01	1.079E+00
Rh-103m	2.180E-01	1.022E+00	1.637E+00
Rh-105	1.753E-01	8.191E-01	1.284E+00
Rh-106	1.433E-01	6.720E-01	1.079E+00
Ce-141	4.504E-02	2.100E-01	3.363E-01
Ce-143	4.473E-02	2.032E-01	3.060E-01
Ce-144	3.421E-02	1.595E-01	2.560E-01
Np-239	7.573E-01	3.479E+00	5.379E+00
Pu-238	2.937E-04	1.371E-03	2.200E-03
Pu-239	1.236E-05	5.767E-05	9.263E-05
Pu-240	2.817E-05	1.315E-04	2.110E-04

Table 7.1-35 (Sheet 4 of 6)
U.S. EPR Source Terms
Radionuclide Releases to Atmosphere for Design Basis LOCA (Ci)

Isotope	8 to 24 hr.	24 to 96 hr.	96 to 720 hr.	Total
Sb-127	2.947E+00	7.152E-01	6.814E-02	8.347E+00
Sb-129	1.172E+00	1.262E-02	9.903E-09	8.142E+00
Te-127m	4.432E-01	1.345E-01	3.221E-02	1.257E+00
Te-127	3.139E+00	8.103E-01	9.679E-02	8.769E+00
Te-129m	1.276E+00	3.779E-01	8.132E-02	3.612E+00
Te-129	2.219E+00	2.610E-01	5.294E-02	1.145E+01
Te-131m	2.700E+00	4.296E-01	9.844E-03	8.066E+00
Te-131	6.079E-01	9.670E-02	2.216E-03	2.474E+00
Te-132	3.181E+01	7.423E+00	6.147E-01	9.053E+01
Te-134	1.926E-03	2.642E-11	1.491E-43	4.244E+00
Sr-89	1.167E+01	3.484E+00	7.831E-01	3.303E+01
Sr-90	1.228E+00	3.731E-01	9.176E-02	3.481E+00
Sr-91	5.720E+00	3.029E-01	1.462E-04	2.240E+01
Sr-92	7.207E-01	1.556E-03	1.220E-12	9.594E+00
Ba-137m	2.535E+01	7.702E+00	1.894E+00	7.332E+01
Ba-139	7.377E-02	2.809E-06	3.953E-23	5.444E+00
Ba-140	1.775E+01	5.031E+00	8.876E-01	5.008E+01
Mo-99	2.036E+00	4.535E-01	3.193E-02	6.218E+00
Tc-99m	1.916E+00	4.358E-01	3.075E-02	5.535E+00
Ru-103	2.175E+00	6.463E-01	1.417E-01	6.155E+00
Ru-105	2.485E-01	2.881E-03	3.096E-09	1.676E+00
Ru-106	1.299E+00	3.939E-01	9.568E-02	3.683E+00
Rh-103m	1.961E+00	5.827E-01	1.277E-01	5.549E+00
Rh-105	1.375E+00	2.453E-01	7.574E-03	3.907E+00
Rh-106	1.299E+00	3.939E-01	9.568E-02	3.683E+00
Ce-141	4.027E-01	1.191E-01	2.551E-02	1.139E+00
Ce-143	3.105E-01	5.212E-02	1.426E-03	9.179E-01
Ce-144	3.085E-01	9.342E-02	2.261E-02	8.743E-01
Np-239	5.860E+00	1.242E+00	7.389E-02	1.679E+01
Pu-238	2.652E-03	8.060E-04	1.984E-04	7.522E-03
Pu-239	1.118E-04	3.413E-05	8.458E-06	3.171E-04
Pu-240	2.543E-04	7.729E-05	1.901E-05	7.212E-04

Table 7.1-35 (Sheet 5 of 6)
U.S. EPR Source Terms
Radionuclide Releases to Atmosphere for Design Basis LOCA (Ci)

Isotope	0 to 1.5 hr.	1.5 to 3.5 hr.	3.5 to 8 hr.
Pu-241	5.110E-03	2.385E-02	3.828E-02
Y-90	3.140E-03	2.339E-02	6.936E-02
Y-91m	5.663E-01	3.441E+00	5.191E+00
Y-91	1.652E-02	8.019E-02	1.426E-01
Y-92	3.112E-01	2.236E+00	3.968E+00
Y-93	1.749E-02	7.414E-02	9.685E-02
Zr-95	1.861E-02	8.589E-02	1.377E-01
Zr-97	1.877E-02	8.243E-02	1.169E-01
Nb-95	1.862E-02	8.599E-02	1.380E-01
La-140	6.044E-02	4.868E-01	1.509E+00
La-141	1.590E-02	5.866E-02	5.613E-02
La-142	1.132E-02	2.986E-02	1.382E-02
Pr-143	1.844E-02	8.551E-02	1.384E-01
Pr-144	3.272E-02	1.590E-01	2.560E-01
Nd-147	7.658E-03	3.525E-02	5.615E-02
Am-241	2.343E-06	1.083E-05	1.740E-05
Cm-242	1.065E-03	4.917E-03	7.889E-03
Cm-244	5.651E-04	2.610E-03	4.190E-03
Total	3.005E+04	1.250E+05	2.852E+05

Table 7.1-35 (Sheet 6 of 6)
U.S. EPR Source Terms
Radionuclide Releases to Atmosphere for Design Basis LOCA (Ci)

Isotope	8 to 24 hr.	24 to 96 hr.	96 to 720 hr.	Total
Pu-241	4.613E-02	1.402E-02	3.446E-03	1.308E-01
Y-90	1.818E-01	1.423E-01	7.603E-02	4.961E-01
Y-91m	3.634E+00	1.924E-01	9.288E-05	1.302E+01
Y-91	2.021E-01	7.064E-02	1.656E-02	5.286E-01
Y-92	2.181E+00	2.160E-02	1.599E-09	8.719E+00
Y-93	6.832E-02	3.943E-03	2.631E-06	2.607E-01
Zr-95	1.654E-01	4.955E-02	1.135E-02	4.685E-01
Zr-97	1.014E-01	1.051E-02	5.726E-05	3.300E-01
Nb-95	1.664E-01	5.053E-02	1.232E-02	4.719E-01
La-140	3.941E+00	2.736E+00	9.057E-01	9.639E+00
La-141	1.940E-02	1.590E-04	3.935E-11	1.502E-01
La-142	1.118E-03	1.026E-07	7.220E-23	5.612E-02
Pr-143	1.698E-01	5.241E-02	1.030E-02	4.748E-01
Pr-144	3.085E-01	9.343E-02	2.261E-02	8.722E-01
Nd-147	6.621E-02	1.857E-02	3.127E-03	1.870E-01
Am-241	2.105E-05	6.475E-06	1.695E-06	5.978E-05
Cm-242	9.495E-03	2.870E-03	6.862E-04	2.692E-02
Cm-244	5.049E-03	1.534E-03	3.772E-04	1.432E-02
Total	9.254E+05	1.463E+06	2.512E+06	5.341E+06

Table 7.1-36
U.S. EPR Source Terms
Radionuclide Releases to Atmosphere for Fuel Handling Accident (Ci)

Isotope	0 to 2 hr.	2 to 8 hr.	8 to 24 hr.	24 to 96 hr.	96 to 720 hr.	Total
Kr-83m	1.437E+00	2.129E-01	4.404E-02	4.294E-04	3.665E-13	1.694E+00
Kr-85m	7.810E+01	3.881E-01	4.693E-08	1.678E-26	0.000E+00	7.849E+01
Kr-85	1.471E+03	9.977E+00	3.052E-06	1.296E-23	0.000E+00	1.481E+03
Kr-87	2.330E-04	5.290E-07	6.148E-15	4.260E-36	0.000E+00	2.335E-04
Kr-88	1.016E+01	4.220E-02	2.983E-09	2.549E-28	0.000E+00	1.020E+01
Xe-131m	5.637E+02	1.475E+01	2.813E+01	1.084E+02	3.282E+02	1.043E+03
Xe-133m	2.609E+03	8.098E+01	1.193E+02	1.540E+02	1.538E+01	2.979E+03
Xe-133	9.442E+04	1.533E+03	1.684E+03	2.174E+03	2.171E+02	1.000E+05
Xe-135m	1.089E+03	1.975E+03	1.834E+03	4.211E+02	2.219E-01	5.319E+03
Xe-135	1.407E+04	7.705E+02	6.412E+02	1.472E+02	7.759E-02	1.563E+04
Xe-138	1.825E-39	3.471E-44	2.388E-58	4.092E-96	0.000E+00	1.825E-39
Br-83	1.610E-03	6.097E-06	3.273E-13	1.343E-32	0.000E+00	1.616E-03
Br-84	2.046E-18	1.009E-21	1.206E-31	4.188E-58	0.000E+00	2.047E-18
I-129	1.459E-05	9.898E-08	3.028E-14	1.286E-31	0.000E+00	1.469E-05
I-130	3.363E+00	2.038E-02	4.453E-09	7.713E-27	0.000E+00	3.383E+00
I-131	3.443E+02	2.319E+00	6.942E-07	2.784E-24	0.000E+00	3.466E+02
I-132	1.118E-02	4.139E-05	2.076E-12	7.100E-32	0.000E+00	1.122E-02
I-133	1.615E+02	1.025E+00	2.567E-07	6.398E-25	0.000E+00	1.625E+02
I-134	8.997E-10	1.249E-12	3.325E-21	4.528E-44	0.000E+00	9.009E-10
I-135	1.282E+01	7.041E-02	1.148E-08	9.113E-27	0.000E+00	1.289E+01
Rb-88	4.884E+00	4.672E-02	3.332E-09	2.846E-28	0.000E+00	4.931E+00
Cs-138	6.206E-40	1.019E-42	1.379E-52	6.210E-79	0.000E+00	6.216E-40
Total	1.148E+05	4.388E+03	4.307E+03	3.005E+03	5.610E+02	1.271E+05

Table 7.1-37
U.S. EPR Source Terms
Radionuclide Releases to Atmosphere for Rod Ejection Accident (REA) with Accident-Induced 36.7% Clad Failure (Ci)

Isotope	0 to 2 hr.	2 to 8 hr.	Total
Kr-83m	6.655E+02	5.477E+02	1.213E+03
Kr-85m	1.872E+03	3.118E+03	4.990E+03
Kr-85	1.026E+02	3.074E+02	4.100E+02
Kr-87	2.651E+03	1.290E+03	3.941E+03
Kr-88	4.894E+03	5.970E+03	1.086E+04
Kr-89	2.967E+02	1.193E-09	2.967E+02
Xe-131m	7.443E+01	2.209E+02	2.953E+02
Xe-133m	4.246E+02	1.209E+03	1.633E+03
Xe-133	1.390E+04	4.078E+04	5.467E+04
Xe-135m	4.932E+02	8.973E+01	5.829E+02
Xe-135	4.202E+03	9.607E+03	1.381E+04
Xe-137	5.606E+02	2.073E-07	5.606E+02
Xe-138	2.009E+03	5.684E+00	2.015E+03
Br-83	3.270E+00	1.566E+01	1.893E+01
Br-84	1.892E+00	6.754E-01	2.567E+00
Br-85	2.564E-02	1.917E-13	2.564E-02
I-129	2.042E-06	3.009E-05	3.213E-05
I-130	2.985E+00	3.487E+01	3.786E+01
I-131	3.385E+01	4.915E+02	5.254E+02
I-132	3.305E+01	1.520E+02	1.851E+02
I-133	6.775E+01	8.692E+02	9.369E+02
I-134	2.896E+01	3.175E+01	6.071E+01
I-135	5.703E+01	5.471E+02	6.042E+02
Rb-86m	4.849E-06	1.306E-39	4.849E-06
Rb-86	1.683E-01	2.480E+00	2.648E+00
Rb-88	4.004E+03	6.652E+03	1.066E+04
Rb-89	2.983E+02	1.662E+00	2.999E+02
Cs-134	1.887E+01	2.796E+02	2.985E+02
Cs-136	4.672E+00	6.863E+01	7.330E+01
Cs-137	7.195E+00	1.067E+02	1.139E+02
Cs-138	1.765E+03	2.733E+02	2.038E+03
Sr-89	2.739E-01	1.163E+00	1.437E+00
Ba-137m	6.794E+00	1.009E+02	1.077E+02
Total	3.848E+04	7.277E+04	1.113E+05

Table 7.1-38
US-APWR Radiological Consequences
Atmospheric Dispersion Factors

Location	Time (hr.)	DCD χ/Q (sec/m^3)	Site χ/Q (sec/m^3)	χ/Q Ratio (Site/DCD)
EAB	0 to 2	5.00E-04	1.41E-04	0.282
LPZ	0 to 8	2.10E-04	2.30E-06	0.011
	8 to 24	1.30E-04	1.61E-06	0.012
	24 to 96	6.90E-05	7.51E-07	0.011
	96 to 720	2.80E-05	3.05E-07	0.011

Table 7.1-39
US-APWR Radiological Consequences
Dose Summary

Accident	DCD Dose (rem TEDE)		χ/Q ratio (Site/DCD)		Site Dose (rem TEDE)		Limit
	EAB	LPZ	EAB	LPZ[a]	EAB	LPZ	
Steam System Piping Failure - Pre-Existing Iodine Spike	0.19	0.11	0.282	0.012	5.36E-02	1.32E-03	25
Steam System Piping Failure - Accident-Initiated Iodine Spike	0.32	0.28	0.282	0.012	9.02E-02	3.36E-03	2.5
Reactor Coolant Pump Rotor Seizure	0.49	0.7	0.282	0.012	1.38E-01	8.40E-03	2.5
Spectrum of Rod Cluster Control Assembly Ejection Accidents	5.1	4.5	0.282	0.012	1.44E+00	5.40E-02	6.3
Failure of Small Lines Carrying Primary Coolant Outside Containment	1.5	0.6	0.282	0.012	4.23E-01	7.20E-03	2.5
Steam Generator Tube Rupture - Pre-Existing Iodine Spike	3.6	1.5	0.282	0.012	1.02E+00	1.80E-02	25
Steam Generator Tube Rupture - Accident-Initiated Iodine Spike	0.96	0.43	0.282	0.012	2.71E-01	5.16E-03	2.5
LOCA	13	13	0.282	0.012	3.67E+00	1.56E-01	25
Fuel Handling Accident	3.3	1.4	0.282	0.012	9.31E-01	1.68E-02	6.3

a) LPZ doses are not given in time-dependent form; therefore, the most conservative Site/DCD χ/Q ratio (from the 8 to 24 hour interval) is used.

Table 7.1-40
ABWR Radiological Consequences
Atmospheric Dispersion Factors

Accident	Location	Time (hr.)	DCD χ/Q (sec/m^3)	Site χ/Q (sec/m^3)	χ/Q Ratio (Site/DCD)
All Accidents	EAB	0 to 2	1.37E-03	1.41E-04	0.103
	LPZ	0 to 2	4.11E-04	4.72E-06	0.011
LOCA Only		0 to 8	1.56E-04	2.30E-06	0.015
		8 to 24	9.61E-05	1.61E-06	0.017
		24 to 96	3.36E-05	7.51E-07	0.022
		96 to 720	7.42E-06	3.05E-07	0.041

Table 7.1-41
ABWR Radiological Consequences
PSEG Site-Specific Dose Summary

Accident	Thyroid Dose (Sv)	Whole Body Dose (Sv)	Thyroid Limit (Sv)	Whole Body Limit (Sv)
Failure of Small Lines Carrying Primary Coolant Outside Containment[(a)]	4.94E-03	9.68E-05	3.00E-01	2.50E-02
LOCA - EAB	2.14E-01	4.62E-03	3.00E+00	2.50E-01
LOCA - LPZ	7.72E-02	9.82E-04	3.00E+00	2.50E-01
Fuel Handling Accident[(a)]	8.46E-02	1.35E-03	7.50E-01	6.25E-02
Main Steamline Break Case 1[(a)(b)]	2.68E-03	6.39E-05	3.00E-01	2.50E-02
Main Steamline Break Case 2[(a)(b)]	5.25E-02	1.34E-03	3.00E+00	2.50E-01

a) The dose is calculated for the maximum two hour EAB meteorology, only, based on the DCD.

b) The level of activity is consistent with an offgas release rate of 3.7 GBq/s for Case 1 and 14.8 GBq/s for Case 2 referenced to a 30 minute decay. The iodine concentrations in the reactor coolant are tabulated below for each case.

	MBq/g	
Isotope	**Case 1**	**Case 2**
I-131	0.001739	0.03515
I-132	0.01536	0.30747
I-133	0.01206	0.24161
I-134	0.02634	0.52688
I-135	0.01647	0.3293

Table 7.1-42
ABWR Radiological Consequences
Doses for an Instrument Line Break Accident

DCD			Site	
Thyroid Dose (Sv)	Whole Body Dose (Sv)	χ/Q Ratio (Site/DCD)	Thyroid Dose (Sv)	Whole Body Dose (Sv)
4.80E-02	9.40E-04	0.103	4.94E-03	9.68E-05

Table 7.1-43
ABWR Radiological Consequences
Doses for a Fuel Handling Accident

DCD				Site	
Thyroid Dose (Sv)	Whole Body Dose (Sv)	χ/Q Ratio (Site/DCD)	Uprate Ratio	Thyroid Dose (Sv)	Whole Body Dose (Sv)
7.50E-01	1.20E-02	0.103	1.095	8.46E-02	1.35E-03

Table 7.1-44
ABWR Radiological Consequences
Doses for a LOCA

		DCD				Site	
Location	**Time (hr.)**	**Thyroid Dose (Sv)**	**Whole Body Dose (Sv)**	**χ/Q Ratio (Site/DCD)**	**Uprate Ratio**	**Thyroid Dose (Sv)**	**Whole Body Dose (Sv)**
EAB	0 to 2	1.90E+00	4.10E-02	0.103	1.095	2.14E-01	4.62E-03
LPZ	0 to 8	3.10E-01	1.00E-02	0.015	1.095	5.09E-03	1.64E-04
	0 to 24	5.10E-01	1.80E-02	0.017	1.095	8.81E-03	3.13E-04
	0 to 96	1.30E+00	2.90E-02	0.022	1.095	2.78E-02	5.78E-04
	0 to 720	2.40E+00	3.80E-02	0.041	1.095	7.72E-02	9.82E-04

Table 7.1-45
ABWR Radiological Consequences
Doses for a Main Steamline Break

	DCD			Site	
	Thyroid Dose (Sv)	**Whole Body Dose (Sv)**	**χ/Q Ratio (Site/DCD)**	**Thyroid Dose (Sv)**	**Whole Body Dose (Sv)**
Case 1	2.60E-02	6.20E-04	0.103	2.68E-03	6.39E-05
Case 2	5.10E-01	1.30E-02	0.103	5.25E-02	1.34E-03

Table 7.1-46
AP1000 Radiological Consequences
Atmospheric Dispersion Factors

Accident	Location	Time (hr.)	DCD χ/Q (sec/m^3)	Site χ/Q (sec/m^3)	χ/Q Ratio (Site/DCD)
LOCA	EAB	0 to 2	5.10E-04	1.41E-04	0.276
	LPZ	0 to 8	2.20E-04	2.30E-06	0.010
		8 to 24	1.60E-04	1.61E-06	0.010
		24 to 96	1.00E-04	7.51E-07	0.008
		96 to 720	8.00E-05	3.05E-07	0.004
Other Accidents	EAB	0 to 2	8.00E-04	1.41E-04	0.176
	LPZ	0 to 8	5.00E-04	2.30E-06	0.005
		8 to 24	3.00E-04	1.61E-06	0.005
		24 to 96	1.50E-04	7.51E-07	0.005
		96 to 720	8.00E-05	3.05E-07	0.004

Table 7.1-47
AP1000 Radiological Consequences
PSEG Site-Specific Dose Summary

Accident	Site Dose (rem TEDE)		
	EAB	LPZ	Limit
Steam System Piping Failure – Pre-Existing Iodine Spike	1.76E-01	3.81E-03	25
Steam System Piping Failure – Accident-Initiated Iodine Spike	1.94E-01	9.67E-03	2.5
Reactor Coolant Pump Shaft Seizure – No Feedwater	1.41E-01	1.95E-03	2.5
Reactor Coolant Pump Shaft Seizure – Feedwater Available	1.06E-01	3.97E-03	2.5
Spectrum of Rod Cluster Control Assembly Ejection Accidents	6.34E-01	2.72E-02	6.3
Failure of Small Lines Carrying Primary Coolant Outside Containment	3.70E-01	5.10E-03	2.5
Steam Generator Tube Rupture – Pre-Existing Iodine Spike	3.87E-01	6.16E-03	25
Steam Generator Tube Rupture – Accident-Initiated Iodine Spike	1.94E-01	3.99E-03	2.5
LOCA	6.71E+00	2.31E-01	25
Fuel Handling Accident	9.15E-01	1.72E-02	6.3

Table 7.1-48
AP1000 Radiological Consequences
Doses for a Steam System Piping Failure

Doses for Steam System Piping Failure with Pre-Existing Iodine Spike

	DCD Dose (rem TEDE)			Site Dose (rem TEDE)	
Time (hr.)	**EAB**	**LPZ**	**χ/Q Ratio (Site/DCD)**	**EAB**	**LPZ**
0 to 2	1.00E+00		0.176	1.76E-01	
0 to 8		5.81E-01	0.005		2.91E-03
8 to 24		7.18E-02	0.005		3.59E-04
24 to 96		1.08E-01	0.005		5.40E-04
96 to 720		0.00E+00	0.004		0.00E+00
Total	1.00E+00	7.61E-01		1.76E-01	3.81E-03
Limit				25	25

Doses for Steam System Piping Failure with Accident-Initiated Iodine Spike

	DCD Dose (rem TEDE)			Site Dose (rem TEDE)	
Time (hr.)	**EAB**	**LPZ**	**χ/Q Ratio (Site/DCD)**	**EAB**	**LPZ**
0 to 2	1.10E+00		0.176	1.94E-01	
0 to 8		1.02E+00	0.005		5.10E-03
8 to 24		3.77E-01	0.005		1.89E-03
24 to 96		5.36E-01	0.005		2.68E-03
96 to 720		0.00E+00	0.004		0.00E+00
Total	1.10E+00	1.93E+00		1.94E-01	9.67E-03
Limit				2.5	2.5

Table 7.1-49
AP1000 Radiological Consequences
Doses for a Reactor Coolant Pump Shaft Seizure Accident

Doses for Reactor Coolant Pump Shaft Seizure with No Feedwater

	DCD Dose (rem TEDE)			Site Dose (rem TEDE)	
Time (hr.)	EAB	LPZ	χ/Q Ratio (Site/DCD)	EAB	LPZ
0 to 2	8.00E-01		0.176	1.41E-01	
0 to 8		3.89E-01	0.005		1.95E-03
8 to 24		0.00E+00	0.005		0.00E+00
24 to 96		0.00E+00	0.005		0.00E+00
96 to 720		0.00E+00	0.004		0.00E+00
Total	8.00E-01	3.89E-01		1.41E-01	1.95E-03
Limit				2.5	2.5

Doses for Reactor Coolant Pump Shaft Seizure with Feedwater Available

	DCD Dose (rem TEDE)			Site Dose (rem TEDE)	
Time (hr.)	EAB	LPZ	χ/Q Ratio (Site/DCD)	EAB	LPZ
0 to 2	6.00E-01		0.176	1.06E-01	
0 to 8		7.94E-01	0.005		3.97E-03
8 to 24		0.00E+00	0.005		0.00E+00
24 to 96		0.00E+00	0.005		0.00E+00
96 to 720		0.00E+00	0.004		0.00E+00
Total	6.00E-01	7.94E-01		1.06E-01	3.97E-03
Limit				2.5	2.5

Table 7.1-50
AP1000 Radiological Consequences
Doses for Spectrum of Rod Cluster Control Assembly Ejection Accidents

	DCD Dose (rem TEDE)			Site Dose (rem TEDE)	
Time (hr.)	**EAB**	**LPZ**	**χ/Q Ratio (Site/DCD)**	**EAB**	**LPZ**
0 to 2	3.60E+00		0.176	6.34E-01	
0 to 8		4.58E+00	0.005		2.29E-02
8 to 24		7.84E-01	0.005		3.92E-03
24 to 96		6.32E-02	0.005		3.16E-04
96 to 720		2.06E-02	0.004		8.24E-05
Total	3.60E+00	5.45E+00		6.34E-01	2.72E-02
Limit				6.3	6.3

Table 7.1-51
AP1000 Radiological Consequences
Doses for Failure of Small Lines Carrying Primary Coolant Outside Containment

	DCD Dose (rem TEDE)			Site Dose (rem TEDE)	
Time (hr.)	**EAB**	**LPZ**	**χ/Q Ratio (Site/DCD)**	**EAB**	**LPZ**
0 to 2	2.10E+00		0.176	3.70E-01	
0 to 8		1.02E+00	0.005		5.10E-03
8 to 24		0.00E+00	0.005		0.00E+00
24 to 96		0.00E+00	0.005		0.00E+00
96 to 720		0.00E+00	0.004		0.00E+00
Total	2.10E+00	1.02E+00		3.70E-01	5.10E-03
Limit				2.5	2.5

Table 7.1-52
AP1000 Radiological Consequences
Doses for Steam Generator Tube Rupture

Doses for Steam Generator Tube Rupture with Pre-Existing Iodine Spike

	DCD Dose (rem TEDE)			Site Dose (rem TEDE)	
Time (hr.)	EAB	LPZ	χ/Q Ratio (Site/DCD)	EAB	LPZ
0 to 2	2.20E+00		0.176	3.87E-01	
0 to 8		1.16E+00	0.005		5.80E-03
8 to 24		7.24E-02	0.005		3.62E-04
24 to 96		0.00E+00	0.005		0.00E+00
96 to 720		0.00E+00	0.004		0.00E+00
Total	2.20E+00	1.23E+00		3.87E-01	6.16E-03
Limit				25	25

Doses for Steam Generator Tube Rupture with Accident-Initiated Iodine Spike

	DCD Dose (rem TEDE)			Site Dose (rem TEDE)	
Time (hr.)	EAB	LPZ	χ/Q Ratio (Site/DCD)	EAB	LPZ
0 to 2	1.10E+00		0.176	1.94E-01	
0 to 8		6.27E-01	0.005		3.14E-03
8 to 24		1.69E-01	0.005		8.45E-04
24 to 96		0.00E+00	0.005		0.00E+00
96 to 720		0.00E+00	0.004		0.00E+00
Total	1.10E+00	7.96E-01		1.94E-01	3.99E-03
Limit				2.5	2.5

Table 7.1-53
AP1000 Radiological Consequences
Doses for LOCA

	DCD Dose (rem TEDE)			Site Dose (rem TEDE)	
Time (hr.)	**EAB**	**LPZ**	**χ/Q Ratio (Site/DCD)**	**EAB**	**LPZ**
0 to 2	2.43E+01		0.276	6.71E+00	
0 to 8		2.17E+01	0.010		2.17E-01
8 to 24		7.69E-01	0.010		7.69E-03
24 to 96		3.71E-01	0.008		2.97E-03
96 to 720		8.70E-01	0.004		3.48E-03
Total	2.43E+01	2.37E+01		6.71E+00	2.31E-01
Limit				25	25

Table 7.1-54
AP1000 Radiological Consequences
Doses for a Fuel Handling Accident

	DCD Dose (rem TEDE)			Site Dose (rem TEDE)	
Time (hr.)	EAB	LPZ	χ/Q Ratio (Site/DCD)	EAB	LPZ
0 to 2	5.20E+00		0.176	9.15E-01	
0 to 8		3.44E+00	0.005		1.72E-02
8 to 24		0.00E+00	0.005		0.00E+00
24 to 96		0.00E+00	0.005		0.00E+00
96 to 720		0.00E+00	0.004		0.00E+00
Total	5.20E+00	3.44E+00		9.15E-01	1.72E-02
Limit				6.3	6.3

Table 7.1-55
U.S. EPR Radiological Consequences
Atmospheric Dispersion Factors

Location	Time (hr.)	DCD χ/Q (sec/m^3)	Site χ/Q (sec/m^3)	χ/Q Ratio (Site/DCD)
EAB	0 to 2	1.00E-03	1.41E-04	0.141
LPZ	0 to 8	1.35E-04	2.30E-06	0.017
	8 to 24	1.00E-04	1.61E-06	0.016
	24 to 96	5.40E-05	7.51E-07	0.014
	96 to 720	2.20E-05	3.05E-07	0.014

Table 7.1-56
U.S. EPR Radiological Consequences
Dose Summary

Accident	DCD Dose (rem TEDE)		χ/Q ratio (Site/DCD)		Site Dose (rem TEDE)		
	EAB	LPZ	EAB	LPZ[(a)]	EAB	LPZ	Max
Main Steam Line Break - Pre-Existing Iodine Spike	0.2	0.1	0.141	0.017	2.82E-02	1.70E-03	25
Main Steam Line Break - Accident-Initiated Iodine Spike	0.3	0.2	0.141	0.017	4.23E-02	3.40E-03	2.5
Main Steam Line Break - Fuel Rod Clad Failure	5.3	2.6	0.141	0.017	7.47E-01	4.42E-02	25
Main Steam Line Break - Fuel Overheat	5.8	2.8	0.141	0.017	8.18E-01	4.76E-02	25
Reactor Coolant Pump Shaft Seizure	2.3	0.9	0.141	0.017	3.24E-01	1.53E-02	2.5
Spectrum of Rod Cluster Control Assembly Ejection Accidents	5.7	3.5	0.141	0.017	8.04E-01	5.95E-02	6.3
Failure of Small Lines Carrying Primary Coolant Outside Containment	1.8	0.3	0.141	0.017	2.54E-01	5.10E-03	2.5
Steam Generator Tube Rupture - Pre-Existing Iodine Spike	1.1	0.3	0.141	0.017	1.55E-01	5.10E-03	25
Steam Generator Tube Rupture - Accident-Initiated Iodine Spike	0.7	0.5	0.141	0.017	9.87E-02	8.50E-03	2.5
LOCA	12.2	11.1	0.141	0.017	1.72E+00	1.89E-01	25
Fuel Handling Accident	5.6	1	0.141	0.017	7.90E-01	1.70E-02	6.3

a) LPZ doses are not given in time-dependent form, therefore, the most conservative Site/DCD χ/Q ratio (from the 0 to 8 hour interval) was used.

7.2 SEVERE ACCIDENTS

This section evaluates the potential environmental impacts of severe accidents at the PSEG Site from four different reactor technologies. The four reactor technologies are: ABWR (4300 MWt), AP1000, US-APWR, and U.S. EPR. These reactor technologies are for a single-unit plant except for the AP1000 case, which is based on two units. The environmental impacts from postulated severe accidents are calculated using site-specific data to demonstrate acceptability.

Severe accidents are defined as accidents with substantial reactor core damage and degradation of containment systems. Because the severe accident probability is low for the considered reactor technologies, these accidents are not part of the new plant design basis. However, the U. S. Nuclear Regulatory Commission (NRC) requires, in *Severe Reactor Accidents Regarding Future Designs and Existing Plants* (Reference 7.2-1), the completion of a probabilistic risk assessment (PRA) for severe accidents for the new reactor designs. This requirement is specified in regulation 10 CFR 52.47, *Contents of Applications; Technical Information*.

A PRA is completed for each of the four reactor technologies as part of the associated application for design certification. This section uses the applicable results of the PRA for severe accidents, along with site-specific characteristics, to determine impacts of severe accidents over an entire new plant life cycle. The purpose of this analysis is to identify potential off-site radiological impacts of severe accidents and demonstrate that the impacts are acceptable.

7.2.1 METHODOLOGY

7.2.1.1 Off-Site Consequences

The NRC computer code MACCS2 (Reference 7.2-2) is used to model the environmental consequences of the severe accidents. Each of the four reactor technologies has a reactor-specific set of severe accidents that correspond to unique accident sequences. The PRA for the four reactor technologies established event trees that define the end states of each accident sequence. Each end state has a corresponding release category source term. The source terms are based on core inventory data and release fractions for specific chemical groups. This data is used as input to the MACCS2 code. Table 7.2-1 contains the list of release categories and their brief descriptions. Table 7.2-4 contains the list of chemical groups and the associated nuclides. Table 7.2-5 contains the release fractions for all chemical groups.

The exposure pathways modeled include external exposure from the passing plume, external exposure from material deposited on the ground, inhalation of material in the passing plume or resuspended from the ground, and ingestion of contaminated food and surface water.

The MACCS2 code primarily addresses dose from the air pathway, but also calculates dose from surface runoff and deposition on surface water. The code evaluates the extent of contamination. The meteorology data used in the analysis is hourly data for one year that includes wind velocity (speed and direction), stability class, and rainfall.

To assess human health impacts, the analysis determined the risk of early fatalities, the risk of latent cancer fatalities, and collective whole body dose-risk from a severe accident for the year 2081 estimated population within a 50-mile (mi.) radius of the new plant. The population data for the year 2081 is selected considering a new plant operating life (40 yr) and the potential license extension (20 yr). If the new plant has a start-up date within the next decade (2010 to 2020), the population data corresponds to the end-point of the plant operating period. This is the most conservative estimate for population because it increases with time.

The economic risk associated with severe accidents is determined. The economic risk is based on costs associated with short-term relocation of people, decontamination of property and equipment, and interdiction of food supplies. Risk calculation is further discussed in Subsection 7.2.1.2.

MACCS2 requires five input files: ATMOS, EARLY, CHRONC, METEOROLOGICAL, and SITE. ATMOS provides data to calculate the amount of material released to the atmosphere that is dispersed and deposited. The calculation uses a Gaussian plume model. Important reactor-specific inputs in this file include the core inventory, release fractions, and geometry of the reactor and associated buildings. EARLY provides inputs to calculations regarding exposure in the time period immediately following the release. Important site-specific information includes emergency response information such as evacuation time. CHRONC provides data for calculating long-term impacts and economic costs and includes region-specific data on agriculture and economic factors. These files access a meteorological file, (METEOROLOGICAL) which uses actual PSEG Site meteorological monitoring data for the year 2004, and a site characteristics file (SITE) which uses site-specific population data, land usage, watershed index, and regions. The meteorological data for year 2004 was selected due to its completeness (hourly data for each day of the year) and it is representative of the overall long-term regional climate (i.e., there are no outliers in the data set compared to the long-term regional climate).

7.2.1.2 Risk Calculation

The results of the MACCS2 calculations and the accident frequency information are used to determine risk. The accident frequencies (the same as the release category frequencies) are listed in Table 7.2-2. Risk is the product of accident frequency and the consequences of the accident. The consequence is either a radiation dose, economic cost, or the area of land contaminated due to the accident. The total risk is determined by summing all the corresponding accident risks.

7.2.2 CONSEQUENCES TO POPULATION GROUPS

This section evaluates impacts of severe accidents from air, surface water, and groundwater pathways. The MACCS2 code is used to evaluate the doses from the air pathway and from water ingestion with PSEG Site-specific data. MACCS2 does not model other surface water and groundwater dose pathways. These are analyzed qualitatively based on a comparison of the new plant atmospheric doses to those of the existing U.S. nuclear fleet.

The four reactor technologies considered here belong to a new generation of reactors that are based on improved design parameters with respect to the associated core damage frequencies (CDFs). The CDF is a measure of the impacts of potential accidents. A CDF is calculated using

PRA modeling to evaluate how changes to the reactor or auxiliary systems change the severity of the accident. The CDFs for the ABWR, AP1000, US-APWR, and U.S. EPR are typically one to three orders of magnitude lower than the CDFs for the current nuclear fleet.

7.2.2.1 Air Pathways

For each reactor technology, the potential severe accidents are grouped into release categories based on their similarity. The number of release categories is reactor-specific. Each release category has a set of characteristics representative of that categories chemical elements. Radionuclides that may be released are organized into groups having similar chemical characteristics. Table 7.2-4 provides the groupings. Release categories for each reactor technology are analyzed with MACCS2 to calculate population dose, number of early and latent fatalities, cost, and farm land requiring decontamination. The analysis assumes that 95 percent of the population is evacuated following declaration of a general emergency.

For each release category, risk is calculated by multiplying each consequence (population dose, fatalities, cost, and area of contaminated land) with its corresponding frequency. A summary of the results is provided in Table 7.2-3. The total cost calculation considers other consequences, such as evacuation costs, value of crops contaminated and condemned, value of milk contaminated and condemned, cost of property decontamination, and indirect costs resulting from loss of property use and incomes as a result of the accident.

7.2.2.2 Surface Water Pathways

A population is exposed to radiation when airborne radioactivity is deposited onto surface water. The exposure pathway is from drinking the water, external radiation from submersion in the water, external radiation from activities near the shoreline, or ingestion of fish or shellfish. MACCS2 only calculates the dose from drinking water. The MACCS2 severe accident dose risk to the 50-mi. population from drinking water is 8.74E-03 person-rem/reactor-year (8.74E-05 person-Sv/reactor-year) (Table 7.2-3) for the US-APWR, which is bounding for the four reactor technologies. This value is the sum of all water ingestion doses for the associated US-APWR release categories.

Surface water pathways involving swimming, fishing, and boating are not modeled by MACCS2. Surface water bodies within the 50-mi. region of PSEG Site include the Laurel Lake, Elkinton Millpond, Chesapeake Bay, Delaware Bay, Delaware River, Susquehanna River, Smyrna River, Schuylkill River, Cooper River and the reservoirs listed on Table 2.3-3. The tributary streams in the vicinity of the PSEG Site are listed in Table 2.3-4. The NRC evaluated doses from the aquatic food pathway (fishing) for the current nuclear fleet discharging to various bodies of water in NUREG-1437, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*. The NRC evaluation concluded that with interdiction, the risk associated with the aquatic food pathway is SMALL relative to the atmospheric pathway for most sites and essentially the same as the atmospheric pathway for the few sites with large annual aquatic food harvests. The new plant atmospheric pathway doses are lower than those of the current U.S. nuclear fleet, therefore, the doses from surface water sources are consistently lower for the new plant as well.

7.2.2.3 Groundwater Pathways

People also receive a dose from groundwater pathways. Radioactivity released during an accident enters groundwater or moves through an aquifer that eventually discharges to surface water. The consequences of a radioactive spill not associated with an accident are evaluated in SSAR Subsection 2.4.13, which determined that if the radioactive liquids are released directly to the groundwater, all radionuclides are below the environmental concentration limits before they reach any local aquifers containing drinking water. NUREG-1437 also evaluated the groundwater pathway dose, based on the analysis in NUREG-0440, *Liquid Pathway Generic Study* (LPGS). NUREG-0440 analyzed a core meltdown that contaminated groundwater and subsequently contaminated surface water. However, NUREG-0440 did not analyze direct groundwater drinking because of the limited number of potable groundwater wells.

The LPGS results provide conservative, uninterdicted population dose estimates for six generic categories of plants. These dose estimates are one or more orders of magnitude less than those attributed to the atmospheric pathway. NUREG-1437 compared potential contamination at the existing Hope Creek Generating Station (HCGS) and found that its estimated uninterdicted total population dose is less than one percent of the LPGS generic dose for estuaries. The new plant proposed location has the same groundwater characteristics as the existing HCGS and the CDFs for the new reactor technologies are lower than that for the HCGS reactor. Therefore, the dose risk from the new reactor technologies via groundwater pathway is smaller than the dose risk from the existing HCGS reactor.

7.2.3 CONCLUSIONS

The total calculated dose risk to the 50-mi., year 2081 population from US-APWR airborne releases at the PSEG Site is 1.15E+00 person-rem/reactor-year (1.15E-02 person-Sv/reactor-year) (Table 7.2-3). The US-APWR bounds the ABWR, AP1000 and U.S.EPR with respect to airborne releases. Similarly, the risks of persons exposed to doses greater than 25 rem (0.25 Sv) and 200 rem (2 Sv) for US-APWR are 3.07E-03 and 9.23E-05 person/reactor-year, respectively (Table 7.2-3).

The US-APWR population dose risk at the PSEG Site is less than that for all five reactors analyzed in NUREG-1150, *Severe Accident Risks; An Assessment for Five U.S. Nuclear Power Plants*. It is however greater than the minimum population risk of the current reactors that have undergone license renewal. Per NUREG-1811, *Environmental Impact Statement for an Early Site Permit (ESP) at the North Anna ESP Site,* and NUREG-1437, the lowest dose risk reported for reactors currently undergoing license renewal (e.g., Arkansas Nuclear One) is 5.5E-01 person-rem/reactor-year (5.5E-03 person-Sv/reactor-year). The reason the US-APWR population dose risk is greater than the minimum dose risk in NUREG-1437 (Arkansas Nuclear One) is due to the significantly larger population within the 50-mi. radius of the PSEG Site (approximately three orders of magnitude).

As discussed in Subsection 7.2.2.2, the risk from surface water contamination resulting from an accident at the PSEG Site is less than the risk from the atmospheric pathway. The risk from the atmospheric pathway for a US-APWR severe accident is bounding. Therefore, the risk from surface water contamination is minor compared to the surface water pathway of the current U.S. nuclear fleet.

As discussed in Subsection 7.2.2.3, the risk of groundwater contamination from a US-APWR severe accident is negligible, and is smaller than the associated risk from the currently licensed reactors.

To gauge the relative magnitude of the severe accident dose risk, the bounding severe accident population dose risk is compared to the population dose risk associated with normal operation of the new plant. As reported in Section 5.4, the total collective doses for the bounding reactor technology at the PSEG Site from normal operation due to liquid and gaseous effluents are 4.55E+01 person-rem/year (4.55E-01 person-Sv/year) and 2.04E+01 person-rem/year (2.04E-01 person-Sv/year), respectively. The sum of these two components is the total collective dose and is equal to 6.59E+01 person-rem/year (6.59E-01 person-Sv/year). As previously described, dose risk is dose times frequency. Normal operation has a frequency of one. Therefore, the dose risk for normal operation is 6.59E+01 person-rem/year (6.59E-01 person-Sv/year). Comparing this value to the bounding severe accident dose risk of 1.15E+00 person-rem/reactor-year (1.15E-02 person-Sv/reactor-year) indicates that the bounding dose risk from severe accidents is 1.7 percent of dose risk from normal operation.

Per Table 7.2-3, the US-APWR severe accident produces a bounding economic risk of 5.03E+03 dollars/reactor-year for the new plant. Similarly, the bounding value for risk of farm land requiring decontamination is for the US-APWR severe reactor accident and is calculated to be 7.34E-03 hectares/reactor-year. The probability-weighted risks of early and latent cancer fatalities from a US-APWR severe accident at the PSEG Site are indicated in Table 7.2-3 as 1.24E-09 persons/reactor-year and 7.36E-04 persons/reactor-year, respectively. Note that because no member of the public resides within a mile of the PSEG Site, the prompt fatality risk for this area is zero and complies with the guideline established in Reference 7.2-3.

7.2.4 REFERENCES

7.2-1. 50 FR 32138, Severe Reactor Accidents Regarding Future Designs and Existing Plants, Nuclear Regulatory Commission, August 8, 1985.

7.2-2. Chanin, D. I. and M. L. Young. Code Manual for MACCS2: Volume 1, User’s Guide, SAND97-0594, Sandia National Laboratories, Albuquerque, New Mexico, March 1997.

7.2-3. Nuclear Regulatory Commission (NRC), “Safety Goals for the Operations of Nuclear Power Plants; Policy Statement; Republication”, 51 FR 30028, August 1986.

Table 7.2-1 (Sheet 1 of 2)
Severe Accident Release Categories for ABWR, AP1000, US-APWR, and U.S. EPR

Release Category	Accident Scenario Description
ABWR	
NCL	No loss of containment.
Case 1	Transients followed by failure of high pressure coolant makeup and failure to depressurize in timely fashion.
Case 2	Short-term station blackout with reactor core isolation cooling (RCIC) failure, onsite power recovery in 8 hr.
Case 3	Station blackout with RCIC available for about 8 hr.
Case 4	Station blackout (more than 8 hr) with RCIC failure.
Case 5	Transients followed by failure of high pressure coolant makeup, successful depressurization of reactor, failure of low-pressure coolant makeup.
Case 6	Transient, loss-of-coolant accident (LOCA), and anticipated transient without scram (ATWS) events with successful coolant makeup, but potential prior failure of containment.
Case 7	Small/medium LOCA followed by failure of high-pressure coolant makeup and failure to depressurize.
Case 8	LOCA followed by failure of high pressure coolant makeup.
Case 9	ATWS followed by boron injection failure and successful high-pressure coolant makeup.
AP1000	
IC	Intact containment.
CFE	Early containment failure.
CFI	Intermediate containment failure.
CFL	Late containment failure.
CI	Containment isolation failure.
BP	Containment bypass.
US-APWR	
RC1	Containment bypass.
RC2	Containment isolation failure.
RC3	Containment failure before core damage.
RC4	Early containment failure.
RC5	Late containment failure.
RC6	Intact containment.
U.S. EPR	
RC101	No containment failure.
RC201	Containment fails before vessel breach due to isolation failure, melt retained in vessel.
RC202	Containment fails before vessel breach due to isolation failure, melt released from vessel, with MCCI, melt not flooded ex-vessel, with containment sprays.
RC203	Containment fails before vessel breach due to isolation failure, melt released from vessel, with MCCI, melt not flooded ex-vessel, without containment sprays.

Table 7.2-1 (Sheet 2 of 2)
Severe Accident Release Categories for ABWR, AP1000, US-APWR, and U.S. EPR

Release Category	Accident Scenario Description
RC204	Containment fails before vessel breach due to isolation failure, melt released from vessel, without MCCI, melt flooded ex-vessel with containment sprays.
RC205	Containment failures before vessel breach due to isolation failure, melt released from vessel, without MCCI, melt flooded ex-vessel without containment sprays.
RC206	Small containment failure due to failure to isolate 2" or smaller lines.
RC301	Containment fails before vessel breach due to containment rupture, with MCCI, melt not flooded ex-vessel, with containment sprays.
RC302	Containment fails before vessel breach due to containment rupture, with MCCI, melt not flooded ex-vessel, without containment sprays.
RC303	Containment fails before vessel breach due to containment rupture, without MCCI, melt flooded ex-vessel, with containment sprays.
RC304	Containment fails before vessel breach due to containment rupture, without MCCI, melt flooded ex-vessel, without containment sprays.
RC401	Containment failures after breach and up to melt transfer to the spreading area, with MCCI, without debris flooding, with containment spray.
RC402	Containment failures after breach and up to melt transfer to the spreading area, with MCCI, without debris flooding, without containment spray.
RC403	Containment failures after breach and up to melt transfer to the spreading area, without MCCI, with debris flooding, with containment spray.
RC404	Containment failures after breach and up to melt transfer to the spreading area, without MCCI, with debris flooding, without containment spray.
RC501	Long term containment failure during and after debris quench, due to rupture, with MCCI, without debris flooding, with containment sprays.
RC502	Long term containment failure during and after debris quench, due to rupture, with MCCI, without debris flooding, without containment sprays.
RC503	Long term containment failure during and after debris quench, due to rupture, without MCCI, with debris flooding, with containment sprays.
RC504	Long term containment failure during and after debris quench, due to rupture, without MCCI, with debris flooding, without containment sprays.
RC602	Long term containment failure due to basemat failure, without debris flooding, without containment sprays.
RC701	Steam Generator Tube Rupture with fission product scrubbing.
RC702	Steam Generator Tube Rupture without fission product scrubbing.
RC802	Interfacing System LOCA without fission product scrubbing.

Table 7.2-2
Severe Accident Release Categories and Frequencies for ABWR, AP1000, US-APWR, and U.S. EPR

ABWR		AP1000		US-APWR		U.S. EPR	
Release Category	**Frequency (Reactor Year)**	**Release Category**	**Frequency (Reactor Year)**	**Release Category**	**Frequency (Reactor Year)**	**Release Category**	**Frequency (Reactor Year)**
NCL	1.34E-07	IC	2.21E-07	RC1	7.5E-09	RC101	3.43E-07
Case 1	2.08E-08	CFE	7.47E-09	RC2	2.1E-09	RC201	4.98E-10
Case 2	1.00E-10	CFI	1.89E-10	RC3	2.0E-08	RC202	3.97E-14
Case 3	1.00E-10	CFL	3.45E-13	RC4	1.1E-08	RC203	1.92E-12
Case 4	1.00E-10	CI	1.33E-09	RC5	6.5E-08	RC204	2.78E-11
Case 5	1.00E-10	BP	1.05E-08	RC6	1.1E-06	RC205	4.08E-10
Case 6	1.00E-10					RC206	1.65E-08
Case 7	3.91E-10					RC301	1.67E-12
Case 8	4.05E-10					RC302	2.18E-11
Case 9	1.70E-10					RC303	2.30E-09
						RC304	1.75E-08
						RC401	1.38E-11
						RC402	2.75E-10
						RC403	6.82E-10
						RC404	1.34E-08
						RC501	5.92E-13
						RC502	2.87E-10
						RC503	6.01E-10
						RC504	1.19E-07
						RC602	6.50E-10
						RC701	1.02E-08
						RC702	5.38E-09
						RC802	2.64E-10

Table 7.2-3 (Sheet 1 of 3)
Environmental Consequence Risk Results

Release Category	Population Dose Risk: Water Ingestion (Person-Sv)/(Reactor-Year)	Population Dose Risk: Total (Person-Sv)/(Reactor-Year)	Risk of Fatalities: Early (Person)/(Reactor-Year)	Risk of Fatalities: Late (Person)/(Reactor-Year)	Risk of Exceeding Threshold Doses: 25 (rem) (Person)/(Reactor-Year)	Risk of Exceeding Threshold Doses: 200 (rem) (Person)/(Reactor-Year)	Economic Risk (Dollars)/(Reactor-Year)	Risk of Farm Land Requiring Decontamination Hectares/(Reactor-Year)
ABWR								
NCL	1.37E-08	2.16E-05	0.00E+00	9.63E-07	0.00E+00	0.00E+00	3.43E-01	1.04E-06
Case 1	1.37E-11	1.78E-06	0.00E+00	7.40E-08	0.00E+00	0.00E+00	1.52E-02	0.00E+00
Case 2	2.19E-12	1.18E-08	0.00E+00	5.01E-10	0.00E+00	0.00E+00	1.14E-04	2.44E-11
Case 3	1.24E-10	2.03E-07	0.00E+00	9.01E-09	0.00E+00	0.00E+00	6.97E-03	3.14E-08
Case 4	7.01E-10	7.32E-07	0.00E+00	3.24E-08	3.49E-15	0.00E+00	8.62E-02	3.35E-07
Case 5	2.63E-09	1.54E-06	0.00E+00	6.81E-08	2.04E-13	0.00E+00	4.17E-01	1.18E-06
Case 6	1.38E-08	3.66E-06	0.00E+00	1.63E-07	2.54E-10	0.00E+00	1.89E+00	3.95E-06
Case 7	1.55E-07	2.10E-05	0.00E+00	9.34E-07	3.49E-09	5.83E-13	1.37E+01	2.13E-05
Case 8	3.37E-07	3.14E-05	1.56E-14	1.42E-06	3.58E-07	5.55E-11	2.27E+01	2.80E-05
Case 9	2.81E-07	1.64E-05	9.98E-14	7.48E-07	3.77E-07	1.77E-10	1.45E+01	1.37E-05
Total (1 Unit)	8.04E-07	9.83E-05	1.15E-13	4.41E-06	7.39E-07	2.33E-10	5.37E+01	6.95E-05

Table 7.2-3 (Sheet 2 of 3)
Environmental Consequence Risk Results

Release Category	Population Dose Risk: Water Ingestion (Person-Sv)/(Reactor-Year)	Population Dose Risk: Total (Person-Sv)/(Reactor-Year)	Risk of Fatalities: Early (Person)/(Reactor-Year)	Risk of Fatalities: Late (Person)/(Reactor-Year)	Risk of Exceeding Threshold Doses: 25 (rem) (Person)/(Reactor-Year)	Risk of Exceeding Threshold Doses: 200 (rem) (Person)/(Reactor-Year)	Economic Risk (Dollars)/(Reactor-Year)	Risk of Farm Land Requiring Decontamination Hectares/(Reactor-Year)
AP1000								
IC	2.32E-08	2.32E-05	0.00E+00	1.04E-06	0.00E+00	0.00E+00	2.61E-01	2.39E-06
CFE	1.58E-06	2.99E-04	1.11E-14	1.42E-05	3.55E-07	8.89E-10	1.71E+02	3.25E-04
CFI	2.68E-08	1.01E-05	0.00E+00	3.95E-07	5.37E-08	4.23E-11	6.10E+00	1.50E-05
CFL	5.97E-12	2.04E-08	0.00E+00	7.62E-10	0.00E+00	0.00E+00	2.12E-02	3.83E-08
CI	2.62E-07	5.40E-05	0.00E+00	3.13E-06	1.72E-06	6.54E-10	2.65E+01	5.49E-05
BP	1.05E-05	1.40E-03	8.36E-13	6.90E-05	8.23E-05	5.27E-08	8.26E+02	1.26E-03
Total (1 Unit)	1.24E-05	1.79E-03	8.47E-13	8.78E-05	8.44E-05	5.43E-08	1.03E+03	1.66E-03
Total (2 Units)	2.48E-05	3.57E-03	1.69E-12	1.76E-04	1.69E-04	1.09E-07	2.06E+03	3.31E-03
US-APWR								
RC1	9.98E-06	9.98E-04	2.57E-12	4.62E-05	6.05E-05	5.93E-08	6.62E+02	9.08E-04
RC2	7.12E-07	2.23E-04	1.93E-15	1.10E-05	2.31E-05	1.21E-08	1.00E+02	2.09E-04
RC3	6.46E-05	5.18E-03	1.24E-09	4.48E-04	2.96E-03	9.22E-05	2.56E+03	2.08E-03
RC4	3.69E-06	8.67E-04	1.06E-13	4.53E-05	2.88E-05	1.40E-08	4.13E+02	7.93E-04
RC5	8.39E-06	4.25E-03	0.00E+00	1.85E-04	8.91E-09	0.00E+00	1.29E+03	3.35E-03
RC6	1.25E-08	1.86E-05	0.00E+00	8.37E-07	0.00E+00	0.00E+00	1.78E-01	3.81E-07
Total (1 Unit)	8.74E-05	1.15E-02	1.24E-09	7.36E-04	3.07E-03	9.23E-05	5.03E+03	7.34E-03

Table 7.2-3 (Sheet 3 of 3)
Environmental Consequence Risk Results

Release Category	Population Dose Risk (Person-Sv)/(Reactor-Year): Water Ingestion	Population Dose Risk (Person-Sv)/(Reactor-Year): Total	Risk of Fatalities (Person)/(Reactor-Year): Early	Risk of Fatalities (Person)/(Reactor-Year): Late	Risk of Exceeding Threshold Doses (Person)/(Reactor-Year): 25 (rem)	Risk of Exceeding Threshold Doses (Person)/(Reactor-Year): 200 (rem)	Economic Risk (Dollars)/(Reactor-Year)	Risk of Farm Land Requiring Decontamination Hectares/(Reactor-Year)
U.S. EPR								
RC101	1.11E-07	2.02E-04	0.00E+00	9.71E-06	0.00E+00	0.00E+00	3.77E+00	2.83E-05
RC201	2.73E-07	1.88E-05	5.48E-14	8.37E-07	1.31E-06	2.47E-12	1.73E+01	1.41E-05
RC202	4.53E-12	1.22E-09	0.00E+00	5.72E-11	2.75E-14	0.00E+00	7.27E-04	1.35E-09
RC203	4.01E-10	9.22E-08	5.91E-19	4.63E-09	3.82E-09	5.55E-15	4.99E-02	8.26E-08
RC204	3.28E-09	9.01E-07	0.00E+00	4.42E-08	6.59E-09	2.81E-16	5.25E-01	9.62E-07
RC205	1.17E-07	2.33E-05	0.00E+00	1.20E-06	2.24E-06	3.99E-12	1.24E+01	1.93E-05
RC206	1.08E-06	4.37E-04	0.00E+00	2.41E-05	3.53E-06	3.20E-09	2.44E+02	5.59E-04
RC301	1.90E-10	5.13E-08	0.00E+00	2.40E-09	1.16E-12	0.00E+00	3.06E-02	5.69E-08
RC302	4.56E-09	1.05E-06	6.71E-18	5.25E-08	4.34E-08	6.30E-14	5.67E-01	9.37E-07
RC303	2.71E-07	7.45E-05	0.00E+00	3.66E-06	5.45E-07	2.32E-14	4.35E+01	7.96E-05
RC304	5.02E-06	9.99E-04	0.00E+00	5.15E-05	9.59E-05	1.71E-10	5.30E+02	8.26E-04
RC401	4.20E-10	1.99E-07	0.00E+00	8.90E-09	1.12E-12	0.00E+00	1.01E-01	2.54E-07
RC402	2.63E-08	8.00E-06	0.00E+00	3.60E-07	6.66E-09	0.00E+00	4.40E+00	8.36E-06
RC403	2.07E-08	9.82E-06	0.00E+00	4.40E-07	5.52E-11	0.00E+00	4.99E+00	1.25E-05
RC404	1.28E-06	3.90E-04	0.00E+00	1.76E-05	3.24E-07	0.00E+00	2.14E+02	4.07E-04
RC501	1.57E-12	3.30E-09	0.00E+00	1.47E-10	0.00E+00	0.00E+00	1.46E-04	3.13E-10
RC502	7.63E-10	1.60E-06	0.00E+00	7.15E-08	0.00E+00	0.00E+00	7.06E-02	1.52E-07
RC503	2.13E-10	3.92E-07	0.00E+00	1.76E-08	0.00E+00	0.00E+00	1.10E-02	8.95E-09
RC504	4.21E-08	7.77E-05	0.00E+00	3.49E-06	0.00E+00	0.00E+00	2.18E+00	1.77E-06
RC602	1.73E-09	3.62E-06	0.00E+00	1.62E-07	0.00E+00	0.00E+00	1.60E-01	3.43E-07
RC701	5.01E-07	2.26E-04	0.00E+00	1.18E-05	5.75E-07	3.55E-11	1.22E+02	2.89E-04
RC702	5.23E-06	8.55E-04	1.39E-11	7.59E-05	4.87E-04	1.19E-05	3.37E+02	3.79E-04
RC802	1.38E-06	1.48E-04	3.99E-11	1.67E-05	8.03E-05	1.76E-05	3.14E+01	1.24E-05
Total (1 Unit)	1.54E-05	3.48E-03	5.39E-11	2.18E-04	6.72E-04	2.95E-05	1.57E+03	2.64E-03

Table 7.2-4
Chemical Group Assignment[a]

Group	Nuclides
1	Kr-85, Kr-85m, Kr-87, Kr-88, Xe-133, Xe-135
2	I-131, I-132, I-133, I-134, I-135
3	Rb-86, Cs-134, Cs-136, Cs-137
4	Sb-127, Sb-129, Te-127, Te-127m, Te-129, Te-129m, Te-131m, Te-132
5	Sr-89, Sr-90, Sr-91, Sr-92
6	Co-58, Co-60, Mo-99, Tc-99m, Ru-103, Ru-105, Ru-106, Rh-105
7	Y-90, Y-91, Y-92, Y-93, Zr-95, Zr-97, Nb-95, La-140, La-141, La-142, Pr-143, Nd-147, Am-241, Cm-242, Cm-244
8	Ce-141, Ce-143, Ce-144, Np-239, Pu-238, Pu-239, Pu-240, Pu-241
9	Ba-139, Ba-140

a) For the ABWR there are 7 groups. Groups 9 and 5 are combined into one (Group 5), and Groups 7 and 8 are combined into one (Group 7).

Table 7.2-5 (Sheet 1 of 4)
Source Release Fractions

ABWR

Release Category	Plume No.	Group No. 1	Group No. 2	Group No. 3	Group No. 4	Group No. 5	Group No. 6	Group No. 7
NCL	1	4.40E-02	0.00E+00	2.30E-05	2.30E-05	0.00E+00	0.00E+00	0.00E+00
Case 1	1	1.00E+00	0.00E+00	1.50E-07	1.30E-05	0.00E+00	0.00E+00	0.00E+00
Case 2	1	1.00E+00	0.00E+00	5.00E-06	5.00E-06	0.00E+00	0.00E+00	0.00E+00
Case 3	1	1.00E+00	0.00E+00	2.80E-04	2.20E-03	0.00E+00	0.00E+00	0.00E+00
Case 4	1	1.00E+00	0.00E+00	1.60E-03	1.60E-03	0.00E+00	0.00E+00	0.00E+00
Case 5	1	1.00E+00	0.00E+00	6.00E-03	5.30E-04	0.00E+00	0.00E+00	0.00E+00
Case 6	1	1.00E+00	0.00E+00	3.10E-02	7.70E-02	0.00E+00	0.00E+00	0.00E+00
Case 7	1	1.00E+00	0.00E+00	8.90E-02	9.90E-02	0.00E+00	0.00E+00	0.00E+00
Case 8	1	1.00E+00	0.00E+00	1.90E-01	2.50E-01	0.00E+00	0.00E+00	0.00E+00
Case 9	1	1.00E+00	0.00E+00	3.70E-01	3.60E-01	0.00E+00	0.00E+00	0.00E+00

Table 7.2-5 (Sheet 2 of 4)
Source Release Fractions

AP1000

Release Category	Plume No.	Group No. 1	Group No. 2	Group No. 3	Group No. 4	Group No. 5	Group No. 6	Group No. 7	Group No. 8	Group No. 9
CFI	1	5.40E-01	3.19E-03	3.18E-03	4.18E-04	2.11E-02	9.11E-03	3.53E-03	2.64E-05	1.62E-02
	2	2.58E-01	1.35E-04	1.35E-04	1.67E-05	6.50E-04	1.68E-04	4.53E-03	1.68E-05	3.40E-04
	3	8.40E-02	0.00E+00	0.00E+00	4.47E-06	0.00E+00	0.00E+00	6.00E-03	2.17E-05	0.00E+00
	4	3.83E-02	0.00E+00	0.00E+00	1.57E-06	0.00E+00	0.00E+00	5.22E-03	1.89E-05	0.00E+00
CFE	1	4.16E-01	5.53E-02	5.37E-02	1.23E-03	3.14E-03	1.16E-02	5.57E-05	9.54E-07	4.63E-03
	2	4.05E-01	1.26E-03	1.21E-03	1.61E-04	3.43E-04	2.58E-03	9.66E-06	4.56E-08	6.45E-04
	3	1.08E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	4	3.43E-02	0.00E+00	0.00E+00	6.04E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
IC	1	9.83E-04	1.20E-05	1.15E-05	8.04E-07	1.07E-05	1.31E-05	1.35E-06	5.85E-09	1.20E-05
	2	4.93E-04	0.00E+00	0.00E+00	4.83E-09	0.00E+00	0.00E+00	6.00E-09	3.20E-11	0.00E+00
	3	3.94E-04	0.00E+00	0.00E+00	1.21E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	4	7.72E-04	0.00E+00	0.00E+00	6.04E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BP	1	1.00E+00	1.69E-01	1.62E-01	6.27E-03	3.57E-03	4.48E-02	1.30E-04	3.19E-06	8.93E-03
	2	0.00E+00	4.64E-02	3.38E-02	3.12E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.00E-06
	3	0.00E+00	2.31E-01	6.60E-02	5.32E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	4	0.00E+00	2.80E-03	9.96E-03	1.57E-03	0.00E+00	0.00E+00	0.00E+00	1.00E-06	0.00E+00
CI	1	5.73E-01	4.56E-02	2.10E-02	1.64E-03	2.03E-02	4.04E-02	2.39E-04	2.97E-06	3.16E-02
	2	1.13E-01	0.00E+00	0.00E+00	1.15E-05	0.00E+00	0.00E+00	1.00E-07	0.00E+00	0.00E+00
	3	5.66E-02	0.00E+00	0.00E+00	8.10E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	4	2.74E-02	0.00E+00	0.00E+00	1.27E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CFL	1	3.36E-04	1.20E-05	1.15E-05	1.00E-06	1.57E-05	1.68E-05	9.96E-07	7.41E-09	1.61E-05
	2	1.19E-03	5.00E-08	3.23E-08	1.75E-08	1.04E-06	2.90E-07	1.07E-05	4.05E-08	6.60E-07
	3	9.79E-01	2.13E-05	1.16E-05	2.47E-05	2.39E-03	1.26E-03	9.75E-02	3.68E-04	2.25E-03
	4	0.00E+00	0.00E+00	2.56E-07	1.20E-05	4.42E-04	1.55E-04	4.39E-02	1.66E-04	3.46E-04

Table 7.2-5 (Sheet 3 of 4)
Source Release Fractions

US-APWR

Release Category	Plume No.	Group No. 1	Group No. 2	Group No. 3	Group No. 4	Group No. 5	Group No. 6	Group No. 7	Group No. 8	Group No. 9
RC1	1	6.88E-01	1.96E-01	1.56E-01	8.55E-02	3.49E-04	1.45E-02	1.47E-05	4.34E-05	2.90E-03
	2	2.48E-01	8.73E-02	3.91E-02	3.91E-02	4.55E-03	3.87E-03	2.25E-04	2.38E-04	8.82E-03
	3	2.72E-03	4.03E-03	8.47E-03	7.88E-03	3.71E-03	4.21E-03	2.12E-03	1.35E-03	3.50E-03
	4	4.87E-03	2.29E-03	2.66E-03	6.09E-04	1.85E-04	7.59E-05	6.23E-04	5.30E-04	9.68E-05
RC2	1	7.31E-01	3.61E-02	2.13E-02	3.56E-02	5.14E-03	1.50E-02	3.62E-03	1.95E-03	8.12E-03
	2	2.38E-01	3.22E-02	4.19E-03	7.24E-03	2.61E-04	7.07E-04	4.01E-04	3.65E-04	4.38E-04
	3	2.20E-02	1.65E-01	1.16E-02	2.86E-02	1.23E-03	4.00E-05	5.18E-05	1.58E-04	1.50E-03
	4	5.37E-03	4.70E-02	5.46E-03	5.88E-03	1.11E-03	6.12E-05	5.64E-05	2.47E-04	1.11E-03
RC3	1	9.38E-01	4.70E-01	4.58E-01	4.19E-01	4.22E-02	2.71E-01	1.49E-03	6.33E-03	1.02E-01
	2	4.74E-02	8.37E-03	6.51E-03	6.41E-03	1.77E-03	4.94E-03	6.60E-05	8.66E-05	3.49E-03
	3	1.45E-03	1.03E-03	1.11E-03	2.84E-03	4.37E-04	1.84E-04	6.37E-06	6.00E-05	2.24E-04
	4	5.54E-04	2.46E-04	1.80E-05	1.49E-03	5.37E-05	0.00E+00	2.33E-07	2.75E-06	2.42E-05
RC4	1	9.98E-01	3.79E-02	3.29E-02	4.88E-02	4.53E-03	2.38E-02	1.21E-04	3.67E-04	2.29E-02
	2	1.56E-03	1.66E-02	8.59E-03	3.77E-03	3.05E-04	2.79E-03	6.78E-07	3.49E-06	5.64E-04
	3	2.72E-04	7.50E-03	3.40E-03	7.78E-03	1.32E-03	1.08E-05	1.51E-05	4.73E-04	4.69E-04
	4	1.04E-04	6.34E-03	1.11E-03	2.78E-03	1.51E-06	0.00E+00	3.05E-08	9.57E-07	9.97E-07
RC5	1	9.28E-01	2.72E-03	1.06E-03	6.42E-03	8.05E-05	9.95E-05	2.99E-05	1.87E-05	6.61E-05
	2	3.53E-02	2.23E-02	4.21E-03	2.53E-03	1.45E-06	1.92E-06	5.29E-07	3.42E-07	1.60E-06
	3	1.83E-02	6.02E-02	8.03E-03	3.11E-03	5.15E-07	1.70E-06	5.69E-08	4.62E-08	1.30E-06
	4	6.47E-03	5.72E-02	6.42E-03	4.56E-03	1.64E-06	9.22E-07	2.10E-09	1.29E-08	3.67E-06
RC6	1	1.24E-04	1.68E-06	1.66E-06	1.30E-06	1.55E-07	6.31E-07	3.19E-09	5.31E-09	2.44E-07
	2	6.54E-04	1.46E-09	0.00E+00	6.96E-09	1.79E-08	6.46E-09	2.88E-10	2.76E-10	2.45E-08
	3	6.90E-04	1.86E-09	0.00E+00	5.08E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	4	6.45E-04	0.00E+00	0.00E+00	8.88E-11	6.46E-11	4.43E-11	4.55E-13	1.23E-12	6.38E-11

Table 7.2-5 (Sheet 4 of 4)
Source Release Fractions

U.S. EPR

Release Category	Plume No.	Group No. 1	Group No. 2	Group No. 3	Group No. 4	Group No. 5	Group No. 6	Group No. 7	Group No. 8	Group No. 9
RC101	1	1.90E-03	2.40E-05	2.00E-05	5.30E-05	8.50E-06	4.40E-05	2.80E-07	7.30E-07	2.40E-05
RC201	1	3.60E-01	1.00E-01	9.50E-02	7.60E-03	7.80E-05	1.10E-03	3.40E-06	1.70E-05	4.10E-04
RC202	1	7.90E-01	2.30E-02	1.50E-02	2.00E-02	2.40E-04	3.40E-03	1.90E-05	6.80E-05	2.40E-03
RC203	1	8.90E-01	5.30E-02	2.80E-02	1.60E-01	1.40E-04	6.80E-03	1.50E-05	2.40E-04	2.20E-03
RC204	1	9.50E-01	2.80E-02	1.60E-02	3.60E-02	1.70E-04	5.30E-03	1.40E-05	6.20E-05	3.20E-03
RC205	1	9.80E-01	5.70E-02	3.60E-02	9.30E-02	4.00E-03	9.80E-03	3.00E-04	5.30E-04	6.10E-03
RC206	1	1.90E-01	5.60E-03	5.00E-03	9.00E-03	1.20E-03	7.30E-03	5.50E-05	1.80E-04	4.20E-03
RC301	1	7.90E-01	2.30E-02	1.50E-02	2.00E-02	2.40E-04	3.40E-03	1.90E-05	6.80E-05	2.40E-03
RC302	1	8.90E-01	5.30E-02	2.80E-02	1.60E-01	1.40E-04	6.80E-03	1.50E-05	2.40E-04	2.20E-03
RC303	1	9.50E-01	2.80E-02	1.60E-02	3.60E-02	1.70E-04	5.30E-03	1.40E-05	6.20E-05	3.20E-03
RC304	1	9.80E-01	5.70E-02	3.60E-02	9.30E-02	4.00E-03	9.80E-03	3.00E-04	5.30E-04	6.10E-03
RC401	1	8.00E-01	4.60E-03	2.30E-03	3.40E-03	2.70E-03	1.50E-03	8.00E-05	3.40E-04	5.20E-03
RC402	1	9.70E-01	2.00E-02	1.00E-02	1.20E-02	3.80E-03	2.10E-03	1.10E-04	4.90E-04	7.30E-03
RC403	1	8.00E-01	4.60E-03	2.30E-03	3.40E-03	2.70E-03	1.50E-03	8.00E-05	3.40E-04	5.20E-03
RC404	1	9.70E-01	2.00E-02	1.00E-02	1.20E-02	3.80E-03	2.10E-03	1.10E-04	4.90E-04	7.30E-03
RC501	1	9.90E-01	7.70E-04	4.00E-04	1.70E-02	7.40E-06	4.40E-05	2.20E-07	7.00E-07	2.40E-05
RC502	1	9.90E-01	7.70E-04	4.00E-04	1.70E-02	7.40E-06	4.40E-05	2.20E-07	7.00E-07	2.40E-05
RC503	1	1.00E+00	4.10E-04	6.90E-05	5.10E-05	8.50E-06	4.40E-05	2.80E-07	7.30E-07	2.40E-05
RC504	1	1.00E+00	4.10E-04	6.90E-05	5.10E-05	8.50E-06	4.40E-05	2.80E-07	7.30E-07	2.40E-05
RC602	1	9.90E-01	7.70E-04	4.00E-04	1.70E-02	7.40E-06	4.40E-05	2.20E-07	7.00E-07	2.40E-05
RC701	1	1.10E-01	4.20E-03	4.40E-03	6.90E-03	6.00E-04	4.80E-03	2.20E-05	1.10E-04	2.70E-03
RC702	1	1.10E-01	8.40E-02	8.70E-02	1.40E-01	1.20E-02	9.60E-02	4.50E-04	2.20E-03	5.40E-02
RC802	1	9.80E-01	7.10E-01	6.90E-01	6.40E-01	1.30E-01	5.70E-01	3.90E-03	2.20E-02	3.80E-01

7.3 SEVERE ACCIDENT MITIGATION ALTERNATIVES

This section is not required for an ESPA.

7.4 TRANSPORTATION ACCIDENTS

This section describes the environmental impacts of postulated transportation accidents involving the shipment of radioactive materials including unirradiated fuel, irradiated (spent) fuel and radioactive waste to and from the PSEG Site and alternative sites. The evaluations in this section assume that all fuel and radioactive waste shipments are by truck.

The evaluations of transportation accidents for the new plant are based on bounding information from the PPE in Section 1.3 of the SSAR. The reactor technologies considered are the ABWR, AP1000, U.S. EPR, and US-APWR. A description of PPE development and intended use is provided in Section 1.3 of the SSAR.

The NRC evaluated the environmental effects of fuel and waste transportation for light-water-cooled reactors in WASH-1238*, Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Plants* (Reference 7.4-6), 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 provide the basis for Table S-4 in 10 CFR 51.52, *Environmental Effects of Transportations of Fuel and Waste – Table S-4,* which summarizes the environmental impacts of fuel and waste transportation to and from one LWR of 3000 to 5000 MWt (1000 to 1500 megawatt electric [MWe]). Impacts are provided for normal transport conditions 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 ER. For reactors not meeting all of the conditions in 10 CFR 51.52 paragraph (a), 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."

A comparison to the parameters in Table S-4 for each of the reactor technologies being considered, including a discussion of the acceptability of the parameters that differ from Table S-4, is provided in Subsection 5.7.2.1. 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 accidents in this section to be consistent with the Table S-4 basis.

These environmental impacts are determined using the TRAGIS (Reference 7.4-3) and RADTRAN (References 7.4-4 and 7.4-5) computer codes. The input and output streams for these codes are contained in Appendix 7A to this report.

7.4.1 RADIOLOGICAL IMPACTS

Accident risks are the product of accident frequency and the consequence of the accident. NUREG-1815, *Environmental Impact Statement for an Early Site Permit (ESP) at the Exelon ESP Site,* Appendix G, 2006, indicates that accident frequencies are likely to be lower than those used in the WASH-1238 analysis, because traffic accident, injury, and fatality rates have fallen over the past 30 years.

7.4.1.1 Transportation of Unirradiated Fuel

Consequences of accidents that are severe enough to result in a release of unirradiated fuel particles are not significantly different for advanced LWRs because the fuel form, cladding, and packaging are similar to those analyzed in WASH-1238. Consequently, the risks of accidents during transport of unirradiated fuel to advanced LWR sites are smaller than the WASH-1238 results that formed the basis for Table S-4.

7.4.1.2 Transportation of Irradiated Fuel

The detailed analyses required by 10 CFR 51.52 are performed using TRAGIS (Reference 7.4-3) and RADTRAN (References 7.4-4 and 7.4-5) computer codes. The ABWR is the bounding reactor technology from the perspective of transportation accident consequences. The ABWR specific design information is used for the irradiated fuel accident analysis.

The evaluation model assumes that irradiated fuel is shipped to the proposed Yucca Mountain repository. The impacts of the transportation of spent fuel to a possible repository in Nevada (NV) provide a reasonable estimate of the transportation risks to a monitored retrievable storage facility because of the distances involved. The distance from the PSEG Site to the proposed repository is 2780 mi. (4474 km) as determined by the TRAGIS computer code for a highway route controlled quantity (HRCQ).

State-specific accident data from Table 4 of ANL/ESD/TM-150, *State-Level Accident Rates of Surface Freight Transportation: A Reexamination*, (Reference 7.4-1) is shown in Table 7.4-1. Only the interstate data is used because the HRCQ route is mainly on Interstate roads. The DOE Federal Motor Carrier Safety Administration evaluated the data underlying the Saricks and Tompkins (Reference 7.4-1) rates, which were taken from the Motor Carrier Management Information System (Reference 7.4-7), and determined that the rates were under-reported. Therefore, the accident, injury, and fatality rates in Saricks and Tompkins were adjusted using factors derived from data provided by the University of Michigan Transportation Research Institute (UMTRI) (Reference 7.4-8). The UMTRI data indicates that accident rates for 1994 to 1996, the same data used by Saricks and Tompkins, were under-reported by about 39 percent. Injury and fatality rates were under-reported by 16 and 36 percent, respectively. As a result, the

accident, injury, and fatality rates were increased by factors of 1.64, 1.20, and 1.57, respectively, to account for the under-reporting.

Fuel shipments are summarized in Tables 5.7-5 and 5.7-6. The average annual quantity of irradiated fuel shipped is assumed to equal the average annual reload quantity, which is consistent with NUREG-1815. For the ABWR, this is 44.7 MTU of irradiated fuel per year. The initial irradiated fuel activity is decayed 5 years to account for the minimum decay period prior to shipment to the repository at Yucca Mountain, NV. The source term used for the analysis (i.e., with 5 years decay) is provided in Table 7.4-2. This source term bounds spent fuel inventories with a burnup of 55 GWt/MTU.

The radionuclides chosen are those in Table G-9 of NUREG-1815 with the addition of those in the RADTRAN 5.6 library (Table 7.4-2). In Appendix G of NUREG-1815, the NRC performed a screening analysis showing that these are the dominant nuclides.

In addition to the source term assumed above, Cobalt-60 is used to represent fuel surface contamination. Using Cobalt-60 in the model is consistent with previously performed studies that quantified fuel rod contamination levels and concluded that the maximum contribution from contamination is Cobalt-60 (Reference 7.4-2). NUREG/CR-6672, *Reexamination of Spent Fuel Shipment Risk Estimates,* 2002, estimates the maximum contamination from Cobalt-60 for PWR fuel at zero year decay is approximately 0.2 Ci/rod (7.4E+09 Bq/rod) (Reference 7.4-2). The Cobalt-60 surface contamination used corresponds to the US-APWR value of approximately 0.3 Ci/rod (1.13E+10 Bq/rod) prior to decay.

The accident severity categories and associated release fractions from Table 7.31 of NUREG/CR-6672 are used and shown in Table 7.4-3. The model severity fractions, release fractions, aerosol fractions, and respirable fractions are the conditional probabilities for specific severity categories of a postulated transportation accident. Other RADTRAN parameters used are the default values from the RADCAT 2.3 User Guide (Reference 7.4-5), and from Appendix G of NUREG-1815.

The dose impact from postulated transportation accidents involving irradiated fuel is 4.49E-06 person-rem per MTU shipped (4.49E-08 person-Sv per MTU shipped). Using the average annual reload requirements for the ABWR of 44.7 MTU, the annual population dose impact is 2.01E-04 person-rem/year (2.01E-06 person-Sv/year) from postulated transportation accidents involving irradiated fuel. These results are summarized in Table 7.4-5.

7.4.1.3 Transportation of Radioactive Waste

The detailed analyses required by 10 CFR 51.52 are performed using TRAGIS (Reference 7.4-3) and RADTRAN (References 7.4-4 and 7.4-5) computer codes.

Radwaste shipments are summarized in Tables 5.7-4 and 5.7-7. The US-APWR is the bounding reactor technology with respect to annual radwaste volume. However, the overall activity is determined, on a radionuclide basis, across the four reactor technologies. The bounding value for each radionuclide in the PPE (SSAR Table 1.3-3) is used for the radwaste accident analysis.

New Jersey is a member of the Atlantic Interstate Low Level Radioactive Waste Management Compact. The PSEG Site repository is Barnwell, South Carolina (SC). The distance from the

PSEG Site to the Barnwell repository is 689 mi. (1109 km) as determined by the TRAGIS computer code for a commercial route.

The accident severity categories and associated release fractions from Table 7.31 of NUREG/CR-6672 are used and shown in Table 7.4-3. The model severity fractions, release fractions, aerosol fractions, and respirable fractions are the conditional probabilities, given an accident occurs, for specific severity categories. Gases are not deposited and have a 0.0 m/s deposition velocity. Other RADTRAN parameters used are the default values from the RADCAT 2.3 User Guide (Reference 7.4-5), and from Appendix G of NUREG-1815.

State-specific accident data from Table 4 of ANL/ESD/TM-150 (Reference 7.4-1) are shown in Table 7.4-1. Only the interstate data are used because the commercial route is mainly on Interstate roads.

The evaluation determined that the average annual population dose impact is 1.48E-05 person-rem/year (1.48E-07 person-Sv/year) from postulated transportation accidents involving radwaste. These results are summarized in Tables 7.4-5.

7.4.2 NON-RADIOLOGICAL IMPACTS

Non-radiological impacts associated with the postulated accidents are calculated for:

- Injuries and fatalities during transportation of unirradiated fuel
- Injuries and fatalities during transportation of irradiated fuel
- Injuries and fatalities during transportation of radwaste

The non-radiological impacts from postulated accidents during transportation are evaluated using the TRAGIS code (Reference 7.4-3) to define appropriate routing and population density along the route, and the RADTRAN code (References 7.4-4 and 7.4-5) to calculate the non-radiological impacts (e.g., injuries and fatalities). The injury rate is calculated by substituting the state specific injury rates in Table 7.4-1 for the state specific fatality rates in the RADTRAN "fatalities per accident" array.

The non-radiological impacts are based on round-trip distances because the return of the empty truck is included in the evaluation. Therefore, the frequency (fatalities/reactor-yr and injuries/reactor-yr) is multiplied by two.

7.4.2.1 Transportation of Unirradiated Fuel

It is assumed that all new fuel shipments came from the fuel fabrication facility located in Richland, Washington, which is the furthest fabrication facility from the PSEG Site.

The annual unirradiated fuel shipment requirements are summarized in Table 5.7-5. A review of the unirradiated fuel shipment requirements for the reactor technologies being considered indicates that the bounding case for the number of shipments is the U.S. EPR with 7.5 shipments/yr. The non-radiological fatality rate and injury rate per shipment, per 10 reactor-years (for injuries) and per 100 reactor-years (for fatalities) are provided in Tables 7.4-6 and 7.4-7.

7.4.2.2 Transportation of Irradiated Fuel

The routing and accident parameters are the same as those used to analyze the radiological impacts of transporting irradiated fuel described in Subsection 7.4.1.2 above.

The annual irradiated fuel shipments are summarized in Table 5.7-6. The US-APWR average annual quantity of irradiated fuel shipped is assumed to equal the average annual reload quantity, consistent with NUREG-1815. A review of the annual unirradiated fuel requirements for the reactor technologies being considered indicates that the bounding case for the number of shipments is the ABWR with 44.7 MTU/yr.

Shipping cask capacity assumptions are based on current shipping cask designs. The irradiated fuel cask capacity is assumed to be 1.8 MTU (4000 lbs U) consistent with NUREG-1815. The irradiated fuel shipments are summarized in Table 5.7-6. As shown in Table 5.7-6, the bounding case for the new plant is the ABWR with 24.8 shipments/yr.

The non-radiological fatality rate and injury rate per shipment, per 10 reactor-years (for injuries) and per 100 reactor-years (for fatalities), are provided in Tables 7.4-6 and 7.4-7.

7.4.2.3 Transportation of Radioactive Waste

The routing and accident parameters are the same as those used to analyze the radiological impacts of transporting radioactive waste described in Subsection 7.4.1.3 above.

For the purposes of this evaluation, each radwaste container is assumed to be shipped separately, (i.e., one container per truck.) The total number of radwaste containers is determined by assuming that dry active waste is shipped in a Sea-Land container with an internal useable volume of 28.32 cubic meters (m^3) (1000 cubic feet [ft^3]). 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 radwaste shipment requirements are summarized in Table 5.7-7.

The radioactive waste shipments are summarized in Table 5.7-7. A review of the annual radwaste requirements for the technologies being considered indicates that the bounding case is the U.S. APWR with 21.8 shipments/yr.

The non-radiological injury rate and fatality rate per shipment, per 10 reactor-years (for injuries) and per 100 reactor-years (for fatalities), are provided in Tables 7.4-6 and 7.4-7.

7.4.2.4 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 normalized number of shipments in Table 5.7-13 is used to determine the environmental impacts due to transportation accidents. Table 7.4-9 and Table 7.4-10 indicate the fatal and non-fatal injury consequences, respectively, for unirradiated fuel, irradiated fuel, and radwaste shipments. Table 7.4-11 summarizes the environmental impacts from transportation accidents for the new plant bounding values based on the normalized number of shipments.

7.4.3 SUMMARY AND CONCLUSION

A detailed accident 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 results of the radiological accident analysis are summarized in Table 7.4-5, and the results of the non-radiological accident analysis are summarized in Tables 7.4.9 and 7.4-10. The values determined by these analyses represent the contribution of such effects to the environmental costs of licensing the reactor.

These environmental impact results of these accidents exceed the values in Table S-4 in 10 CFR 51.52(c), as shown in Table 7.4-11. Subsection 5.7.2.4 addresses key reasons that the consequences from the transportation analysis exceed Table S-4 values.

Therefore, the corresponding impacts from accidents associated with the transportation of fuel and waste, to and from the proposed new plant, are SMALL.

7.4.4 REFERENCES

7.4-1 Argonne National Laboratory, “State-Level Accident Rates of Surface Freight Transportation: A Reexamination,” ANL/ESD/TM-150, 1999.

7.4-2 Nuclear Regulatory Commission, “Re-Examination of Spent Fuel Shipment Risk Estimates,” NUREG/CR-6672, 2000.

7.4-3 Oak Ridge National Laboratory, P. Johnson, and R. Michelhaugh, “Transportation Routing Analysis Geographic Information System (TRAGIS) User’s Manual,” ORNL/NTRC-006, 2003.

7.4-4 Sandia National Laboratories, K. S. Neuhauser, F.L. Kanipe, and R. F. Weiner, “RADTRAN 5,” SAND2000-1256, 2000.

7.4-5 Sandia National Laboratories, R. Weiner, D. Osborn, G. Mills, D. Hinojosa, T. Heames, and D. Orcutt, “RADCAT 2.3 User Guide,” SAND2006-6315, 2006. (bundled with RADTRAN 5.6).

7.4-6 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.

7.4-7 MCMIS. 2009. U.S. Department of Transportation Federal Motor Carrier Safety Adminstration. *Motor Carrier Management Information System.* Accessed at http://mciscatalog.fmcsa.dot.gov/.

7.4-8 University of Michigan Transportation Research Institute (UMTRI). 2003. *Evaluation of Motor Carrier Management Information System Crash Fire, Phase One.* UMTRI 2003-6. Ann Arbor, Michigan.

Table 7.4-1
PSEG Site Model
Accident, Fatality and Injury Rates

State	Accident Rate Accident/Truck-mi. (Accident/Truck-km)	Fatality Rate Fatality/Truck-mi. (Fatality/Truck-km)	Fatality Rate Fatality /Accident[(a)]	Injury Rate Injury /Truck-mi. (Injury/Truck-km)	Injury Rate Injury/Accident[(b)]
AZ	2.12E-07 (1.32E-07)	1.51E-08 (9.40E-09)	7.12E-02	1.88E-07 (1.17E-07)	8.86E-01
DE	8.34E-07 (5.18E-07)	9.01E-09 (5.60E-09)	1.08E-02	5.5E-07 (3.42E-07)	6.60E-01
ID	4.75E-07 (2.95E-07)	6.12E-09 (3.80E-09)	1.29E-02	4.94E-07 (3.07E-07)	1.04E+00
IL	3.57E-07 (2.22E-07)	1.34E-08 (8.30E-09)	3.74E-02	2.41E-07 (1.50E-07)	6.76E-01
IN	3.62E-07 (2.25E-07)	1.08E-08 (6.70E-09)	2.98E-02	2.25E-07 (1.40E-07)	6.22E-01
IA	1.80E-07 (1.12E-07)	1.51E-08 (9.40E-09)	8.39E-02	1.38E-07 (8.60E-08)	7.68E-01
MD	8.69E-07 (5.40E-07)	1.05E-08 (6.50E-09)	1.20E-02	7.39E-07 (4.59E-07)	8.50E-01
NC	5.57E-07 (3.46E-07)	2.37E-08 (1.49E-08)	4.25E-02	5.10E-07 (3.17E-07)	9.16E-01
NE	5.13E-07 (3.19E-07)	2.20E-08 (1.37E-08)	4.29E-02	3.17E-07 (1.97E-07)	6.18E-01
NJ	9.09E-07 (5.65E-07)	1.95E-08 (1.21E-8)	2.14E-02	6.29E-07 (3.91E-07)	6.92E-01
NV	3.62E-07 (2.25E-07)	1.06E-08 (6.60E-09)	2.93E-02	2.38E-07 (1.48E-07)	6.58E-01
OH	2.64E-07 (1.64E-07)	6.28E-09 (3.90E-09)	2.38E-02	2.25E-07 (1.40E-07)	8.54E-01
OR	5.07E-07 (3.15E-07)	3.28E-08 (2.04E-08)	6.48E-02	3.65E-07 (2.27E-07)	7.21E-01
PA	8.27E-07 (5.14E-07)	2.17E-08 (1.35E-08)	2.63E-02	6.16E-07 (3.83E-07)	7.45E-01
SC	5.07E-07 (3.15E-07)	1.42E-08 (8.8E-09)	2.79E-02	3.65E-07 (2.27E-07)	7.21E-01
UT	4.67E-07 (2.90E-07)	1.92E-08 (1.19E-08)	4.10E-02	4.07E-07 (2.53E-07)	8.72E-01
VA	6.32E-07 (3.93E-07)	2.59E-08 (1.61E-08)	4.10E-02	4.99E-07 (3.10E-07)	7.89E-01
WA	4.26E-07 (2.65E-07)	2.70E-08 (1.68E-08)	6.34E-02	2.90E-07 (1.80E-07)	6.79E-01
WV	2.77E-07 (1.72E-07)	2.90E-09 (1.80E-09)	1.05E-02	1.80E-07 (1.12E-07)	6.51E-01
WY	1.08E-06 (6.74E-07)	1.74E-08 (1.08E-08)	1.60E-02	5.20E-07 (3.23E-07)	4.79E-01

a) Fatality/Accident = Fatality/Truck-km / Accident/Truck-km
b) Injury/Accident = Injury/Truck-km / Accident/Truck-km

Table 7.4-2
PSEG Site Model
Irradiated Fuel Source Term

Nuclide	ABWR Inventory (Ci/MTU)	ABWR Inventory (Bq/MTU)
Am-241	1.44E+03	5.33E+13
Am-242m	3.30E+01	1.22E+12
Am-243	6.00E+01	2.22E+12
Ce-144	1.32E+04	4.88E+14
Cm-242	6.20E+01	2.29E+12
Cm-243	6.20E+01	2.29E+12
Cm-244	1.35E+04	5.00E+14
Cm-245	2.00E+00	7.40E+10
Co-60 (crud)	1.69E+02	6.25E+12
Co-60 (particulate)	3.63E+03	1.34E+14
Cs-134	7.76E+04	2.87E+15
Cs-137	1.58E+05	5.85E+15
Eu-154	1.56E+04	5.77E+14
Eu-155	8.27E+03	3.06E+14
Pm-147	3.13E+04	1.16E+15
Pu-238	1.09E+04	4.03E+14
Pu-239	4.27E+02	1.58E+13
Pu-240	8.52E+02	3.15E+13
Pu-241	1.35E+05	5.00E+15
Pu-242	3.00E+00	1.11E+11
Ru-106	2.29E+04	8.47E+14
Sb-125	7.17E+03	2.65E+14
Sr-90	1.06E+05	3.92E+15
Y-90	1.06E+05	3.92E+15
Total	7.12E+05	2.64E+16

Table 7.4-3
PSEG Site Model
Severity and Release Fractions[a]

Severity Category	Severity Fraction	Gas	Release Fractions: Cesium	Ruthenium	Particulate	Corrosion Product
0	1.53E-08	0.8	2.40E-08	6.00E-07	6.00E-07	2.00E-03
1	5.88E-05	0.14	4.10E-09	1.00E-07	1.00E-07	1.40E-03
2	1.81E-06	0.18	5.40E-09	1.30E-07	1.30E-07	1.80E-03
3	7.49E-08	0.84	3.60E-05	3.80E-06	3.80E-06	3.20E-03
4	4.65E-07	0.43	1.30E-08	3.20E-07	3.20E-07	1.80E-03
5	3.31E-09	0.49	1.50E-08	3.70E-07	3.70E-07	2.10E-03
6	0	0.85	2.70E-05	2.10E-06	2.10E-06	3.10E-03
7	1.13E-08	0.82	2.40E-08	6.10E-07	6.10E-07	2.00E-03[b]
8	8.03E-11	0.89	2.70E-08	6.70E-07	6.70E-07	2.20E-03
9	0	0.91	5.90E-06	6.80E-07	6.80E-07	2.50E-03
10	1.44E-10	0.82	2.40E-08	6.10E-07	6.10E-07	2.00E-03
11	1.02E-12	0.89	2.70E-08	6.70E-07	6.70E-07	2.20E-03
12	0	0.91	5.90E-06	6.80E-07	6.80E-07	2.50E-03
13	7.49E-11	0.84	9.60E-05	8.40E-05	1.80E-05	6.40E-03
14	0	0.85	5.50E-05	5.00E-05	9.00E-06	5.90E-03
15	0	0.91	5.90E-06	6.40E-06	6.80E-07	3.30E-03
16	0	0.91	5.90E-06	6.40E-06	6.80E-07	3.30E-03
17	5.86E-06	0.84	1.70E-05	6.70E-08	6.70E-08	2.50E-03
18	0.99993	0	0	0	0	0

a) Aerosol and Respirable Fractions set to 1.0.
b) A conservative value for the crud release fraction of 2.00E-02 was used to calculate the transportation accident risks in RADTRAN. See Appendix 7A.

Table 7.4-4 Not Used.

Table 7.4-5
PSEG Site Model
Radiological Accident Analysis Results

Environmental Impact	Unirradiated Fuel	Irradiated Fuel	Radwaste	Total
Person-rem per reactor-year (person-Sv per reactor-year)	See below	2.01E-04 (2.01E-06)	1.48E-05 (1.48E-07)	2.16E-04 (2.16E-06)

The dose from unirradiated fuel accidents is assumed to be negligible compared to the doses from Irradiated Fuel and Radioactive Waste as described in Subsection 7.4.1.1.

Table 7.4-6
PSEG Site Model
Non-Radiological Accident Analysis Results: Fatalities

	Fatalities per Shipment	Shipments per Year	Fatalities per Year[(a)]	Fatalities per 100 Years
		ABWR		
New Fuel	7.33E-05	6.1	8.94E-04	8.94E-02
Spent Fuel	7.35E-05	24.8	3.65E-03	3.65E-01
Radwaste	2.09E-05	23.7	9.91E-04	9.91E-02
Total				5.54E-01
		Single AP1000 Unit		
New Fuel	7.33E-05	3.8	5.57E-04	5.57E-02
Spent Fuel	7.35E-05	13.6	2.00E-03	2.00E-01
Radwaste	2.09E-05	7.9	3.30E-04	3.30E-02
Total				2.89E-01
		U.S. EPR		
New Fuel	7.33E-05	7.5	1.10E-03	1.10E-01
Spent Fuel	7.35E-05	20.8	3.06E-03	3.06E-01
Radwaste	2.09E-05	12.1	5.06E-04	5.06E-02
Total				4.67E-01
		US-APWR		
New Fuel	7.33E-05	5.3	7.77E-04	7.77E-02
Spent Fuel	7.35E-05	19.4	2.85E-03	2.85E-01
Radwaste	2.09E-05	21.8	9.11E-04	9.11E-02
Total				4.54E-01

a) The fatalities per year are calculated assuming a round trip for the truck

Table 7.4-7
PSEG Site Model
Non-Radiological Accident Analysis Results: Injuries

	Injuries per Shipment	Shipments per Year	Injuries per Year[(a)]	Injuries per 10 Years
ABWR				
New Fuel	1.22E-03	6.1	1.49E-02	1.49E-01
Spent Fuel	1.22E-03	24.8	6.05E-02	6.05E-01
Radwaste	4.25E-04	23.7	2.01E-02	2.01E-01
Total				9.55E-01
Single AP1000 Unit				
New Fuel	1.22E-03	3.8	9.27E-03	9.27E-02
Spent Fuel	1.22E-03	13.6	3.32E-02	3.32E-01
Radwaste	4.25E-04	7.9	6.72E-03	6.72E-02
Total				4.92E-01
U.S. EPR				
New Fuel	1.22E-03	7.5	1.83E-02	1.83E-01
Spent Fuel	1.22E-03	20.8	5.08E-02	5.08E-01
Radwaste	4.25E-04	12.1	1.03E-02	1.03E-01
Total				7.94E-01
US-APWR				
New Fuel	1.22E-03	5.3	1.29E-03	1.29E-02
Spent Fuel	1.22E-03	19.4	4.73E-02	4.73E-01
Radwaste	4.25E-04	21.8	1.85E-02	1.85E-01
Total				7.87E-01

a) The injuries per year are calculated assuming a round trip for the truck

Table 7.4-8 Not Used.

**Table 7.4-9
PSEG Site Model
Non-Radiological Accident Analysis Results for
Normalized Number of Shipments: Fatalities**

	Fatalities per Shipment	Normalized Shipments per Year	Fatalities per Year[(a)]	Fatalities per 100 Years
ABWR				
New Fuel	7.33E-05	4.3	6.30E-04	6.30E-02
Spent Fuel	7.35E-05	54.5	8.01E-03	8.01E-01
Radwaste	2.09E-05	15.5	6.48E-04	6.48E-02
Total				9.29E-01
Single AP1000 Unit				
New Fuel	7.33E-05	3.5	5.13E-04	5.13E-02
Spent Fuel	7.35E-05	39.0	5.73E-03	5.73E-01
Radwaste	2.09E-05	6.7	2.80E-04	2.80E-02
Total				6.52E-01
U.S. EPR				
New Fuel	7.33E-05	4.9	7.18E-04	7.18E-02
Spent Fuel	7.35E-05	42.7	6.28E-03	6.28E-01
Radwaste	2.09E-05	7.2	3.01E-04	3.01E-02
Total				7.30E-01
US-APWR				
New Fuel	7.33E-05	3.5	5.13E-04	5.13E-02
Spent Fuel	7.35E-05	39.8	5.85E-03	5.85E-01
Radwaste	2.09E-05	12.8	5.35E-04	5.35E-02
Total				6.90E-01

a) The fatalities per year are calculated assuming a round trip for the truck

Table 7.4-10
PSEG Site Model
Non-Radiological Accident Analysis Results for Normalized Number of Shipments: Injuries

	Injuries per Shipment	Normalized Shipments per Year	Injuries per Year[(a)]	Injuries per 10 Years
ABWR				
New Fuel	1.22E-03	4.3	1.05E-02	1.05E-01
Spent Fuel	1.22E-03	54.5	1.33E-01	1.33E+00
Radwaste	4.25E-04	15.5	1.32E-02	1.32E-01
Total				1.57E+00
Single AP1000 Unit				
New Fuel	1.22E-03	3.5	8.54E-03	8.54E-02
Spent Fuel	1.22E-03	39.0	9.52E-02	9.52E-01
Radwaste	4.25E-04	6.7	5.70E-03	5.70E-02
Total				1.09E+00
U.S. EPR				
New Fuel	1.22E-03	4.9	1.20E-02	1.20E-01
Spent Fuel	1.22E-03	42.7	1.04E-01	1.04E+00
Radwaste	4.25E-04	7.2	6.12E-03	6.12E-02
Total				1.22E+00
US-APWR				
New Fuel	1.22E-03	3.5	8.54E-03	8.54E-02
Spent Fuel	1.22E-03	39.8	9.71E-02	9.71E-01
Radwaste	4.25E-04	12.8	1.09E-02	1.09E-01
Total				1.17E+00

a) The injuries per year are calculated assuming a round trip for the truck

Table 7.4-11
PSEG Site Model Comparison to
10 CFR 51.52 Summary Table S-4: "Accidents in Transport"
Bounding Technology Summary

Types of Effects	Environmental Risk	PSEG Site Model
	10 CFR 51.52 Table S-4	Bounding Reactor
Radiological effects	Small	
Person-rem per reactor-year		2.16E-04
(person-Sv per reactor-year)		(2.16E-06)
Common (nonradiological) causes	1 fatal injury in 100 reactor years	9.29E-01
	1 nonfatal injury in 10 reactor years	1.57E+00
	$475 property damage per reactor year	(a)

a) No attempt has been made to update the property damage value to account for inflation or other considerations such as changes in the type and value of property that could be damaged. However, because the quantified environmental risk for the PSEG Site is less than the corresponding quantified risk determined for Table S-4, the property damage per reactor year attributable to the PSEG Site is also less than that which would be shown for a Table S-4 updated for the current year.

APPENDIX 7A

TRAGIS AND RADTRAN INPUT AND OUTPUT

This appendix contains TRAGIS and RADCAT/RADTRAN input and output streams corresponding to the Irradiated Fuel Analysis, Radwaste Analysis, and New Fuel Analysis that are the basis for discussion in relevant Sections of 5.7 and 7.4.

Information pertaining to Irradiated Fuel Analysis is in Section 7A.1. This information contains the TRAGIS and RADCAT/RADTRAN input and output for one irradiated fuel shipment from the PSEG Site to Yucca Mt., NV. The nuclide inventories are for 1 MTU of irradiated fuel for the bounding technology, which, for irradiated fuel, is the ABWR.

Information pertaining to Radwaste Analysis is in Section 7A.2. This information contains the TRAGIS and RADCAT/RADTRAN input and output for one radwaste shipment from the PSEG Site to Barnwell, SC. The nuclide inventories are the total annual production for the bounding technology, which is the GE ABWR.

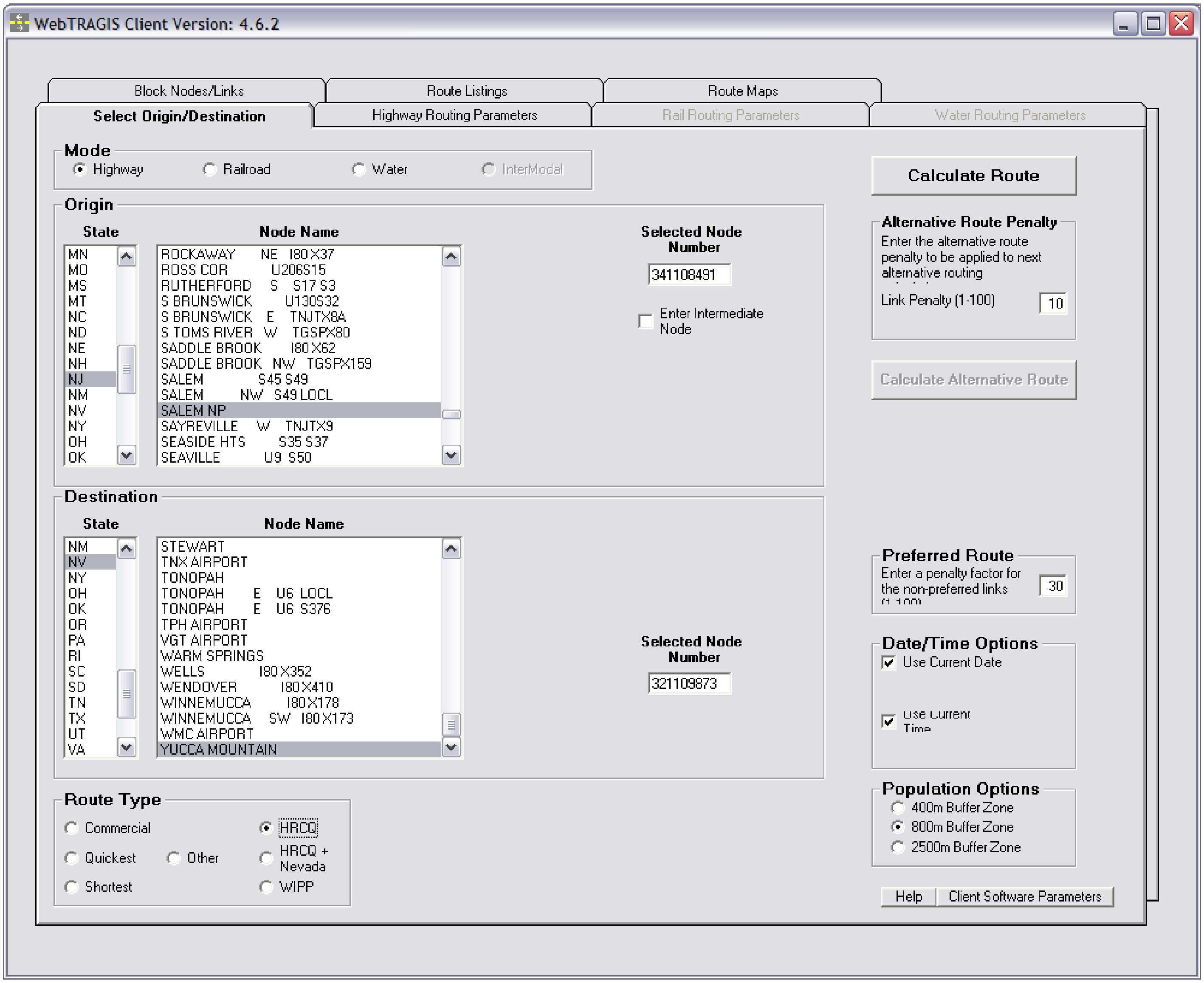
Information pertaining to New Fuel Analysis is in Section 7A.3. This information contains the TRAGIS and RADCAT/RADTRAN input and output for one new fuel shipment from Richland, WA to the PSEG Site.

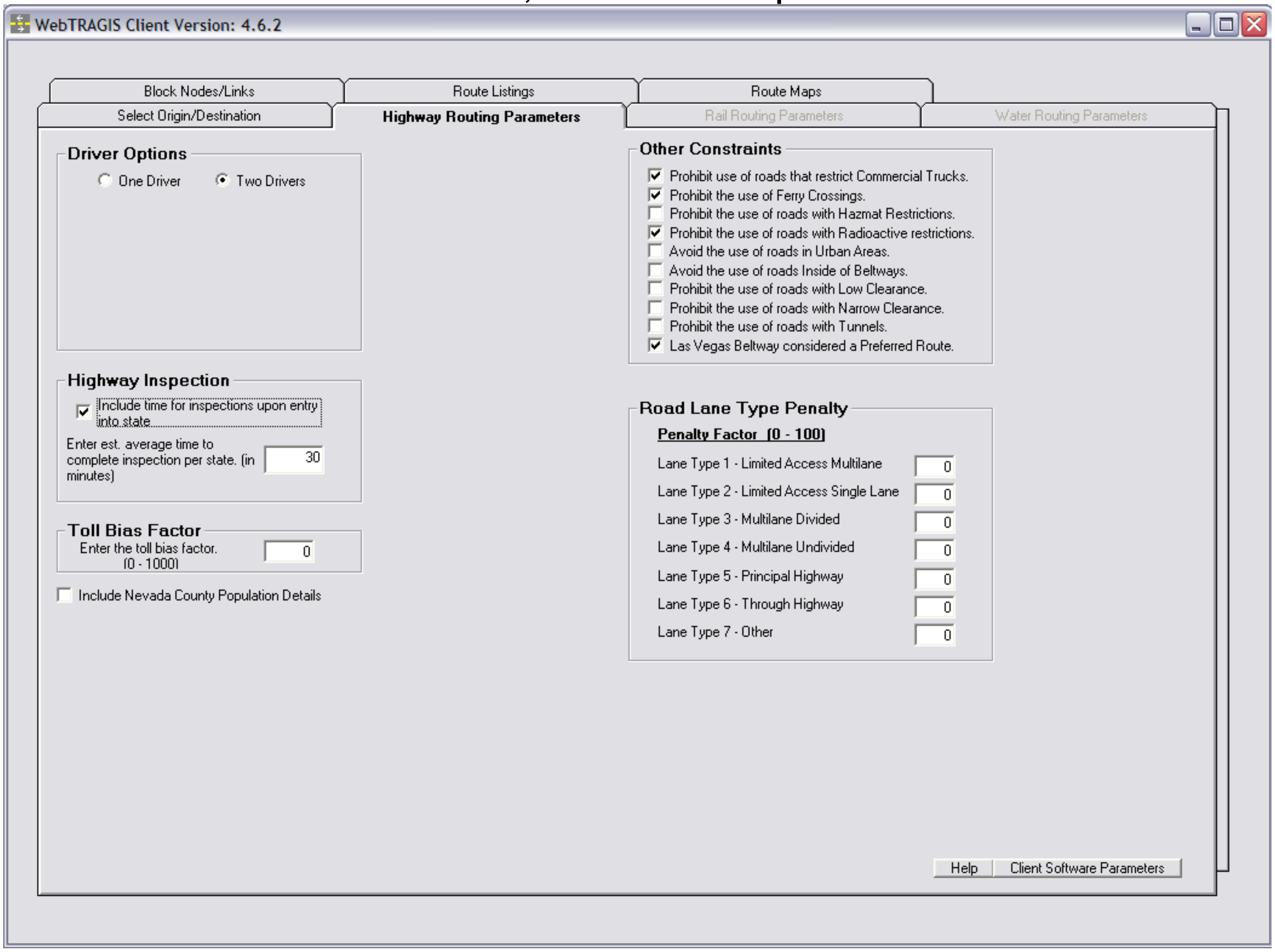
7A.1 IRRADIATED FUEL ANALYSIS

This attachment contains the TRAGIS and RADCAT/RADTRAN input and output for one irradiated fuel shipment from the PSEG Site to Yucca Mt., NV. The nuclide inventories are for 1 MTU of irradiated fuel for the bounding technology, which, for irradiated fuel, is the ABWR.

1 TRAGIS INPUT

The TRAGIS input screens are reproduced below.




WebTRAGIS Client Version: 4.6.2
Block Nodes/Links
Route Listings
Route Maps
Select Origin/Destination
Highway Routing Parameters
Rail Routing Parameters
Water Routing Parameters
Driver Options
One Driver
Two Drivers
Highway Inspection
Include time for inspections upon entry into state
Enter est. average time to complete inspection per state. (in minutes)
30
Toll Bias Factor
Enter the toll bias factor. (0 - 1000)
0
Include Nevada County Population Details
Other Constraints
Prohibit use of roads that restrict Commercial Trucks.
Prohibit the use of Ferry Crossings.
Prohibit the use of roads with Hazmat Restrictions.
Prohibit the use of roads with Radioactive restrictions.
Avoid the use of roads in Urban Areas.
Avoid the use of roads Inside of Beltways.
Prohibit the use of roads with Low Clearance.
Prohibit the use of roads with Narrow Clearance.
Prohibit the use of roads with Tunnels.
Las Vegas Beltway considered a Preferred Route.
Road Lane Type Penalty
Penalty Factor (0 - 100)
Lane Type 1 - Limited Access Multilane 0
Lane Type 2 - Limited Access Single Lane 0
Lane Type 3 - Multilane Divided 0
Lane Type 4 - Multilane Undivided 0
Lane Type 5 - Principal Highway 0
Lane Type 6 - Through Highway 0
Lane Type 7 - Other 0
Help
Client Software Parameters

2 TRAGIS OUTPUT

```
TRAGIS Routing Engine Version 1.5.4        -- Highway Data Network   4.0

FROM:    SALEM NP                     NJ         Leaving  : 06/26/09 17:15
TO  :    YUCCA MOUNTAIN               NV              Arriving : 06/28/09 20:50


Routing parameters used to calculate the route-

  Routing type: HRCQ Preferred Route with 2 driver(s)
    Preferred roads     Time bias: 1.00  Mile bias: 0.00, Toll bias: 1.00
    Nonpreferred roads  Time bias: 0.00  Mile bias: 1.00, Toll bias: 1.00, Penalty factor:
30.0

  Constraints used on route:
    Prohibit use of links prohibiting truck use
    Prohibit use of ferry crossing
    Prohibit use of roads with Radioactive materials prohibition
    Las Vegas Beltway is considered a preferred route


  Miles  Hwy Sign     City           Dir  Junction  State   Dist  Time Date     Hour
------------------------------------------------------------------------------------
    0.0               SALEM NP                      NJ       0.0 0:00 06/26/09 17:15
   12.3  LOCAL        SALEM          NW   S49 LOCL  NJ      12.3 0:24 06/26/09 17:39
    3.0  S49          PENNSVILLE     S    S49 C551  NJ      15.3 0:29 06/26/09 17:44
    4.7  C551         DEEPWATER      SE   TNJTI295  NJ      19.9 0:36 06/26/09 17:51
    0.4  I295$  TNJT$ DEEPWATER      S    I295X1    NJ      20.3 0:37 06/26/09 17:52
    0.9  I295#        crossing state border DE/NJ   BD      21.3 1:07 06/26/09 18:22
                      State Inspection took 30 minutes
    2.5  I295#        NEW CASTLE     N    I295S9    DE      23.8 1:10 06/26/09 18:25
    2.1  I295         NEWPORT        SE   I295I95   DE      25.9 1:12 06/26/09 18:27
    0.8  I95          NEWPORT        SE   I495I95   DE      26.6 1:13 06/26/09 18:28
   10.8  I495         CLAYMONT       N    I495I95   DE      37.5 1:25 06/26/09 18:40
    0.4  I95          crossing state border DE/PA   BD      37.9 1:56 06/26/09 19:11
                      State Inspection took 30 minutes
    6.6  I95          EDDYSTONE      N    I476I95   PA      44.5 2:02 06/26/09 19:17
   16.0  I476         CONSHOHOCKEN   SW   I476I76   PA      60.6 2:17 06/26/09 19:32
    5.3  I76          VALLEY FORGE   SE   I276I76   PA      65.8 2:22 06/26/09 19:37
   78.3  I76 $        HIGHSPIRE      N    I283I76   PA     144.2 3:38 06/26/09 20:53
    3.1  I283         HARRISBURG     SE   I283I83   PA     147.3 3:41 06/26/09 20:56
    4.1  I83          PENBROOK       NE   I81 I83   PA     151.3 3:45 06/26/09 21:00
                      Rest  30 minutes
   81.1  I81          DRUMS          N    I80 I81   PA     232.4 5:31 06/26/09 22:46
                      Rest  30 minutes
  254.1  I80          WEST MIDDLESEX NE   I80 X4    PA     486.4 9:56 06/27/09 03:11
    4.0  I80          crossing state border OH/PA   BD     490.5 10:30 06/27/09 03:45
                      State Inspection took 30 minutes
   17.9  I80          NORTH JACKSON  NE   I76 I80   OH     508.4 10:50 06/27/09 04:05
   76.0  I80 $        ELYRIA         NW   I80 I90   OH     584.4 12:12 06/27/09 05:27
                      Rest  30 minutes
  128.7  I80 $  I90 $ WEST JEFFERSON N    I80 X13   OH     713.1 15:03 06/27/09 08:18
   13.1  I80 $  I90 $ crossing state border IN/OH   BD     726.1 15:47 06/27/09 09:02
                      State Inspection took 30 minutes
                      Rest  30 minutes
  135.4  I80 $  I90 $ PORTAGE        W    I80 I90   IN     861.5 18:33 06/27/09 10:48
    0.5  I80          LAKE STATION   NE   I80 I94   IN     862.0 18:33 06/27/09 10:48
   14.5  I80    I94   HAMMOND        W    I80 X1    IN     876.5 18:49 06/27/09 11:04
    0.9  I80    I94   crossing state border IL/IN   BD     877.4 19:20 06/27/09 11:35
                      State Inspection took 30 minutes
    3.0  I80    I94   LANSING        W    I294I94   IL     880.3 19:23 06/27/09 11:38
    4.9  I294$  I80 $ HOMEWOOD       NW   I294I80   IL     885.3 19:28 06/27/09 11:43
                      Rest  30 minutes
```

```
  154.4  I80          RAPIDS CITY    W    I80 X1      IL   1039.7 22:47 06/27/09 15:02
    0.3  I80          crossing state border IA/IL     BD   1040.0 23:17 06/27/09 15:32
                      State Inspection took 30 minutes
                      Rest  30 minutes
  168.0  I80          DES MOINES     N    I235I35     IA   1207.9 26:23 06/27/09 18:38
   14.2  I35    I80   DES MOINES     W    I235I35     IA   1222.1 26:37 06/27/09 18:52
   95.7  I80          MINDEN         NW   I680I80     IA   1317.8 28:05 06/27/09 20:20
   16.5  I680         LOVELAND       SW   I29 I680    IA   1334.3 28:20 06/27/09 20:35
    9.7  I29    I680  CRESCENT       W    I29 I680    IA   1344.0 28:29 06/27/09 20:44
    3.0  I680         crossing state border IA/NE     BD   1347.0 29:02 06/27/09 21:17
                      State Inspection took 30 minutes
   13.4  I680         OMAHA          SW   I680I80     NE   1360.4 29:17 06/27/09 21:32
                      Rest  30 minutes
                      Rest  30 minutes
  422.7  I80          KIMBALL        S    I80 X20     NE   1783.1 35:56 06/28/09 03:11
   20.6  I80          crossing state border NE/WY     BD   1803.6 36:43 06/28/09 03:58
                      State Inspection took 30 minutes
                      Rest  30 minutes
  382.4  I80          EVANSTON       NE   I80 X18     WY   2186.0 42:19 06/28/09 09:34
   18.2  I80          crossing state border UT/WY     BD   2204.2 43:03 06/28/09 10:18
                      Rest  30 minutes
                      State Inspection took 30 minutes
   68.4  I80          HOLLADAY       N    I215I80     UT   2272.5 44:28 06/28/09 11:43
   10.2  I215         MIDVALE             I15 I215    UT   2282.8 44:37 06/28/09 11:52
                      Rest  30 minutes
  294.2  I15          SGU AIRPORT         I15 X6      UT   2577.0 49:06 06/28/09 16:21
    6.4  I15          crossing state border AZ/UT     BD   2583.4 49:41 06/28/09 16:56
                      State Inspection took 30 minutes
   20.6  I15          LITTLEFIELD         I15 X8      AZ   2604.0 49:58 06/28/09 16:13
    8.6  I15          crossing state border AZ/NV     BD   2612.7 50:35 06/28/09 16:50
                      State Inspection took 30 minutes
   73.6  I15          N LAS VEGAS    NE   I15 S215    NV   2686.2 51:35 06/28/09 17:50
                      Rest  30 minutes
   14.8  C215         LAS VEGAS      NW   U95 C215    NV   2701.0 52:04 06/28/09 18:19
   46.1  U95          MERCURY        S    U95 LOCL    NV   2747.1 53:20 06/28/09 19:35
   33.1  LOCAL        YUCCA MOUNTAIN              NV   2780.1 54:35 06/28/09 20:50

Total elapsed time: 54:35      Total trip mileage:  2780.1      Impedance:  5371.4


Mileage by State :
AZ:    29.2   DE:    16.6   IA:   307.1   IL:   162.6   IN:   151.2   NE:   456.6
NJ:    21.3   NV:   167.5   OH:   235.7   PA:   452.5   UT:   379.2   WY:   400.5


Mileage by Sign Type:
1-INTERSTATE: 2666.3         2-US:   46.1       3-STATE:    3.0      5-COUNTY:   19.4
     6-LOCAL:   45.3

Mileage by Lane Type:
  1-Multi-Lane Controlled Access:  2666.3       3-Multi-Lane Divided Highway:    60.9
                5-Principle Road:     3.0                            7-Other:    50.0


Mileage by Tribal Lands:
  Total Outside Tribal Lands     :  2766.2
  Total Inside Tribal Lands      :    13.9

Las Vegas Colony                    :  2.8   Moapa River Reservation            :  9.2
Paiute (UT) Reservation             :  1.9


TRAGIS Routing Engine Version 1.5.4        --   2000 Census Data
```

POPULATION DENSITY within 800 meter Buffer Zone:
FROM: SALEM NP NJ
TO : YUCCA MOUNTAIN NV

ST	MILES	0	>0.0 -22.7	22.7 -59.7	59.7 -139	139 -326	326 -821	821 -1861	1861 -3326	3326 -5815	5815 -9996	>9996
AZ	29.2	16.37	10.91	1.52	0.26	0.13	0.07	0.00	0.00	0.00	0.00	0.00
DE	16.6	3.25	0.34	0.47	0.65	1.61	2.37	2.24	2.42	1.83	0.99	0.45
IL	162.6	19.10	37.80	30.07	23.86	18.01	12.57	9.39	5.42	3.67	2.24	0.40
IN	151.2	1.73	19.97	37.40	25.85	28.69	17.16	8.92	5.71	3.55	1.89	0.41
IA	307.1	26.27	73.66	93.61	51.14	25.99	18.72	10.70	3.86	2.30	0.64	0.20
NE	456.6	167.07	80.87	107.72	49.64	24.69	10.77	7.27	4.24	2.75	1.02	0.59
NV	167.5	108.64	21.16	17.66	9.52	3.96	3.65	1.23	0.77	0.53	0.40	0.00
NJ	21.3	4.37	3.43	2.66	2.36	1.85	3.25	1.70	0.99	0.55	0.14	0.00
OH	235.7	5.72	33.46	51.22	42.02	37.15	29.12	17.51	10.25	6.65	1.89	0.68
PA	452.5	33.02	76.68	87.18	81.49	62.74	51.70	31.14	14.78	8.20	4.10	1.47
UT	379.2	118.00	70.04	66.60	38.43	23.87	17.36	14.41	10.53	10.42	8.06	1.52
WY	400.5	207.08	105.56	52.54	12.14	6.48	6.02	4.33	4.26	1.86	0.22	0.06
TOTALS	2780.1	710.62	533.88	548.65	337.36	235.17	172.76	108.84	63.23	42.31	21.59	5.78
PERCENTAGES		25.56	19.20	19.73	12.13	8.46	6.21	3.91	2.27	1.52	0.78	0.21

BASIS: 2000 Census data

RADTRAN Input Data	RURAL	SUBURBAN	URBAN	
WEIGHTED POPULATION				
People/sq. mi.	29.8	799.5	6137.2	
People/sq. km.	11.5	308.7	2369.6	
DISTANCE				TOTALS
Miles	2130.5	580.0	69.7	2780.1
Kilometers	3428.6	933.4	112.1	4474.1
Percentages	76.6	20.9	2.5	
BASIS (people/sq mi.)	<139	139-3326	>3326	

Population within 800 meter Buffer Zone by State:
AZ 245 DE 28510 IL 72678 IN 79041 IA 60053 NE 59486 NV 12582 NJ 8552
OH 123201 PA 189259 UT 159594 WY 32573

Total Population within 800 meter Buffer Zone: 825774

3 TRAGIS GENERATED INPUT FOR RADTRAN

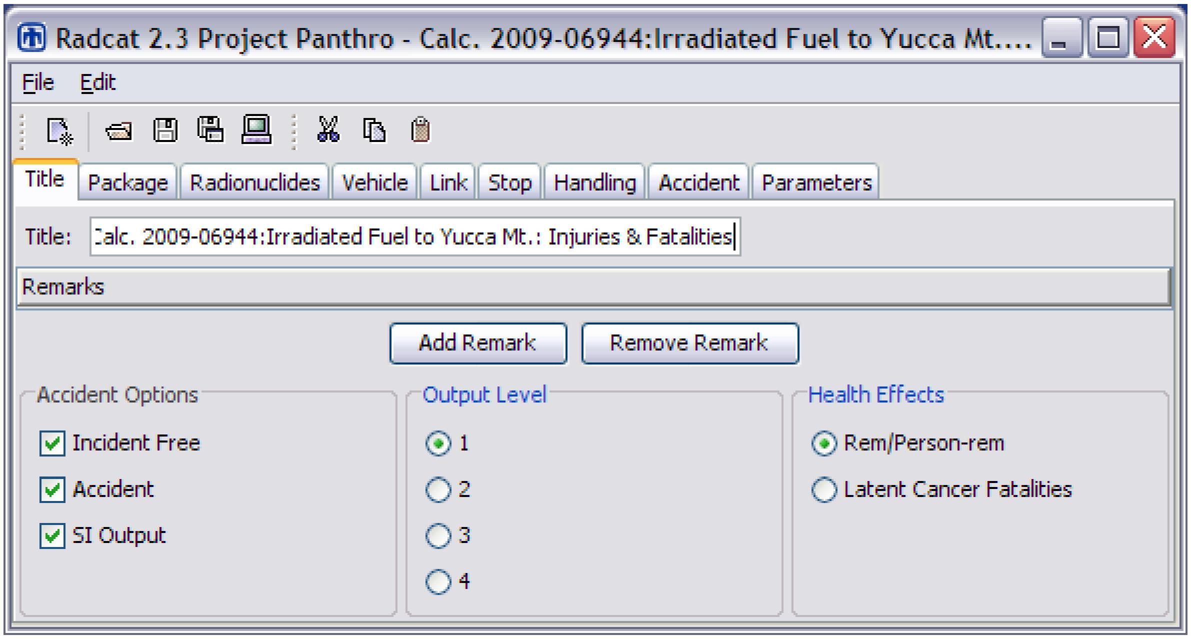
```
[TRAGIS]
TRAGIS Version=1.5.4
Mode=H
Network Version=4.0
Census Data=2000
Buffer Zone=800
[ROUTEINFO]
From CITY=SALEM NP
From STATE=NJ
From SUBNET=
To CITY=YUCCA MOUNTAIN
To STATE=NV
To SUBNET=
[AZ]
Rural - KM=  46.8
Suburban - KM=   0.3
Urban - KM=   0.0
Total - KM=  47.1
Rural Pop Density=   3.2
Suburban Pop Density= 135.8
Urban Pop Density=   0.0
[DE]
Rural - KM=   7.6
Suburban - KM=  13.9
Urban - KM=   5.3
Total - KM=  26.8
Rural Pop Density=   7.3
Suburban Pop Density= 492.2
Urban Pop Density=2496.1
[IL]
Rural - KM= 178.4
Suburban - KM=  73.0
Urban - KM=  10.2
Total - KM= 261.7
Rural Pop Density=  14.4
Suburban Pop Density= 323.6
Urban Pop Density=2379.1
[IN]
Rural - KM= 136.7
Suburban - KM=  97.3
Urban - KM=   9.4
Total - KM= 243.4
Rural Pop Density=  19.9
Suburban Pop Density= 276.3
Urban Pop Density=2354.7
[IA]
Rural - KM= 393.8
Suburban - KM=  95.4
Urban - KM=   5.1
Total - KM= 494.1
Rural Pop Density=  15.7
Suburban Pop Density= 268.0
Urban Pop Density=2185.2
[NE]
Rural - KM= 652.2
Suburban - KM=  75.6
```

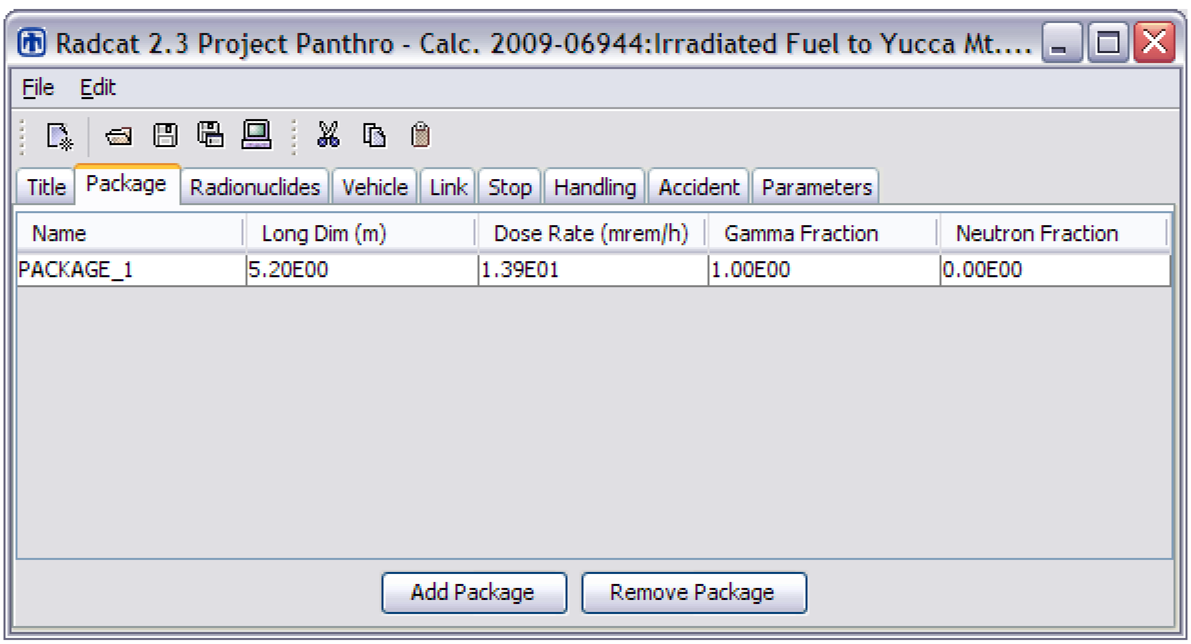
```
Urban - KM=   7.0
Total - KM= 734.8
Rural Pop Density=  10.0
Suburban Pop Density= 268.5
Urban Pop Density=2401.8
[NV]
Rural - KM= 252.6
Suburban - KM=  15.5
Urban - KM=   1.5
Total - KM= 269.5
Rural Pop Density=   4.8
Suburban Pop Density= 267.6
Urban Pop Density=2318.5
[NJ]
Rural - KM=  20.6
Suburban - KM=  12.5
Urban - KM=   1.1
Total - KM=  34.3
Rural Pop Density=  11.8
Suburban Pop Density= 353.9
Urban Pop Density=2025.9
[OH]
Rural - KM= 213.1
Suburban - KM= 151.3
Urban - KM=  14.8
Total - KM= 379.3
Rural Pop Density=  19.7
Suburban Pop Density= 309.6
Urban Pop Density=2211.7
[PA]
Rural - KM= 448.0
Suburban - KM= 258.1
Urban - KM=  22.2
Total - KM= 728.3
Rural Pop Density=  17.7
Suburban Pop Density= 299.3
Urban Pop Density=2413.1
[UT]
Rural - KM= 471.6
Suburban - KM= 106.5
Urban - KM=  32.2
Total - KM= 610.3
Rural Pop Density=   9.9
Suburban Pop Density= 362.6
Urban Pop Density=2472.3
[WY]
Rural - KM= 607.2
Suburban - KM=  33.9
Urban - KM=   3.4
Total - KM= 644.6
Rural Pop Density=   4.9
Suburban Pop Density= 399.4
Urban Pop Density=1966.6
[Total]
Rural - KM=3428.6
Suburban - KM= 933.4
Urban - KM= 112.1
```

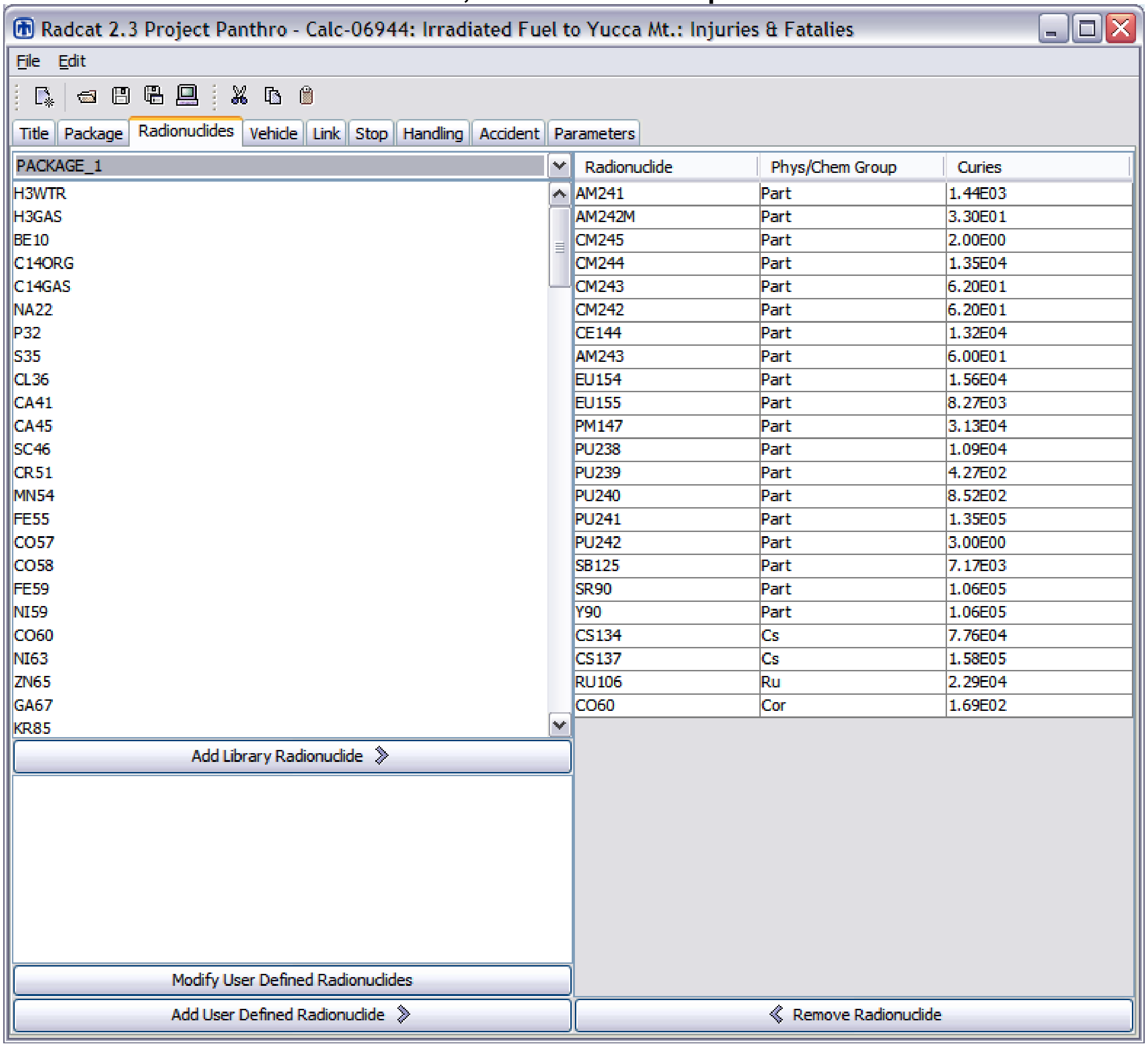
```
Total - KM=4474.1
Rural Pop Density=  11.5
Suburban Pop Density= 308.7
Urban Pop Density=2369.6
```

4 RADTRAN INPUT

The RADTRAN/RADCAT input screens are reproduced below.







Radionuclide	Phys/Chem Group	Curies
AM241	Part	1.44E03
AM242M	Part	3.30E01
CM245	Part	2.00E00
CM244	Part	1.35E04
CM243	Part	6.20E01
CM242	Part	6.20E01
CE144	Part	1.32E04
AM243	Part	6.00E01
EU154	Part	1.56E04
EU155	Part	8.27E03
PM147	Part	3.13E04
PU238	Part	1.09E04
PU239	Part	4.27E02
PU240	Part	8.52E02
PU241	Part	1.35E05
PU242	Part	3.00E00
SB125	Part	7.17E03
SR90	Part	1.06E05
Y90	Part	1.06E05
CS134	Cs	7.76E04
CS137	Cs	1.58E05
RU106	Ru	2.29E04
CO60	Cor	1.69E02

Radcat 2.3 Project Panthro - Calc. 2009-06944:Irradiated Fuel to Yucca Mt.: Fatalities

File Edit

Title | Package | Radionuclides | Vehicle | Link | Stop | Handling | Accident | Parameters

Link Name	Vehicle	Length (km)	Speed (km/h)	Population Density (persons/km²)	Vehicle Density (vehicles/hr)	Persons per Vehicle	Accident Rate (accidents/veh-km)	Fatalities per Accident	Zone	
RURAL_AZ	VEHICLE_1	4.68E01	8.89E01	3.20E00	5.30E02	1.50E00	1.32E-07	7.12E-02	Rural	F
SUBURBN_AZ	VEHICLE_1	3.00E-01	8.89E01	1.36E02	7.60E02	1.50E00	1.32E-07	7.12E-02	Suburban	F
URBAN_AZ	VEHICLE_1	0.00E00	8.89E01	0.00E00	2.40E03	1.50E00	1.32E-07	7.12E-02	Urban	F
RURAL_DE	VEHICLE_1	7.60E00	8.89E01	7.30E00	5.30E02	1.50E00	5.18E-07	1.08E-02	Rural	F
SUBURBN_DE	VEHICLE_1	1.39E01	8.89E01	4.92E02	7.60E02	1.50E00	5.18E-07	1.08E-02	Suburban	F
URBAN_DE	VEHICLE_1	5.30E00	8.89E01	2.50E03	2.40E03	1.50E00	5.18E-07	1.08E-02	Urban	F
RURAL_IL	VEHICLE_1	1.78E02	8.89E01	1.44E01	5.30E02	1.50E00	2.22E-07	3.74E-02	Rural	F
SUBURBN_IL	VEHICLE_1	7.30E01	8.89E01	3.24E02	7.60E02	1.50E00	2.22E-07	3.74E-02	Suburban	F
URBAN_IL	VEHICLE_1	1.02E01	8.89E01	2.38E03	2.40E03	1.50E00	2.22E-07	3.74E-02	Urban	F
RURAL_IN	VEHICLE_1	1.37E02	8.89E01	1.99E01	5.30E02	1.50E00	2.25E-07	2.98E-02	Rural	F
SUBURBN_IN	VEHICLE_1	9.73E01	8.89E01	2.76E02	7.60E02	1.50E00	2.25E-07	2.98E-02	Suburban	F
URBAN_IN	VEHICLE_1	9.40E00	8.89E01	2.35E03	2.40E03	1.50E00	2.25E-07	2.98E-02	Urban	F
RURAL_IA	VEHICLE_1	3.94E02	8.89E01	1.57E01	5.30E02	1.50E00	1.12E-07	8.39E-02	Rural	F
SUBURBN_IA	VEHICLE_1	9.54E01	8.89E01	2.68E02	7.60E02	1.50E00	1.12E-07	8.39E-02	Suburban	F
URBAN_IA	VEHICLE_1	5.10E00	8.89E01	2.19E03	2.40E03	1.50E00	1.12E-07	8.39E-02	Urban	F
RURAL_NE	VEHICLE_1	6.52E02	8.89E01	1.00E01	5.30E02	1.50E00	3.19E-07	4.29E-02	Rural	F
SUBURBN_NE	VEHICLE_1	7.56E01	8.89E01	2.68E02	7.60E02	1.50E00	3.19E-07	4.29E-02	Suburban	F
URBAN_NE	VEHICLE_1	7.00E00	8.89E01	2.40E03	2.40E03	1.50E00	3.19E-07	4.29E-02	Urban	F
RURAL_NV	VEHICLE_1	2.53E02	8.89E01	4.80E00	5.30E02	1.50E00	2.25E-07	2.93E-02	Rural	F
SUBURBN_NV	VEHICLE_1	1.55E01	8.89E01	2.68E02	7.60E02	1.50E00	2.25E-07	2.93E-02	Suburban	F
URBAN_NV	VEHICLE_1	1.50E00	8.89E01	2.32E03	2.40E03	1.50E00	2.25E-07	2.93E-02	Urban	F
RURAL_NJ	VEHICLE_1	2.06E01	8.89E01	1.18E01	5.30E02	1.50E00	5.65E-07	2.14E-02	Rural	F
SUBURBN_NJ	VEHICLE_1	1.25E01	8.89E01	3.54E02	7.60E02	1.50E00	5.65E-07	2.14E-02	Suburban	F
URBAN_NJ	VEHICLE_1	1.10E00	8.89E01	2.03E03	2.40E03	1.50E00	5.65E-07	2.14E-02	Urban	F
RURAL_OH	VEHICLE_1	2.13E02	8.89E01	1.97E01	5.30E02	1.50E00	1.64E-07	2.38E-02	Rural	F
SUBURBN_OH	VEHICLE_1	1.51E02	8.89E01	3.10E02	7.60E02	1.50E00	1.64E-07	2.38E-02	Suburban	F
URBAN_OH	VEHICLE_1	1.48E01	8.89E01	2.21E03	2.40E03	1.50E00	1.64E-07	2.38E-02	Urban	F
RURAL_PA	VEHICLE_1	4.48E02	8.89E01	1.77E01	5.30E02	1.50E00	5.14E-07	2.63E-02	Rural	F
SUBURBN_PA	VEHICLE_1	2.58E02	8.89E01	2.99E02	7.60E02	1.50E00	5.14E-07	2.63E-02	Suburban	F
URBAN_PA	VEHICLE_1	2.22E01	8.89E01	2.41E03	2.40E03	1.50E00	5.14E-07	2.63E-02	Urban	F
RURAL_UT	VEHICLE_1	4.72E02	8.89E01	9.90E00	5.30E02	1.50E00	2.90E-07	4.10E-02	Rural	F
SUBURBN_UT	VEHICLE_1	1.06E02	8.89E01	3.63E02	7.60E02	1.50E00	2.90E-07	4.10E-02	Suburban	F
URBAN_UT	VEHICLE_1	3.22E01	8.89E01	2.47E03	2.40E03	1.50E00	2.90E-07	4.10E-02	Urban	F
RURAL_WY	VEHICLE_1	6.07E02	8.89E01	4.90E00	5.30E02	1.50E00	6.74E-07	1.60E-02	Rural	F
SUBURBN_WY	VEHICLE_1	3.39E01	8.89E01	3.99E02	7.60E02	1.50E00	6.74E-07	1.60E-02	Suburban	F
URBAN_WY	VEHICLE_1	3.40E00	8.89E01	1.97E03	2.40E03	1.50E00	6.74E-07	1.60E-02	Urban	F

Add Link | Remove Link | Import Web Tragis

Injuries per Accident in Column Labeled “Fatalities per Accident”

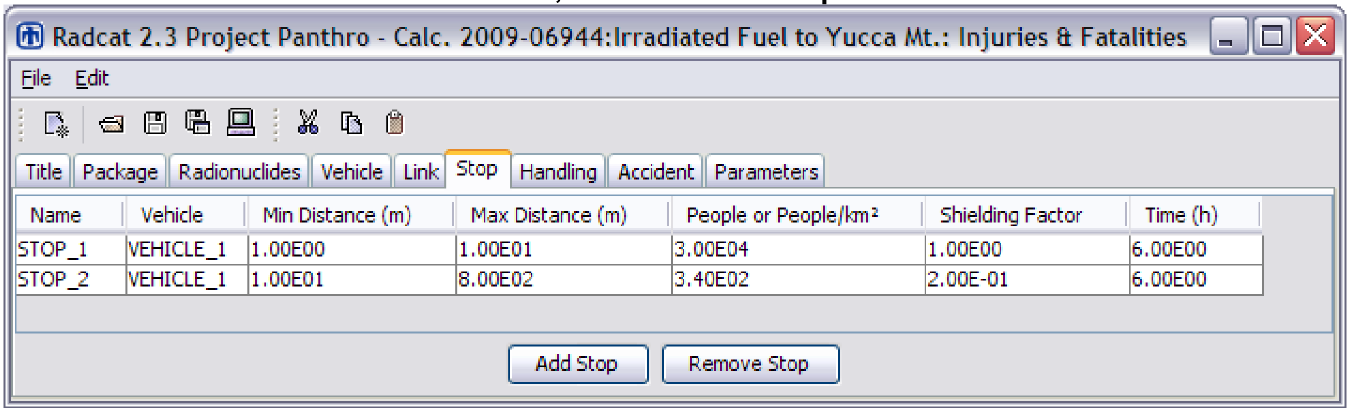
Radcat 2.3 Project Panthro - Calc. 2009-06944:Irradiated Fuel to Yucca Mt.: Injuries

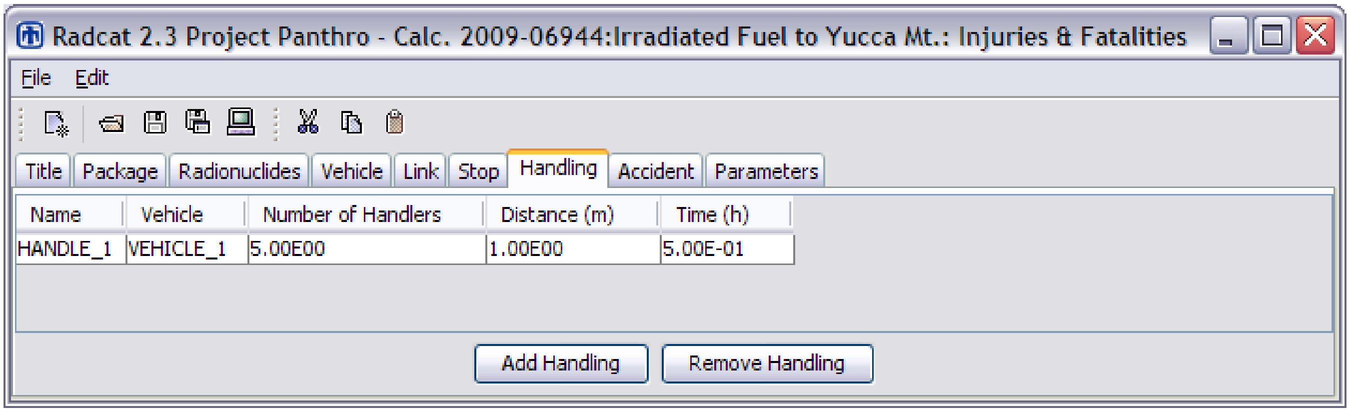
File Edit

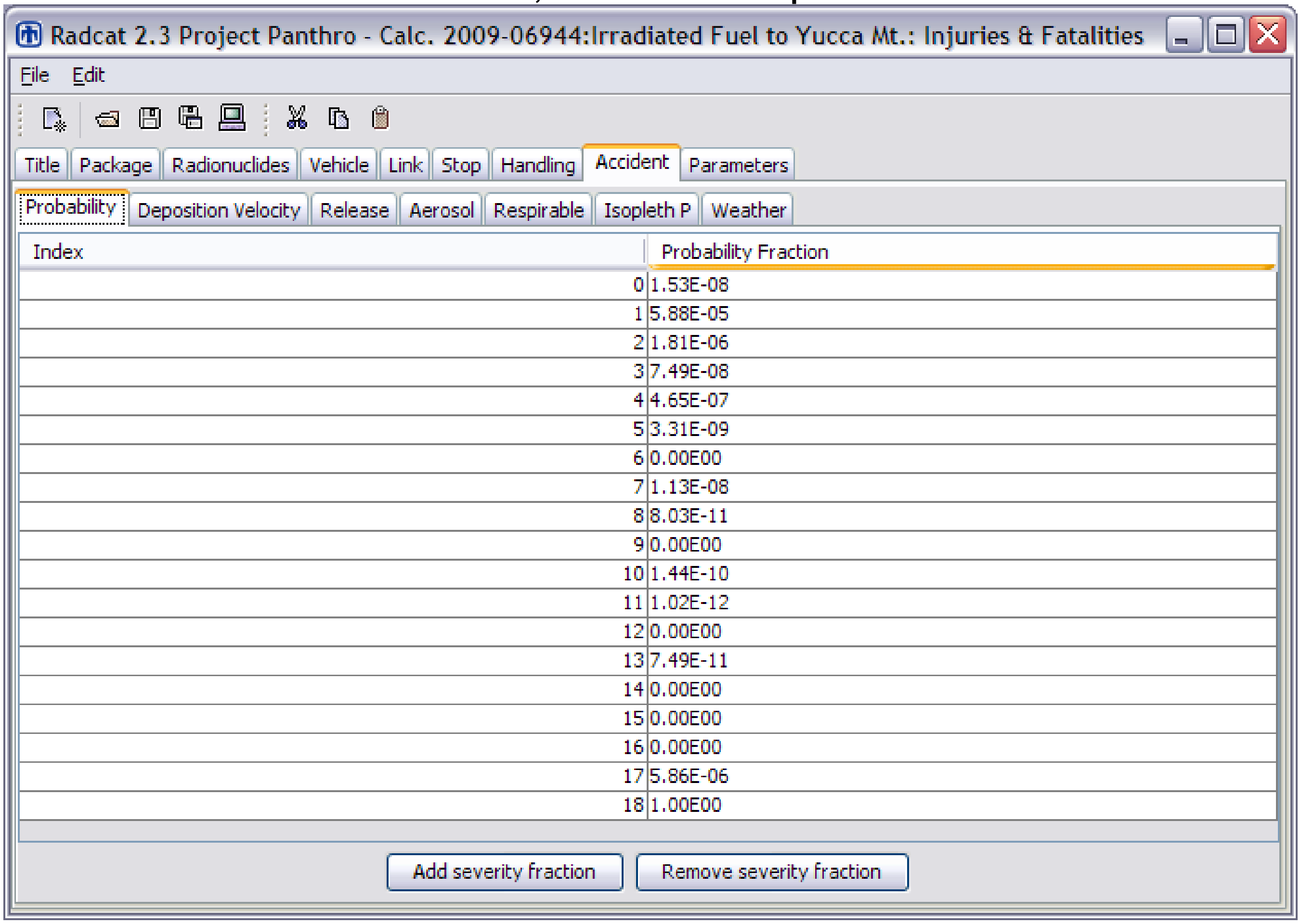
Title | Package | Radionuclides | Vehicle | Link | Stop | Handling | Accident | Parameters

Link Name	Vehicle	Length (km)	Speed (km/h)	Population Density (persons/km²)	Vehicle Density (vehicles/hr)	Persons per Vehicle	Accident Rate (accidents/veh-km)	Fatalities per Accident	Zone	
RURAL_AZ	VEHICLE_1	4.68E01	8.89E01	3.20E00	5.30E02	1.50E00	1.32E-07	8.86E-01	Rural	Primary
SUBURBN_AZ	VEHICLE_1	3.00E-01	8.89E01	1.36E02	7.60E02	1.50E00	1.32E-07	8.86E-01	Suburban	Primary
URBAN_AZ	VEHICLE_1	0.00E00	8.89E01	0.00E00	2.40E03	1.50E00	1.32E-07	8.86E-01	Urban	Primary
RURAL_DE	VEHICLE_1	7.60E00	8.89E01	7.30E00	5.30E02	1.50E00	5.18E-07	6.60E-01	Rural	Primary
SUBURBN_DE	VEHICLE_1	1.39E01	8.89E01	4.92E02	7.60E02	1.50E00	5.18E-07	6.60E-01	Suburban	Primary
URBAN_DE	VEHICLE_1	5.30E00	8.89E01	2.50E03	2.40E03	1.50E00	5.18E-07	6.60E-01	Urban	Primary
RURAL_IL	VEHICLE_1	1.78E02	8.89E01	1.44E01	5.30E02	1.50E00	2.22E-07	6.76E-01	Rural	Primary
SUBURBN_IL	VEHICLE_1	7.30E01	8.89E01	3.24E02	7.60E02	1.50E00	2.22E-07	6.76E-01	Suburban	Primary
URBAN_IL	VEHICLE_1	1.02E01	8.89E01	2.38E03	2.40E03	1.50E00	2.22E-07	6.76E-01	Urban	Primary
RURAL_IN	VEHICLE_1	1.37E02	8.89E01	1.99E01	5.30E02	1.50E00	2.25E-07	6.22E-01	Rural	Primary
SUBURBN_IN	VEHICLE_1	9.73E01	8.89E01	2.76E02	7.60E02	1.50E00	2.25E-07	6.22E-01	Suburban	Primary
URBAN_IN	VEHICLE_1	9.40E00	8.89E01	2.35E03	2.40E03	1.50E00	2.25E-07	6.22E-01	Urban	Primary
RURAL_IA	VEHICLE_1	3.94E02	8.89E01	1.57E01	5.30E02	1.50E00	1.12E-07	7.68E-01	Rural	Primary
SUBURBN_IA	VEHICLE_1	9.54E01	8.89E01	2.68E02	7.60E02	1.50E00	1.12E-07	7.68E-01	Suburban	Primary
URBAN_IA	VEHICLE_1	5.10E00	8.89E01	2.19E03	2.40E03	1.50E00	1.12E-07	7.68E-01	Urban	Primary
RURAL_NE	VEHICLE_1	6.52E02	8.89E01	1.00E01	5.30E02	1.50E00	3.19E-07	6.18E-01	Rural	Primary
SUBURBN_NE	VEHICLE_1	7.56E01	8.89E01	2.68E02	7.60E02	1.50E00	3.19E-07	6.18E-01	Suburban	Primary
URBAN_NE	VEHICLE_1	7.00E00	8.89E01	2.40E03	2.40E03	1.50E00	3.19E-07	6.18E-01	Urban	Primary
RURAL_NV	VEHICLE_1	2.53E02	8.89E01	4.80E00	5.30E02	1.50E00	2.25E-07	6.58E-01	Rural	Primary
SUBURBN_NV	VEHICLE_1	1.55E01	8.89E01	2.68E02	7.60E02	1.50E00	2.25E-07	6.58E-01	Suburban	Primary
URBAN_NV	VEHICLE_1	1.50E00	8.89E01	2.32E03	2.40E03	1.50E00	2.25E-07	6.58E-01	Urban	Primary
RURAL_NJ	VEHICLE_1	2.06E01	8.89E01	1.18E01	5.30E02	1.50E00	5.65E-07	6.92E-01	Rural	Primary
SUBURBN_NJ	VEHICLE_1	1.25E01	8.89E01	3.54E02	7.60E02	1.50E00	5.65E-07	6.92E-01	Suburban	Primary
URBAN_NJ	VEHICLE_1	1.10E00	8.89E01	2.03E03	2.40E03	1.50E00	5.65E-07	6.92E-01	Urban	Primary
RURAL_OH	VEHICLE_1	2.13E02	8.89E01	1.97E01	5.30E02	1.50E00	1.64E-07	8.54E-01	Rural	Primary
SUBURBN_OH	VEHICLE_1	1.51E02	8.89E01	3.10E02	7.60E02	1.50E00	1.64E-07	8.54E-01	Suburban	Primary
URBAN_OH	VEHICLE_1	1.48E01	8.89E01	2.21E03	2.40E03	1.50E00	1.64E-07	8.54E-01	Urban	Primary
RURAL_PA	VEHICLE_1	4.48E02	8.89E01	1.77E01	5.30E02	1.50E00	5.14E-07	7.45E-01	Rural	Primary
SUBURBN_PA	VEHICLE_1	2.58E02	8.89E01	2.99E02	7.60E02	1.50E00	5.14E-07	7.45E-01	Suburban	Primary
URBAN_PA	VEHICLE_1	2.22E01	8.89E01	2.41E03	2.40E03	1.50E00	5.14E-07	7.45E-01	Urban	Primary
RURAL_UT	VEHICLE_1	4.72E02	8.89E01	9.90E00	5.30E02	1.50E00	2.90E-07	8.72E-01	Rural	Primary
SUBURBN_UT	VEHICLE_1	1.06E02	8.89E01	3.63E02	7.60E02	1.50E00	2.90E-07	8.72E-01	Suburban	Primary
URBAN_UT	VEHICLE_1	3.22E01	8.89E01	2.47E03	2.40E03	1.50E00	2.90E-07	8.72E-01	Urban	Primary
RURAL_WY	VEHICLE_1	6.07E02	8.89E01	4.90E00	5.30E02	1.50E00	6.74E-07	4.79E-01	Rural	Primary
SUBURBN_WY	VEHICLE_1	3.39E01	8.89E01	3.99E02	7.60E02	1.50E00	6.74E-07	4.79E-01	Suburban	Primary
URBAN_WY	VEHICLE_1	3.40E00	8.89E01	1.97E03	2.40E03	1.50E00	6.74E-07	4.79E-01	Urban	Primary

Add Link | Remove Link | Import Web Tragis


Radcat 2.3 Project Panthro - Calc. 2009-06944:Irradiated Fuel to Yucca Mt.: Injuries & Fatalities
File Edit
Title Package Radionuclides Vehicle Link Stop Handling Accident Parameters
Name Vehicle Min Distance (m) Max Distance (m) People or People/km² Shielding Factor Time (h)
STOP_1 VEHICLE_1 1.00E00 1.00E01 3.00E04 1.00E00 6.00E00
STOP_2 VEHICLE_1 1.00E01 8.00E02 3.40E02 2.00E-01 6.00E00
Add Stop
Remove Stop


Radcat 2.3 Project Panthro - Calc. 2009-06944:Irradiated Fuel to Yucca Mt.: Injuries & Fatalities
File Edit
Title Package Radionuclides Vehicle Link Stop Handling Accident Parameters
Name Vehicle Number of Handlers Distance (m) Time (h)
HANDLE_1 VEHICLE_1 5.00E00 1.00E00 5.00E-01
Add Handling
Remove Handling



Radcat 2.3 Project Panthro - Calc. 2009-06944:Irradiated Fuel to Yucca Mt.: Injuries & Fatalities

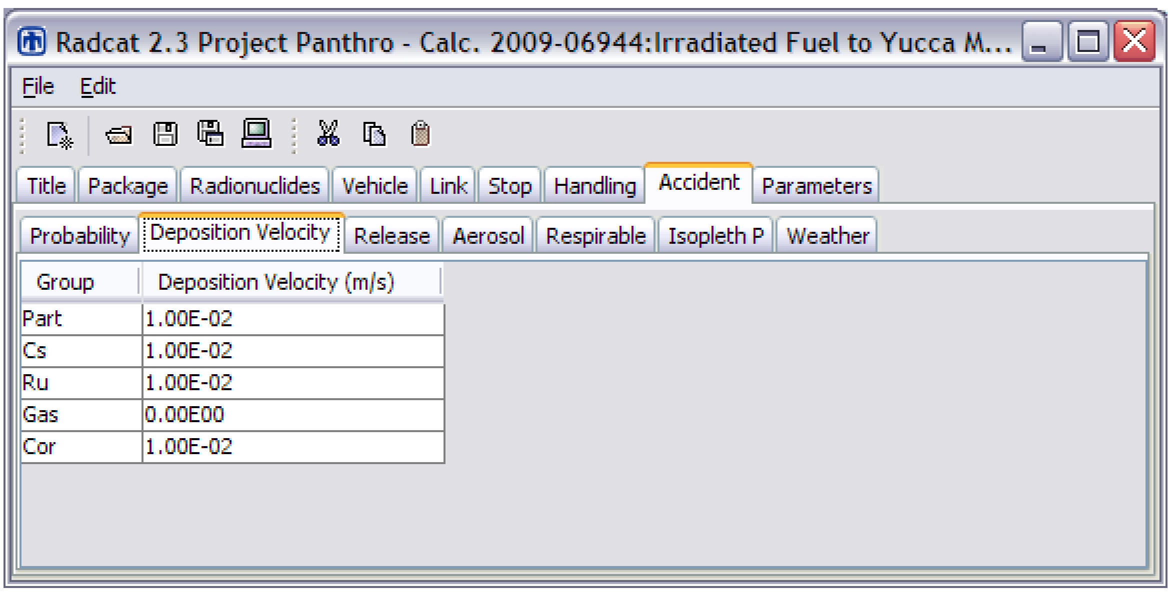
File Edit

Title | Package | Radionuclides | Vehicle | Link | Stop | Handling | Accident | Parameters

Probability | Deposition Velocity | Release | Aerosol | Respirable | Isopleth P | Weather

Index	Probability Fraction
0	1.53E-08
1	5.88E-05
2	1.81E-06
3	7.49E-08
4	4.65E-07
5	3.31E-09
6	0.00E00
7	1.13E-08
8	8.03E-11
9	0.00E00
10	1.44E-10
11	1.02E-12
12	0.00E00
13	7.49E-11
14	0.00E00
15	0.00E00
16	0.00E00
17	5.86E-06
18	1.00E00

Add severity fraction | Remove severity fraction



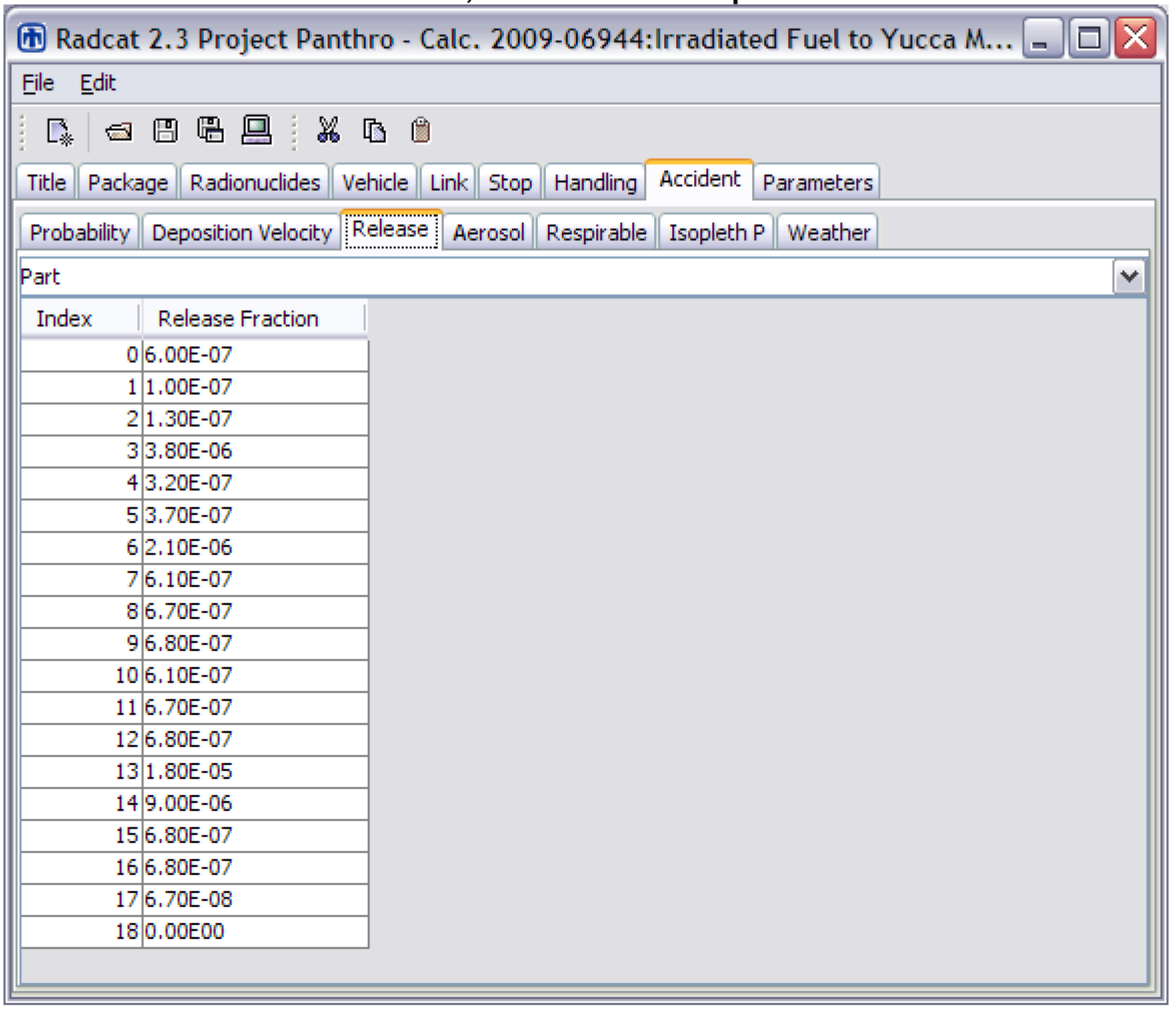
Radcat 2.3 Project Panthro - Calc. 2009-06944:Irradiated Fuel to Yucca M...

File Edit

Title | Package | Radionuclides | Vehicle | Link | Stop | Handling | Accident | Parameters

Probability | Deposition Velocity | Release | Aerosol | Respirable | Isopleth P | Weather

Group	Deposition Velocity (m/s)
Part	1.00E-02
Cs	1.00E-02
Ru	1.00E-02
Gas	0.00E00
Cor	1.00E-02



Radcat 2.3 Project Panthro - Calc. 2009-06944:Irradiated Fuel to Yucca M...

File Edit

Title | Package | Radionuclides | Vehicle | Link | Stop | Handling | Accident | Parameters

Probability | Deposition Velocity | Release | Aerosol | Respirable | Isopleth P | Weather

Part

Index	Release Fraction
0	6.00E-07
1	1.00E-07
2	1.30E-07
3	3.80E-06
4	3.20E-07
5	3.70E-07
6	2.10E-06
7	6.10E-07
8	6.70E-07
9	6.80E-07
10	6.10E-07
11	6.70E-07
12	6.80E-07
13	1.80E-05
14	9.00E-06
15	6.80E-07
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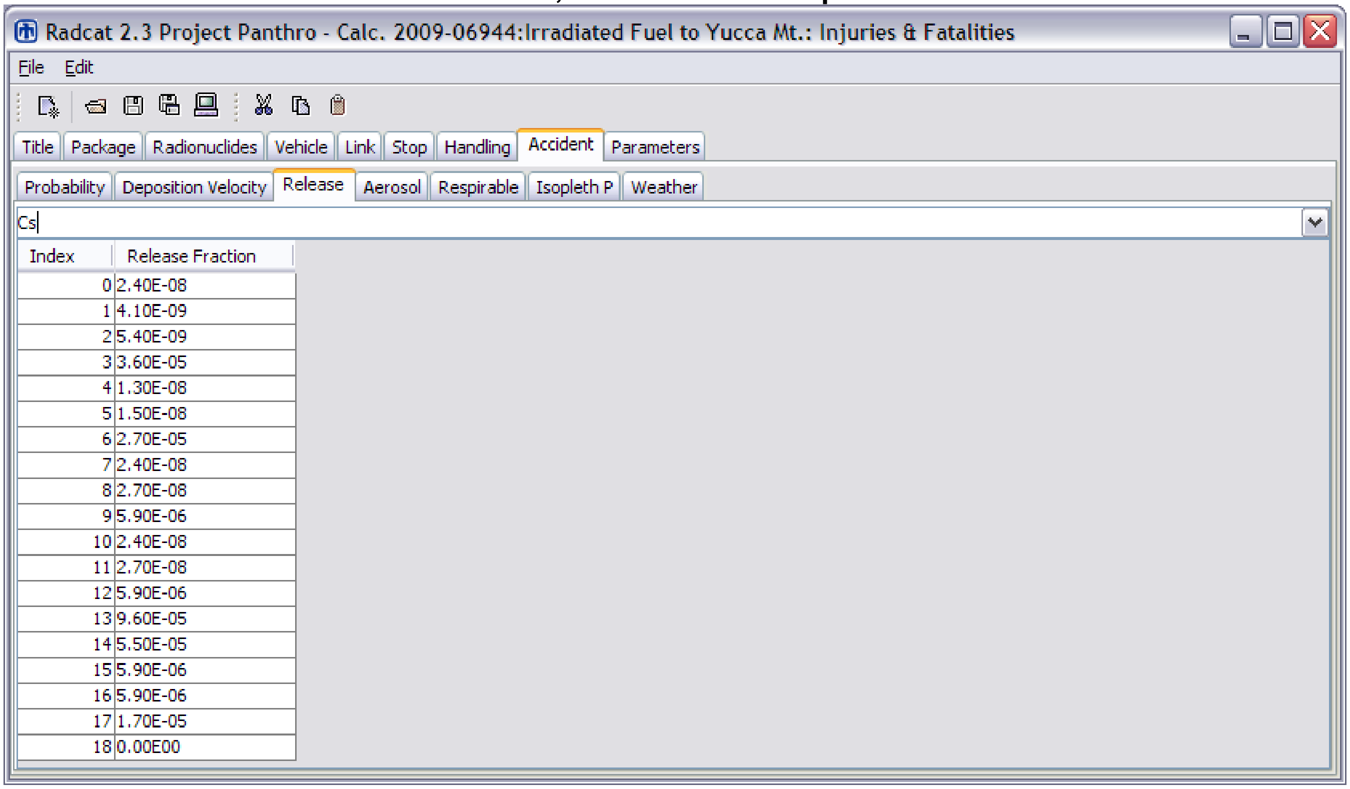
17	6.70E-08
18	0.00E00


Radcat 2.3 Project Panthro - Calc. 2009-06944:Irradiated Fuel to Yucca Mt.: Injuries & Fatalities
File Edit
Title Package Radionuclides Vehicle Link Stop Handling Accident Parameters
Probability Deposition Velocity Release Aerosol Respirable Isopleth P Weather
Cs
Index Release Fraction
0 2.40E-08
1 4.10E-09
2 5.40E-09
3 3.60E-05
4 1.30E-08
5 1.50E-08
6 2.70E-05
7 2.40E-08
8 2.70E-08
9 5.90E-06
10 2.40E-08
11 2.70E-08
12 5.90E-06
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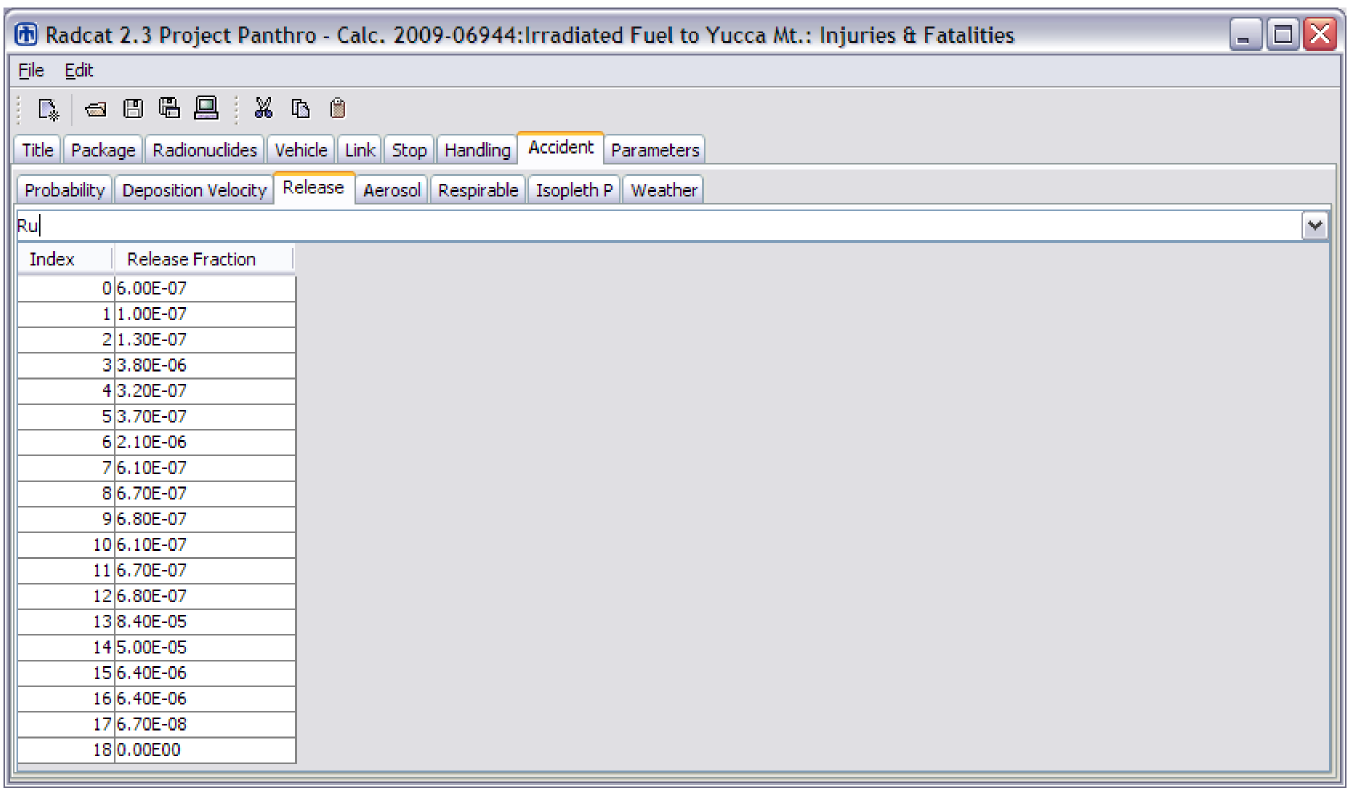
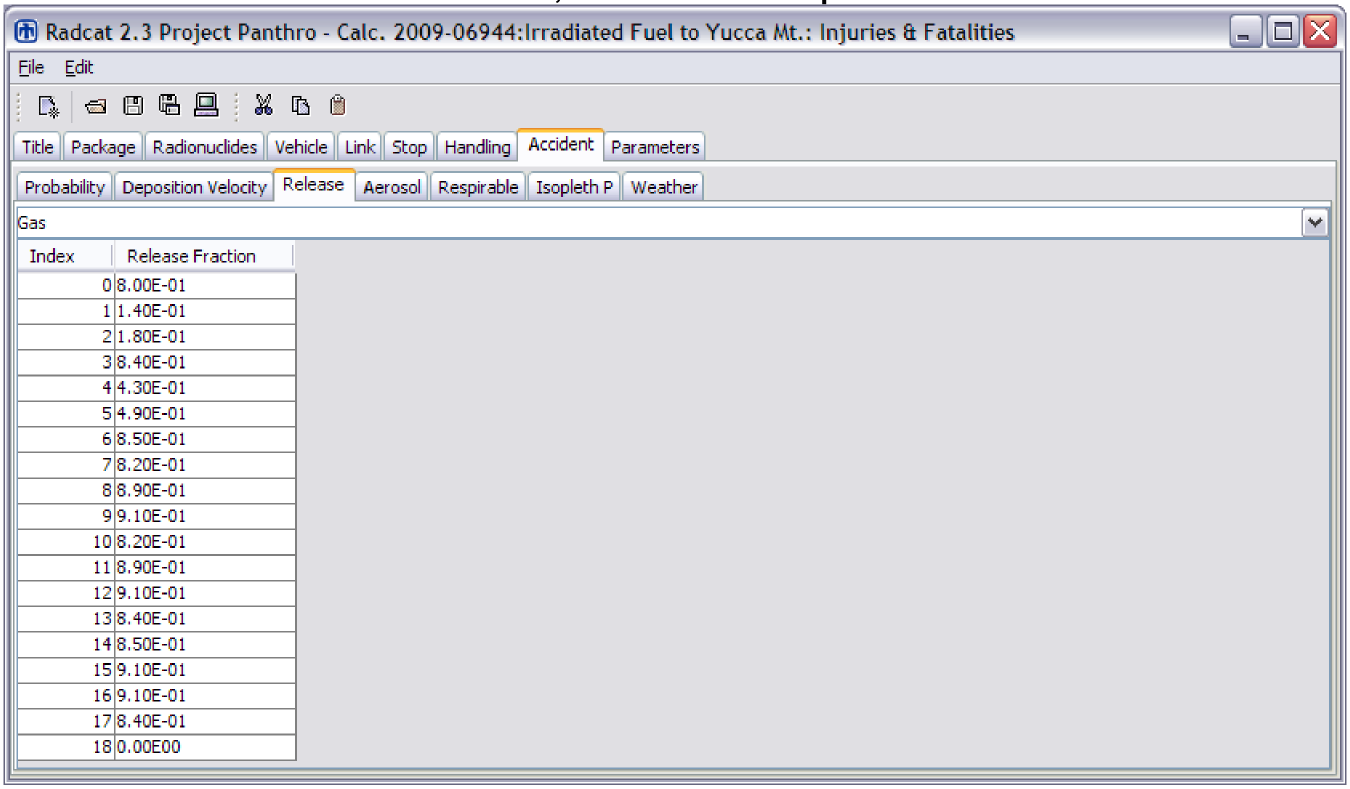
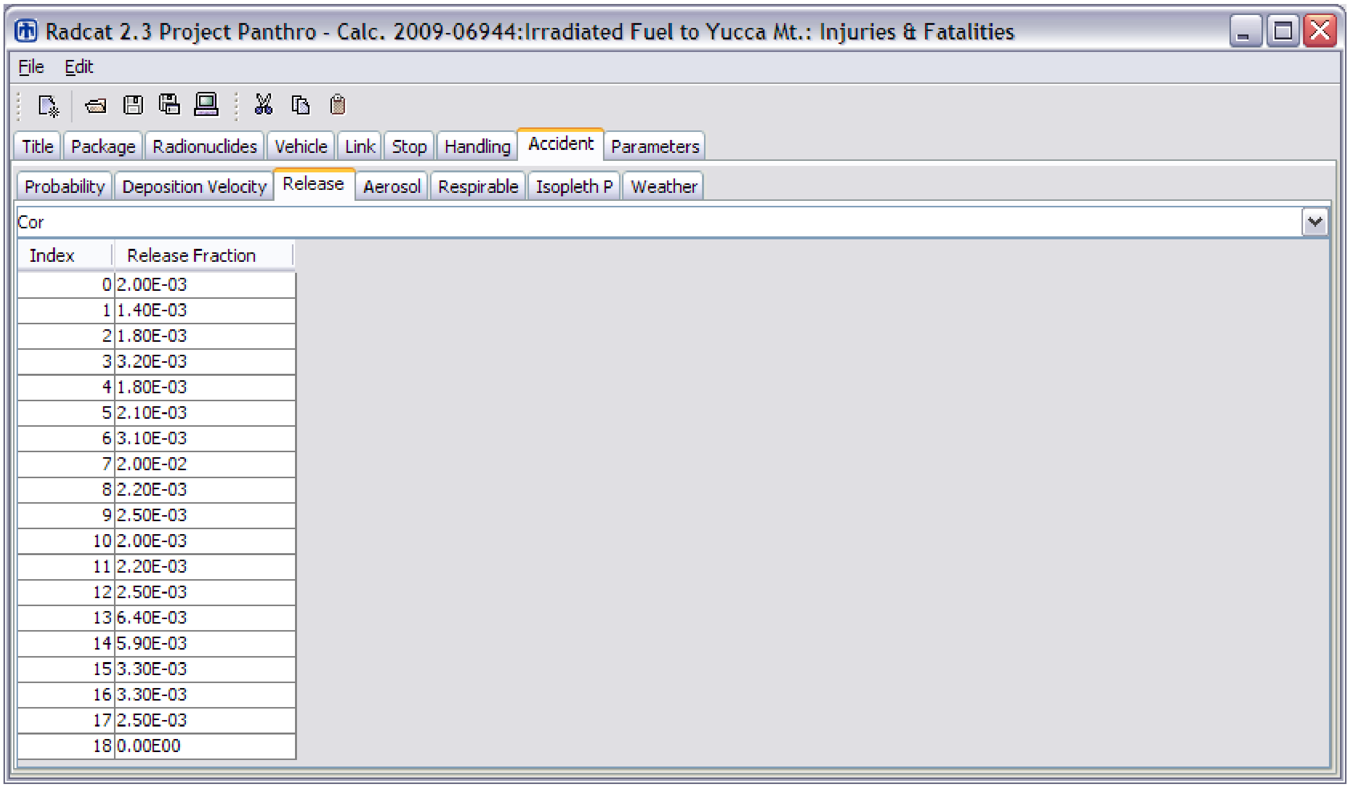
16 5.90E-06
17 1.70E-05
18 0.00E00

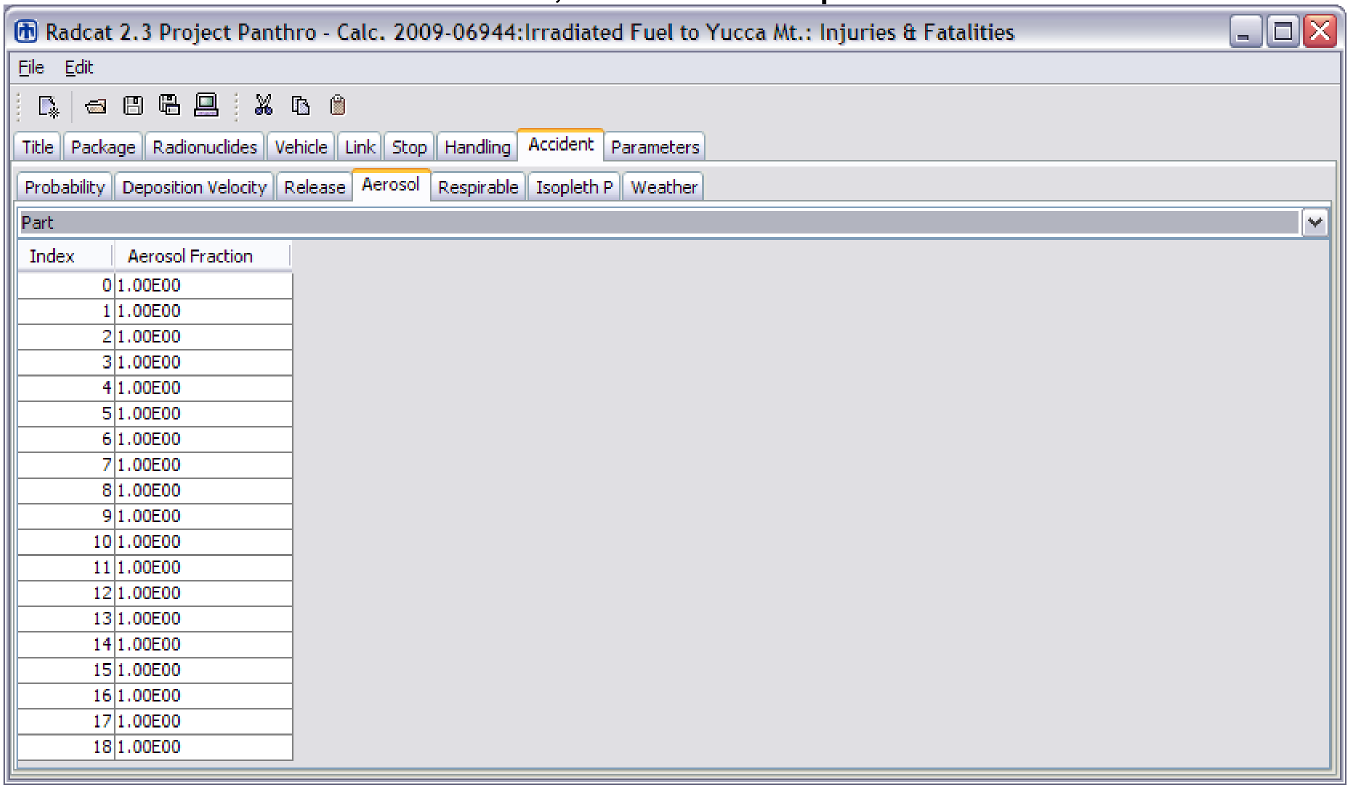

Radcat 2.3 Project Panthro - Calc. 2009-06944:Irradiated Fuel to Yucca Mt.: Injuries & Fatalities
File Edit
Title Package Radionuclides Vehicle Link Stop Handling Accident Parameters
Probability Deposition Velocity Release Aerosol Respirable Isopleth P Weather
Ru
Index Release Fraction
0 6.00E-07
1 1.00E-07
2 1.30E-07
3 3.80E-06
4 3.20E-07
5 3.70E-07
6 2.10E-06
7 6.10E-07
8 6.70E-07
9 6.80E-07
10 6.10E-07
11 6.70E-07
12 6.80E-07
13 8.40E-05
14 5.00E-05
15 6.40E-06
16 6.40E-06
17 6.70E-08
18 0.00E00



Index	Release Fraction
0	8.00E-01
1	1.40E-01
2	1.80E-01
3	8.40E-01
4	4.30E-01
5	4.90E-01
6	8.50E-01
7	8.20E-01
8	8.90E-01
9	9.10E-01
10	8.20E-01
11	8.90E-01
12	9.10E-01
13	8.40E-01
14	8.50E-01
15	9.10E-01
16	9.10E-01
17	8.40E-01
18	0.00E00



Index	Release Fraction
0	2.00E-03
1	1.40E-03
2	1.80E-03
3	3.20E-03
4	1.80E-03
5	2.10E-03
6	3.10E-03
7	2.00E-02
8	2.20E-03
9	2.50E-03
10	2.00E-03
11	2.20E-03
12	2.50E-03
13	6.40E-03
14	5.90E-03
15	3.30E-03
16	3.30E-03
17	2.50E-03
18	0.00E00


Radcat 2.3 Project Panthro - Calc. 2009-06944:Irradiated Fuel to Yucca Mt.: Injuries & Fatalities
File
Edit
Title
Package
Radionuclides
Vehicle
Link
Stop
Handling
Accident
Parameters
Probability
Deposition Velocity
Release
Aerosol
Respirable
Isopleth P
Weather
Part
Index
Aerosol Fraction
0 1.00E00
1 1.00E00
2 1.00E00
3 1.00E00
4 1.00E00
5 1.00E00
6 1.00E00
7 1.00E00
8 1.00E00
9 1.00E00
10 1.00E00
11 1.00E00
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13 1.00E00
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15 1.00E00
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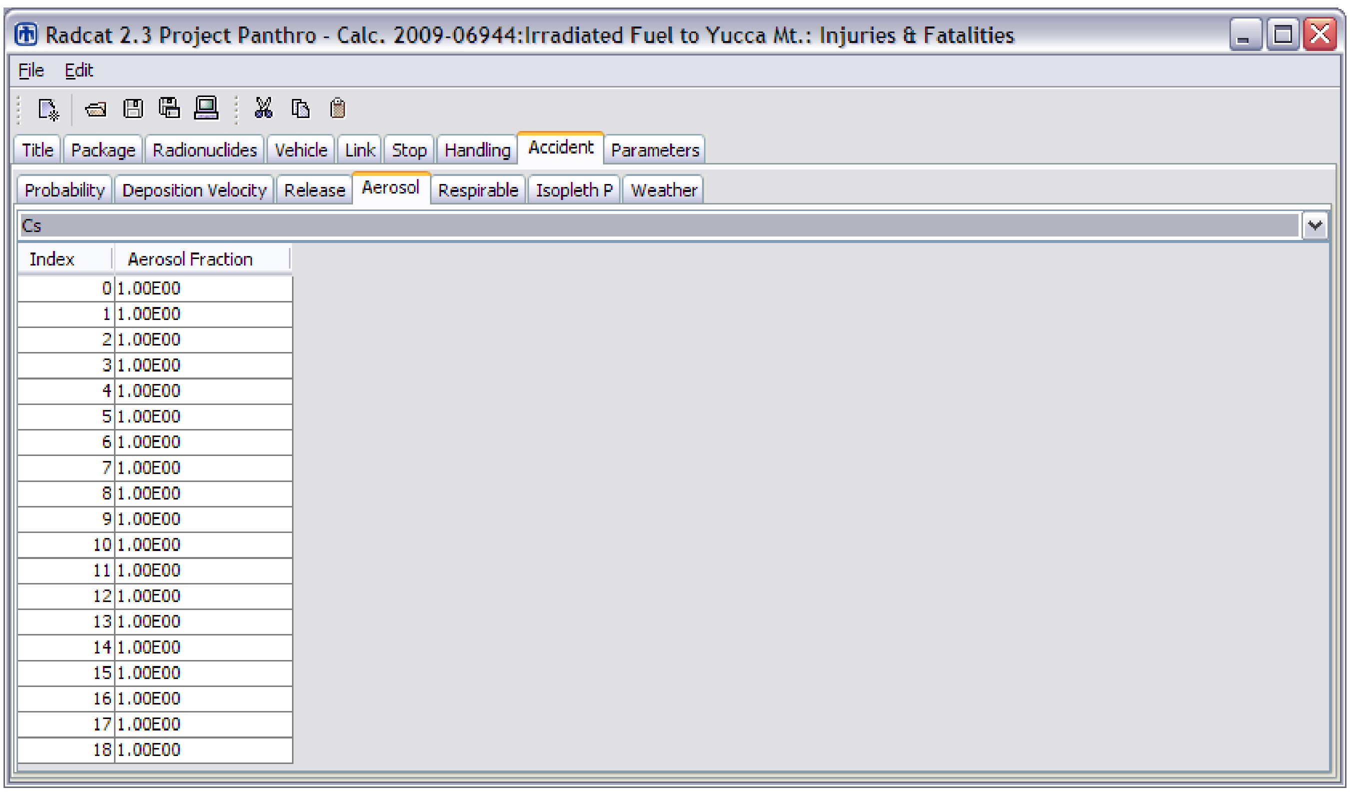
17 1.00E00
18 1.00E00


Radcat 2.3 Project Panthro - Calc. 2009-06944:Irradiated Fuel to Yucca Mt.: Injuries & Fatalities
File
Edit
Title
Package
Radionuclides
Vehicle
Link
Stop
Handling
Accident
Parameters
Probability
Deposition Velocity
Release
Aerosol
Respirable
Isopleth P
Weather
Cs
Index
Aerosol Fraction
0 1.00E00
1 1.00E00
2 1.00E00
3 1.00E00
4 1.00E00
5 1.00E00
6 1.00E00
7 1.00E00
8 1.00E00
9 1.00E00
10 1.00E00
11 1.00E00
12 1.00E00
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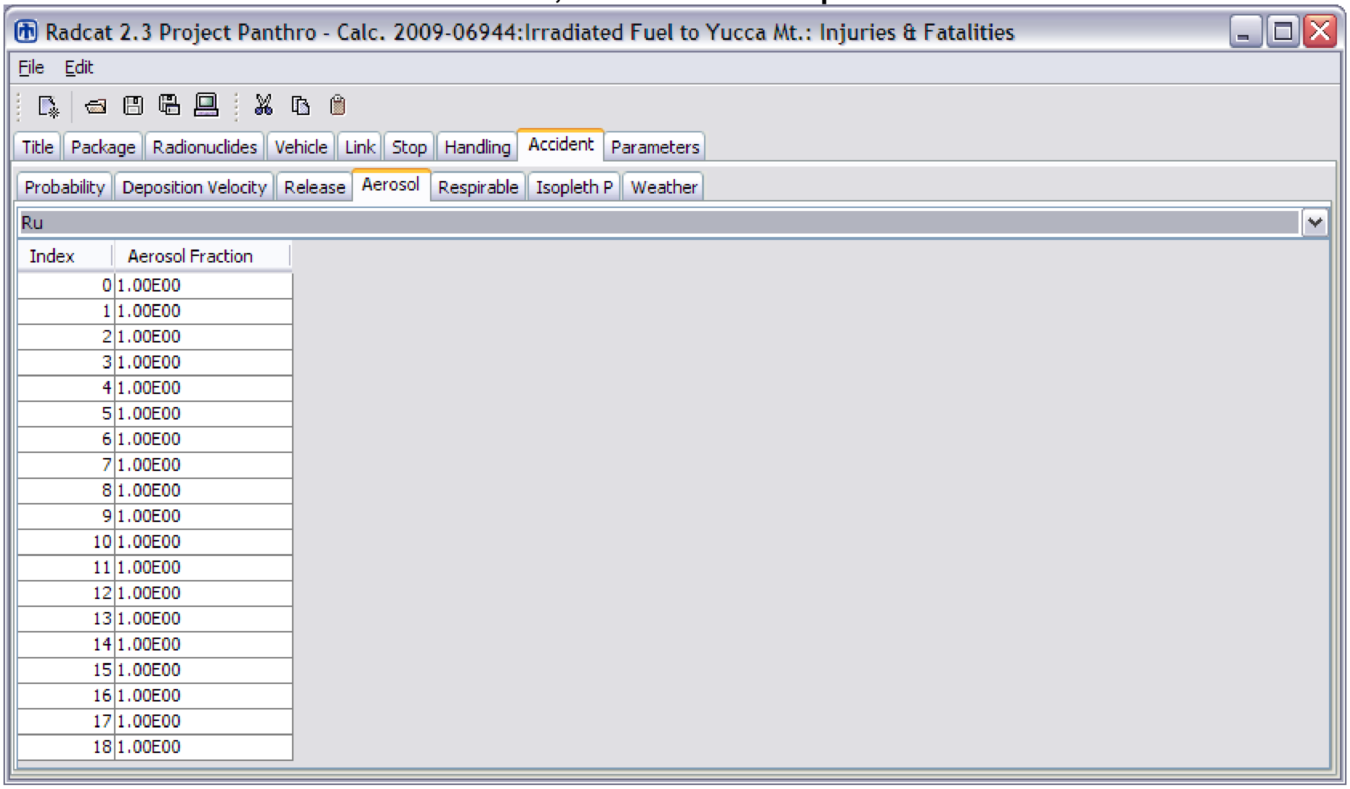
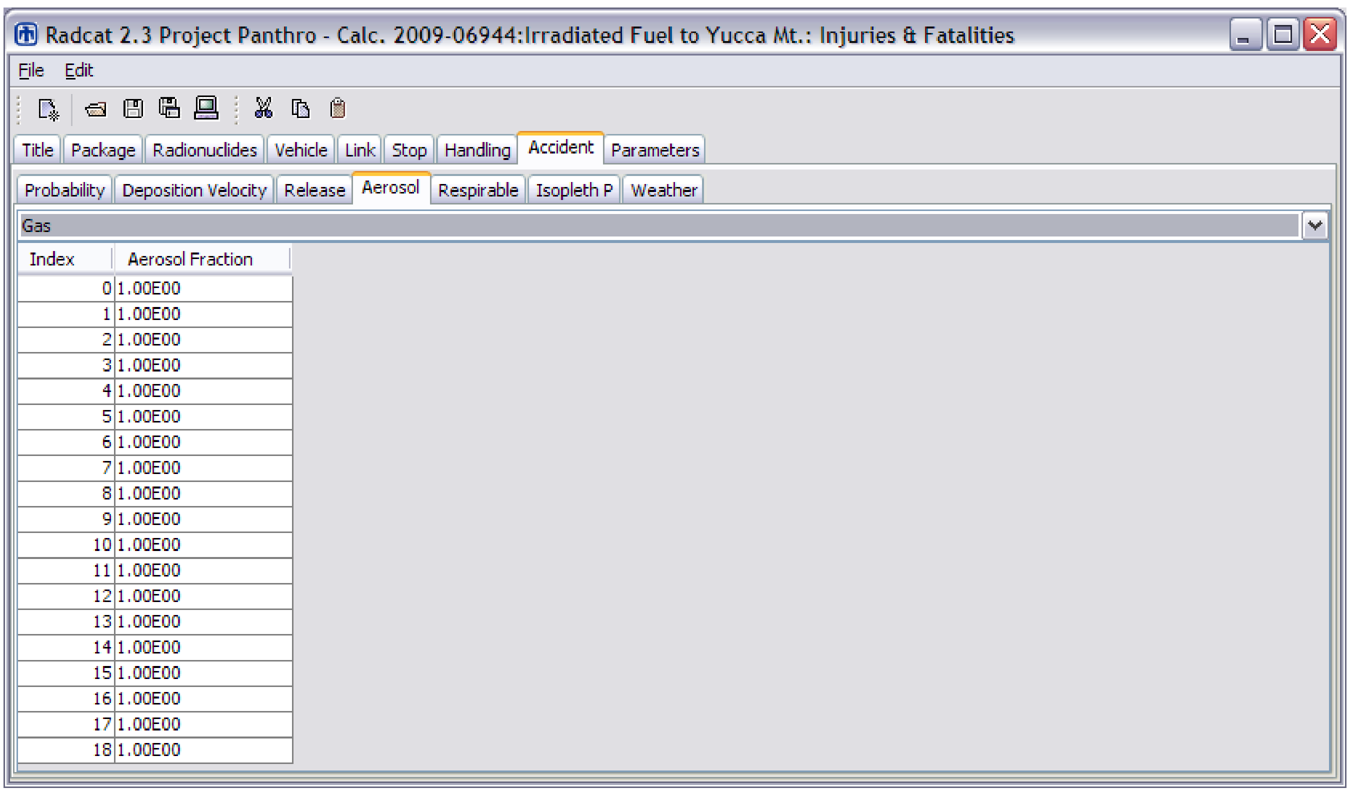
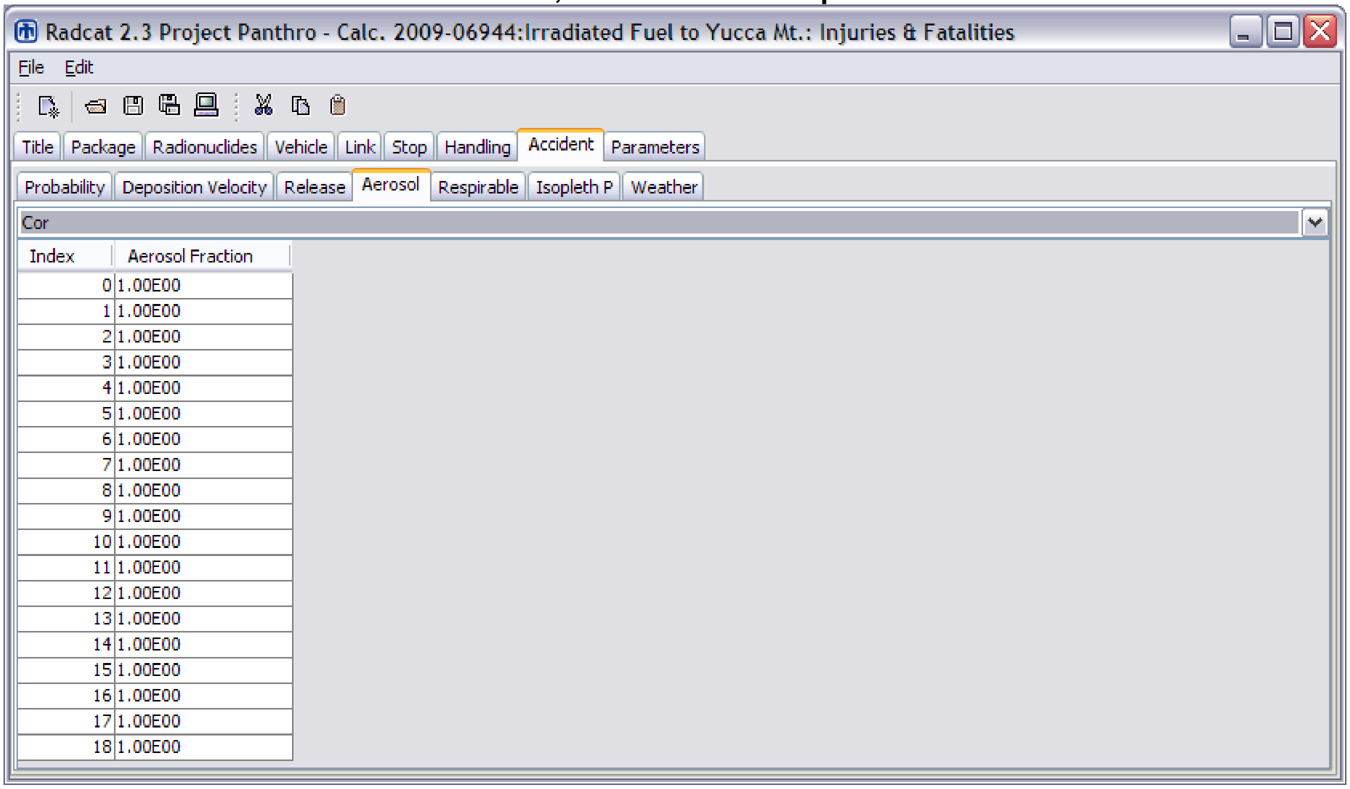
15 1.00E00
16 1.00E00
17 1.00E00
18 1.00E00



Index	Aerosol Fraction
0	1.00E00
1	1.00E00
2	1.00E00
3	1.00E00
4	1.00E00
5	1.00E00
6	1.00E00
7	1.00E00
8	1.00E00
9	1.00E00
10	1.00E00
11	1.00E00
12	1.00E00
13	1.00E00
14	1.00E00
15	1.00E00
16	1.00E00
17	1.00E00
18	1.00E00



Index	Aerosol Fraction
0	1.00E00
1	1.00E00
2	1.00E00
3	1.00E00
4	1.00E00
5	1.00E00
6	1.00E00
7	1.00E00
8	1.00E00
9	1.00E00
10	1.00E00
11	1.00E00
12	1.00E00
13	1.00E00
14	1.00E00
15	1.00E00
16	1.00E00
17	1.00E00
18	1.00E00



Radcat 2.3 Project Panthro - Calc. 2009-06944:Irradiated Fuel to Yucca Mt.: Injuries & Fatalities

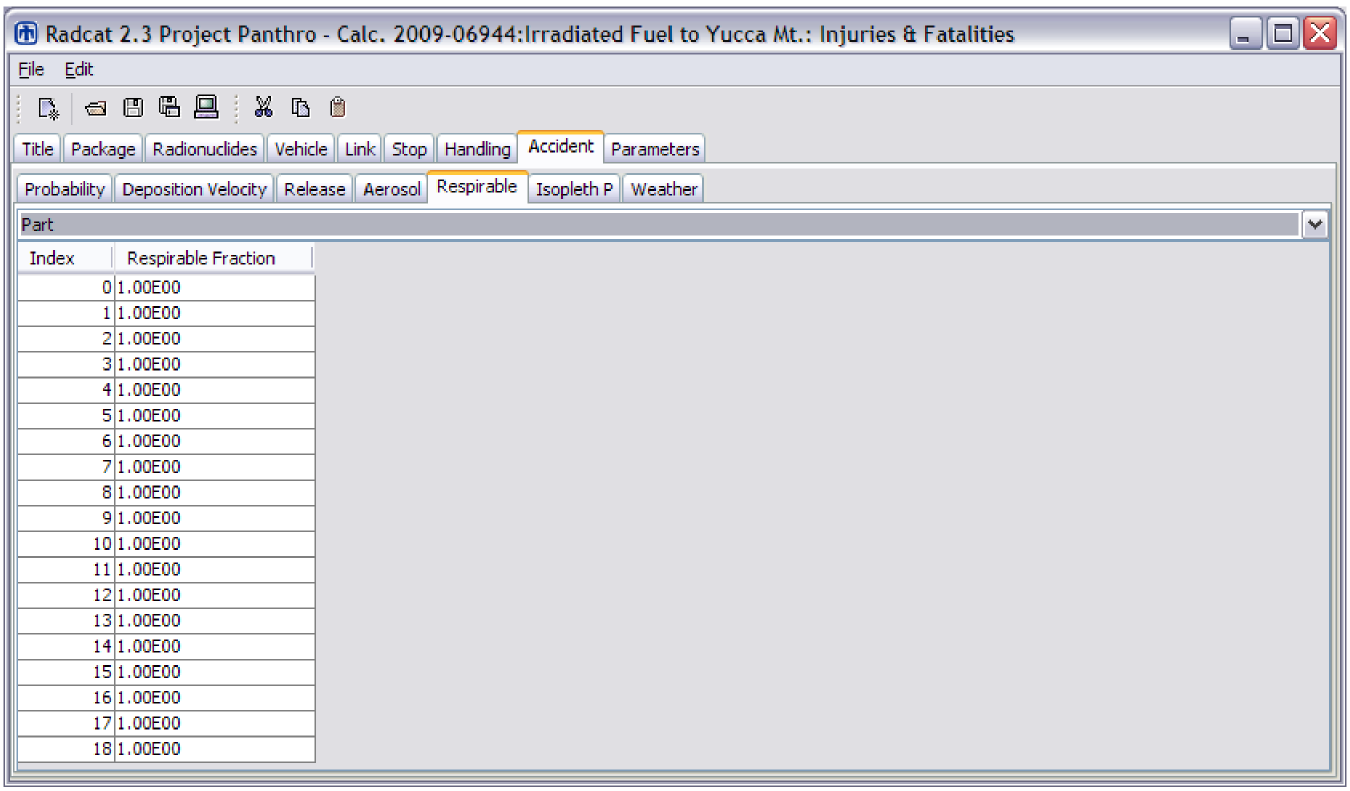
File Edit

Title | Package | Radionuclides | Vehicle | Link | Stop | Handling | Accident | Parameters

Probability | Deposition Velocity | Release | Aerosol | Respirable | Isopleth P | Weather

Cor

Index	Aerosol Fraction
0	1.00E00
1	1.00E00
2	1.00E00
3	1.00E00
4	1.00E00
5	1.00E00
6	1.00E00
7	1.00E00
8	1.00E00
9	1.00E00
10	1.00E00
11	1.00E00
12	1.00E00
13	1.00E00
14	1.00E00
15	1.00E00
16	1.00E00
17	1.00E00
18	1.00E00



Radcat 2.3 Project Panthro - Calc. 2009-06944:Irradiated Fuel to Yucca Mt.: Injuries & Fatalities

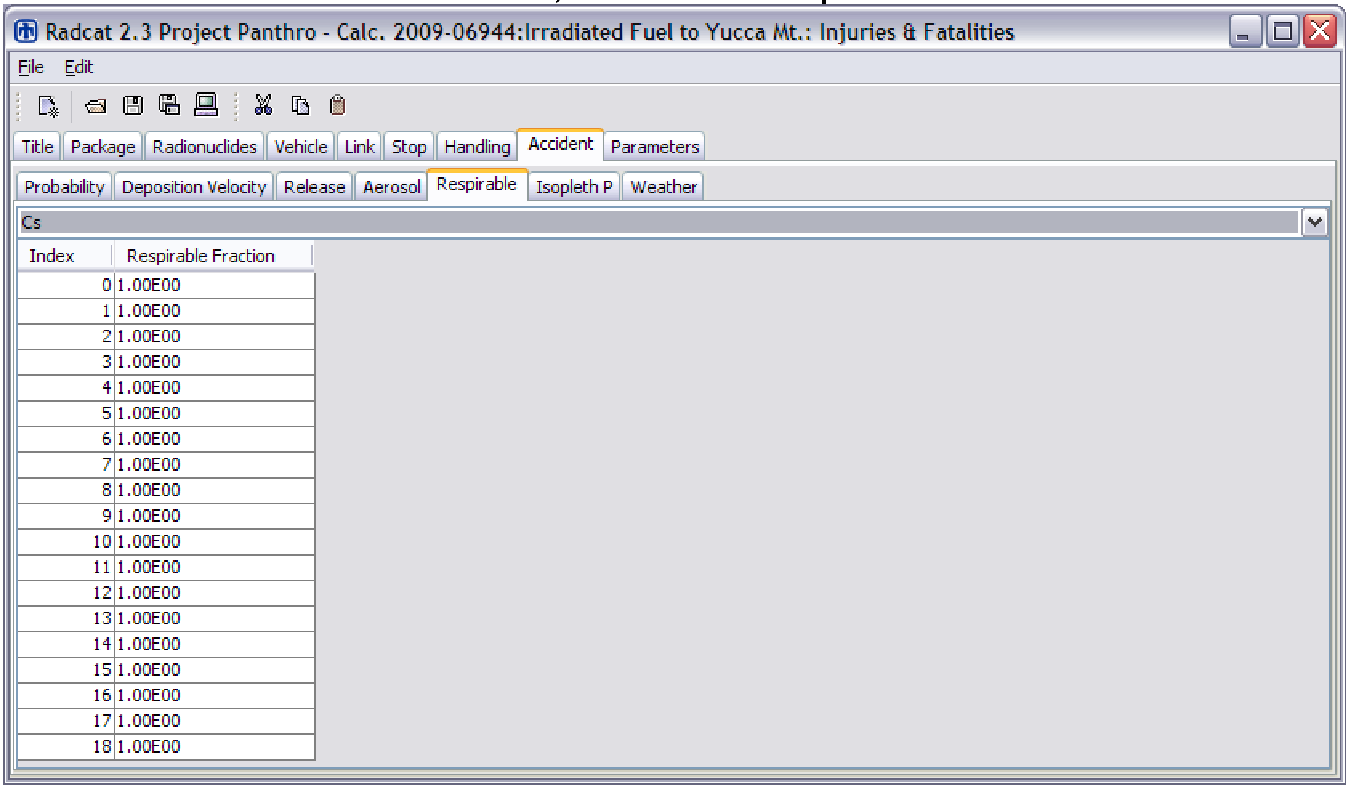
File Edit

Title | Package | Radionuclides | Vehicle | Link | Stop | Handling | Accident | Parameters

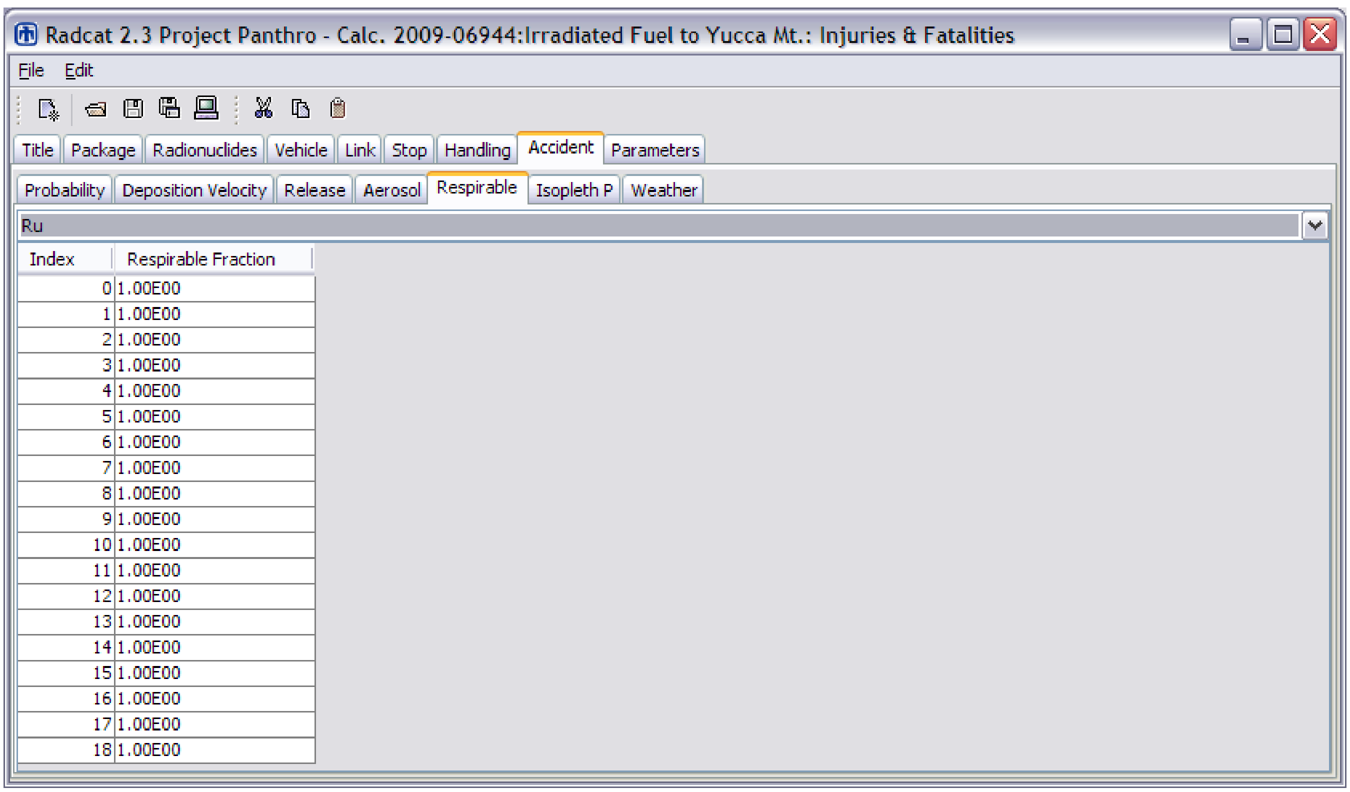
Probability | Deposition Velocity | Release | Aerosol | Respirable | Isopleth P | Weather

Part

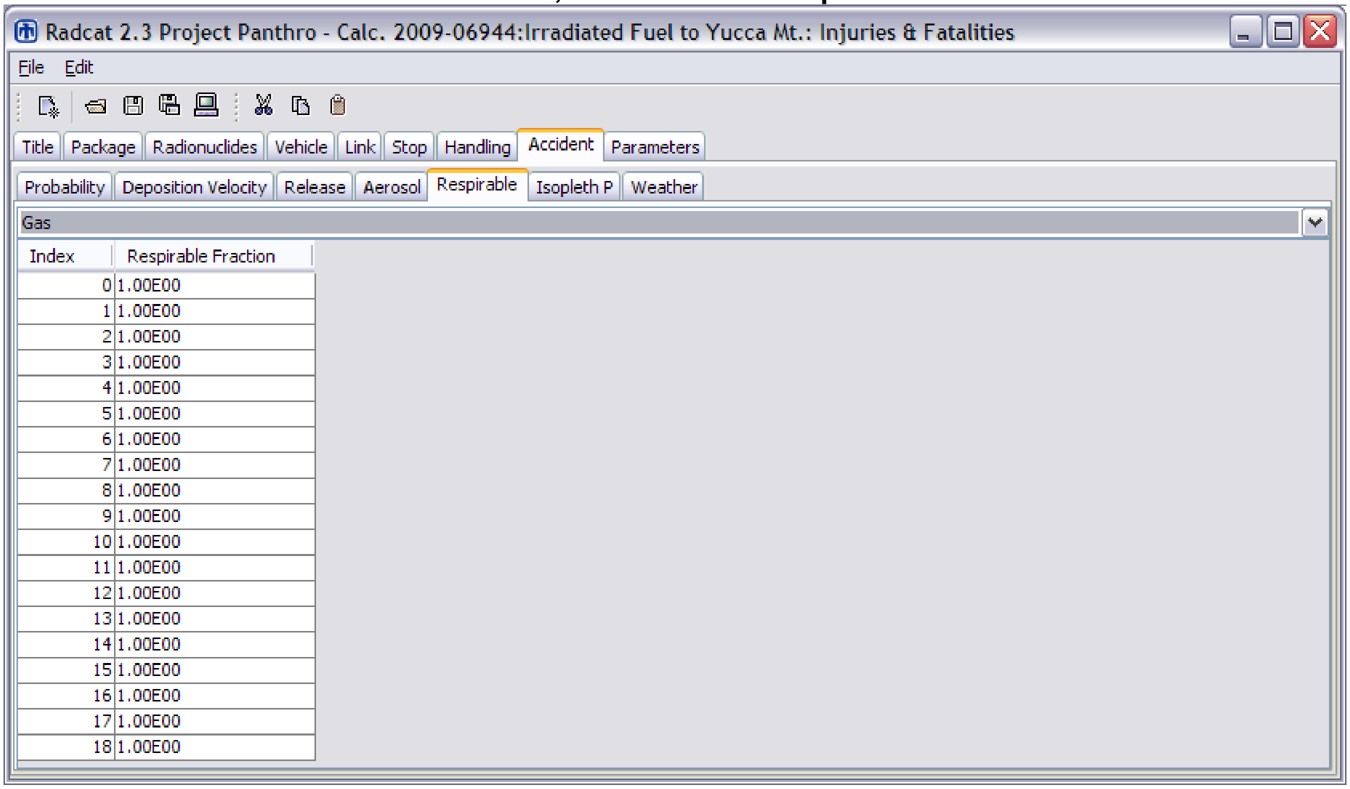
Index	Respirable Fraction
0	1.00E00
1	1.00E00
2	1.00E00
3	1.00E00
4	1.00E00
5	1.00E00
6	1.00E00
7	1.00E00
8	1.00E00
9	1.00E00
10	1.00E00
11	1.00E00
12	1.00E00
13	1.00E00
14	1.00E00
15	1.00E00
16	1.00E00
17	1.00E00
18	1.00E00



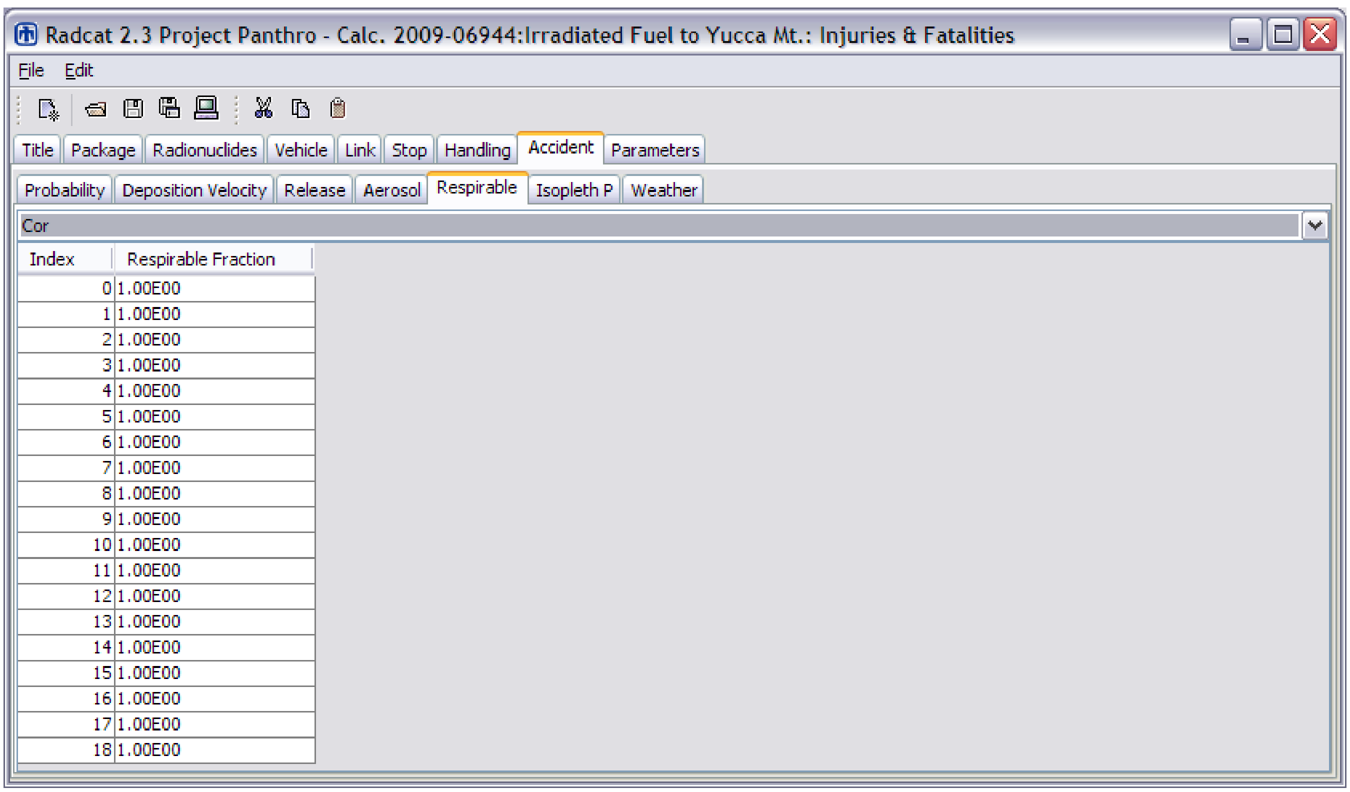
Index	Respirable Fraction
0	1.00E00
1	1.00E00
2	1.00E00
3	1.00E00
4	1.00E00
5	1.00E00
6	1.00E00
7	1.00E00
8	1.00E00
9	1.00E00
10	1.00E00
11	1.00E00
12	1.00E00
13	1.00E00
14	1.00E00
15	1.00E00
16	1.00E00
17	1.00E00
18	1.00E00



Index	Respirable Fraction
0	1.00E00
1	1.00E00
2	1.00E00
3	1.00E00
4	1.00E00
5	1.00E00
6	1.00E00
7	1.00E00
8	1.00E00
9	1.00E00
10	1.00E00
11	1.00E00
12	1.00E00
13	1.00E00
14	1.00E00
15	1.00E00
16	1.00E00
17	1.00E00
18	1.00E00



Index	Respirable Fraction
0	1.00E00
1	1.00E00
2	1.00E00
3	1.00E00
4	1.00E00
5	1.00E00
6	1.00E00
7	1.00E00
8	1.00E00
9	1.00E00
10	1.00E00
11	1.00E00
12	1.00E00
13	1.00E00
14	1.00E00
15	1.00E00
16	1.00E00
17	1.00E00
18	1.00E00



Index	Respirable Fraction
0	1.00E00
1	1.00E00
2	1.00E00
3	1.00E00
4	1.00E00
5	1.00E00
6	1.00E00
7	1.00E00
8	1.00E00
9	1.00E00
10	1.00E00
11	1.00E00
12	1.00E00
13	1.00E00
14	1.00E00
15	1.00E00
16	1.00E00
17	1.00E00
18	1.00E00

Radcat 2.3 Project Panthro - Calc. 2009-06944:Irradiated Fuel to Yucca Mt.: Injuries & Fatalities

File Edit

Title | Package | Radionuclides | Vehicle | Link | Stop | Handling | Accident | Parameters

Probability | Deposition Velocity | Release | Aerosol | Respirable | Isopleth P | Weather

(•) Use the default population densities

( ) Specify your own population densities

people/km²

Add Isopleth P | Remove Isopleth P

Radcat 2.3 Project Panthro - Calc. 2009-06944:Irradiated Fuel to Yucca Mt.: Injuries & Fatalities

File Edit

Title | Package | Radionuclides | Vehicle | Link | Stop | Handling | Accident | Parameters

Probability | Deposition Velocity | Release | Aerosol | Respirable | Isopleth P | Weather

( ) Pasquill (•) Average ( ) User-Defined

Isopleth Area Size (m²)	Time Integrated Concentration	Center-Line Distance (m)
4.59E02	3.42E-03	3.30E01
1.53E03	1.72E-03	6.80E01
3.94E03	8.58E-04	1.05E02
1.25E04	3.42E-04	2.44E02
3.04E04	1.72E-04	3.69E02
6.85E04	8.58E-05	5.61E02
1.76E05	3.42E-05	1.02E03
4.45E05	1.72E-05	1.63E03
8.59E05	8.58E-06	2.31E03
2.55E06	3.42E-06	4.27E03
4.45E06	1.72E-06	5.47E03
1.03E07	8.58E-07	1.11E04
2.16E07	3.42E-07	1.31E04
5.52E07	1.72E-07	2.13E04
1.77E08	8.58E-08	4.05E04
4.89E08	5.42E-08	7.00E04
8.12E08	4.30E-08	8.99E04
1.35E09	3.42E-08	1.21E05

Add Average Area | Remove Average Area

Radcat 2.3 Project Panthro - Calc. 2009-06944:Irradiated Fuel to Yucca Mt.: Injuries & Fatalities

File Edit

Title | Package | Radionuclides | Vehicle | Link | Stop | Handling | Accident | Parameters

Parameter	Value
Shielding factor for rural residents	1.00E00
Shielding factor for suburban residents	8.70E-01
Shielding factor for urban residents	1.80E-02
Fraction of outside air in urban buildings	5.00E-02
Fraction of urban population occupying the sidewalk	4.80E-01
Fraction of urban population inside buildings	5.20E-01
Ratio of pedestrians/km² to residential population/km²	6.00E00
Minimum small package dimension for handling (m)	5.00E-01
Distance from shipment for maximum exposure (m)	3.00E01
Vehicle speed for maximum exposure (km/hr)	2.40E01
Imposed regulatory limit on vehicle external dose	Yes
Average breathing rate (m³/sec)	3.30E-04
Cleanup Level (microcuries/m²)	2.00E-01
Interdiction Threshold	4.00E01
Evacuation time for groundshine (days)	1.00E00
Survey interval for groudshine (days)	1.00E01
Occupational latent cancer fatalities per person-rem	4.00E-04
Public latent cancer fatalities per person-rem	5.00E-04
Genetic effects per person-rem (public)	1.00E-04
Campaign (year)	8.33E-02
Iodine	I129
Rem per curie thyroid via inhalation (Rem/Ci)	5.77E06
Distance of freeway vehicle carrying radioactive cargo to pede...	3.00E01
Distance of freeway vehicle carrying radioactive cargo to right-...	3.00E01
Distance of freeway vehicle carrying radioactive cargo to maxi...	8.00E02
Distance of non-freeway vehicle carrying radioactive cargo to p...	2.70E01
Distance of non-freeway vehicle carrying radioactive cargo to ri...	3.00E01
Distance of non-freeway vehicle carrying radioactive cargo to ...	8.00E02
Distance of city street vehicle carrying radioactive cargo to ped...	5.00E00
Distance of city street vehicle carrying radioactive cargo to righ...	8.00E00
Distance of city street vehicle carrying radioactive cargo to ma...	8.00E02
Perpendicular distance to freeway vehicle going in opposite dire...	1.50E01
Perpendicular distance to non-freeway vehicle going in opposit...	3.00E00
Perpendicular distance to city vehicle going in opposite direction...	3.00E00
Perpendicular distance to all vehicles going in same direction (m)	4.00E00

5 RADTRAN FATALITIES CASE OUTPUT

```
                    RUN DATE: [ 15-FEB-13 AT 14:17:03 ]            PAGE    1


  RRRR    AAA   DDDD   TTTTT  RRRR    AAA   N   N  55555         6
  R   R  A   A  D   D    T    R   R  A   A  NN  N  5             6
  R   R  A   A  D   D    T    R   R  A   A  N N N  5             6
  RRRR   A   A  D   D    T    RRRR   A   A  N  NN  5555          6666
  R R    AAAAA  D   D    T    R R    AAAAA  N   N      5         6   6
  R  R   A   A  D   D    T    R  R   A   A  N   N  5   5         6   6
  R   R  A   A  DDDD     T    R   R  A   A  N   N  5555      *    666

                           RADTRAN 5.6   February 20, 2006

                                   INPUT ECHO
                                   ----------

 TITLE Calc-06944: Irradiated Fuel to Yucca Mt.: Fatalities
 INPUT STANDARD
STD: 0 10 18                              && DIMEN=NSEV NRAD NAREAS
STD: 1 3 3 0                              && PARM=IRNKC IANA ISEN IPSQSB
STD: .TRUE. .FALSE.                       && FORM = UNIT, SI-UNITS?
STD: 2.3E12                               && NEVAL FOR CF252
STD: 9.25E5 5.77E6 1.27E6                 && RPCTHY FOR I125, I129, I131
STD: 0.0 0.0 0.0 0.0 0.0                  && TRANSFER GAMMA
STD: 7.42E-3 2.02E-2 6.17E-5 3.17E-8 0.0  && TRANSFER NEUTRON
STD: 30  24                               && MITDDIST  MITDVEL
STD: 1  2   .0018                         && ITRAIN FMINCL DDRWEF
STD:    33    68    105   244   369               && CENTER LINE
STD:   561  1018   1628  2308  4269               && DISTANCES
STD:  5468 11136  13097 21334 40502               && FOR AVERAGE
STD: 69986 89860 120878 0 0 0 0 0 0 0 0 0 0 0 0 0   && US CLOUD
STD: 4.59E+02 1.53E+03 3.94E+03 1.25E+04 3.04E+04 6.85E+04 1.76E+05 4.45E+05
STD: 8.59E+05 2.55E+06 4.45E+06 1.03E+07 2.16E+07 5.52E+07 1.77E+08 4.89E+08
STD: 8.12E+08 1.35E+09 0 0 0 0 0 0 0 0 0 0 0 0 0 0     && AREADA
STD: 3.42E-03 1.72E-03 8.58E-04 3.42E-04 1.72E-04 8.58E-05 3.42E-05 1.72E-05
STD:  8.58E-06 3.42E-06 1.72E-06 8.58E-07 3.42E-07 1.72E-07 8.58E-08 5.42E-08
STD:  4.30E-08 3.42E-08 0 0 0 0 0 0 0 0 0 0 0 0 0 0     && DFLEV
STD: 3 6 9 12 15 30 61 91 152 305 0 0 0 0 0
STD: 3 6 9 12 15 30 61 91 152 305 0 0 0 0 0
STD: 3 6 9 12 15 30 61 91 152 305 0 0 0 0 0 && RADIST
STD: 0.5                              && SMLPKG
STD: 1.0  0.87  0.018                 && SHIELDING FACTORS RR  RS  RU
STD:  30  30  800                     && OFFLINK {FREEWAY}
STD:  27  30  800                     && OFFLINK {NON-FREEWAY}
STD:   5   8  800                     && OFFLINK {CITY STREETS}
STD:  30  30  800                     && OFFLINK {RAILWAY}
STD: 200 200 1000                     && OFFLINK {WATERWAY}
STD: 15  3  3  3  4                   && ONLINK {FWAY NONFWY STREET RAIL ADJ}
STD: 6.0  4  40.0                     && RPD FNOATT INTERDICT
STD: 0.05   0.2   3.3E-4              && BDF CULVL BRATE
STD: 0.9   0.1                        && UBF USWF
STD: 1.0  10.0 1.0                    && EVACUATION SURVEY CAMPAIGN
```

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                 RUN DATE: [ 15-FEB-13 AT 14:17:03 ]           PAGE    2

         Calc-06944: Irradiated Fuel to Yucca Mt.: Fatalities

STD: 0.0  0.0     1.5E-8  5.3E-8      && HIGHWAY - RURAL - NONRAD
STD: 0.0  0.0     3.7E-9  1.3E-8      && HIGHWAY - SUBURBAN - NONRAD
STD: 0.0  0.0     2.1E-9  7.5E-9      && HIGHWAY - URBAN - NONRAD
STD: 0.0  0.0    1.81E-9  2.64E-8     && GENERAL FREIGHT - R - NONRAD
STD: 0.0  0.0    1.81E-9  2.64E-8     && GENERAL FREIGHT - S - NONRAD
STD: 0.0  0.0    1.81E-9  2.64E-8     && GENERAL FREIGHT - U - NONRAD
STD: 0.0  0.0    1.27E-7  1.85E-6     && DEDICATED RAIL - R - NONRAD
STD: 0.0  0.0    1.27E-7  1.85E-6     && DEDICATED RAIL - S - NONRAD
STD: 0.0  0.0    1.27E-7  1.85E-6     && DEDICATED RAIL - U - NONRAD
STD: 0.0 0.0 0.0 0.0 0.0 0.0          && PSPROB
STD: 0.67  0.67  0.42                 && TIMENDE NON-DISPERSAL EVAC TIME (LCF&EARLY)
STD: 2 2 1                            && FLAGS=IUOPT IACC REGCHECK
STD: 5E-4, 4E-4, 1.0E-4               && LCFCON(1), LCFCON(2), GECON
STD: R5INGEST.BIN                     && INGESTION FILE
 OUTPUT BQ_SV
 FORM UNIT
 DIMEN 19 10 18
 PARM 1 3 1 0
 SEVERITY
    NPOP=1
       NMODE=1
        1.53E-8
  5.88E-5 1.81E-6 7.49E-8 4.65E-7 3.31E-9
  0.0 1.13E-8 8.03E-11 0.0 1.44E-10
  1.02E-12 0.0 7.49E-11 0.0 0.0
  0.0 5.86E-6 0.99993
    NPOP=2
       NMODE=1
        1.53E-8
  5.88E-5 1.81E-6 7.49E-8 4.65E-7 3.31E-9
  0.0 1.13E-8 8.03E-11 0.0 1.44E-10
  1.02E-12 0.0 7.49E-11 0.0 0.0
  0.0 5.86E-6 0.99993
    NPOP=3
       NMODE=1
        1.53E-8
  5.88E-5 1.81E-6 7.49E-8 4.65E-7 3.31E-9
  0.0 1.13E-8 8.03E-11 0.0 1.44E-10
  1.02E-12 0.0 7.49E-11 0.0 0.0
  0.0 5.86E-6 0.99993
 RELEASE
    GROUP=Part
       RFRAC
          6.0E-7
  1.0E-7 1.3E-7 3.8E-6 3.2E-7 3.7E-7
  2.1E-6 6.1E-7 6.7E-7 6.8E-7 6.1E-7
  6.7E-7 6.8E-7 1.8E-5 9.0E-6 6.8E-7
  6.8E-7 6.7E-8 0.0
       AERSOL
          1.0
```

Calc-06944: Irradiated Fuel to Yucca Mt.: Fatalities

```
1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0
     RESP
        1.0
1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0
     LOS
        0.0
0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0
     DEPVEL 0.01
  GROUP=Cs
     RFRAC
        2.4E-8
4.1E-9 5.4E-9 3.6E-5 1.3E-8 1.5E-8
2.7E-5 2.4E-8 2.7E-8 5.9E-6 2.4E-8
2.7E-8 5.9E-6 9.6E-5 5.5E-5 5.9E-6
5.9E-6 1.7E-5 0.0
     AERSOL
        1.0
1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0
     RESP
        1.0
1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0
     LOS
        0.0
0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0
     DEPVEL 0.01
  GROUP=Ru
     RFRAC
        6.0E-7
1.0E-7 1.3E-7 3.8E-6 3.2E-7 3.7E-7
2.1E-6 6.1E-7 6.7E-7 6.8E-7 6.1E-7
6.7E-7 6.8E-7 8.4E-5 5.0E-5 6.4E-6
6.4E-6 6.7E-8 0.0
     AERSOL
        1.0
1.0 1.0 1.0 1.0 1.0
```

Calc-06944: Irradiated Fuel to Yucca Mt.: Fatalities

```
 1.0 1.0 1.0 1.0 1.0
 1.0 1.0 1.0 1.0 1.0
 1.0 1.0 1.0
      RESP
         1.0
 1.0 1.0 1.0 1.0 1.0
 1.0 1.0 1.0 1.0 1.0
 1.0 1.0 1.0 1.0 1.0
 1.0 1.0 1.0
      LOS
         0.0
 0.0 0.0 0.0 0.0 0.0
 0.0 0.0 0.0 0.0 0.0
 0.0 0.0 0.0 0.0 0.0
 0.0 0.0 0.0
      DEPVEL 0.01
   GROUP=Cor
      RFRAC
         0.0020
 0.0014 0.0018 0.0032 0.0018 0.0021
 0.0031 0.02 0.0022 0.0025 0.0020
 0.0022 0.0025 0.0064 0.0059 0.0033
 0.0033 0.0025 0.0
      AERSOL
         1.0
 1.0 1.0 1.0 1.0 1.0
 1.0 1.0 1.0 1.0 1.0
 1.0 1.0 1.0 1.0 1.0
 1.0 1.0 1.0
      RESP
         1.0
 1.0 1.0 1.0 1.0 1.0
 1.0 1.0 1.0 1.0 1.0
 1.0 1.0 1.0 1.0 1.0
 1.0 1.0 1.0
      LOS
         0.0
 0.0 0.0 0.0 0.0 0.0
 0.0 0.0 0.0 0.0 0.0
 0.0 0.0 0.0 0.0 0.0
 0.0 0.0 0.0
      DEPVEL 0.01
PACKAGE PACKAGE_1 13.9 1.0 0.0 5.2
   AM241 1440.0 Part
   AM242M 33.0 Part
   CM245 2.0 Part
   CM244 13500.0 Part
   CM243 62.0 Part
   CM242 62.0 Part
   CE144 13200.0 Part
   AM243 60.0 Part
   EU154 15600.0 Part
   EU155 8270.0 Part
```

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       Calc-06944: Irradiated Fuel to Yucca Mt.: Fatalities

   PM147 31300.0 Part
   PU238 10900.0 Part
   PU239 427.0 Part
   PU240 852.0 Part
   PU241 135000.0 Part
   PU242 3.0 Part
   SB125 7170.0 Part
   SR90 106000.0 Part
   Y90 106000.0 Part
   CS134 77600.0 Cs
   CS137 158000.0 Cs
   RU106 22900.0 Ru
   CO60 169.0 Cor
END
VEHICLE -1 VEHICLE_1 1.39E01 1.0 0.0 5.2 1.0 2.0 4.0 1.0 1.0
      PACKAGE_1 1.0
FLAGS
   IACC 2
   IUOPT 2
   REGCHECK 1
MODSTD
   DISTOFF FREEWAY 3.00E01 3.00E01 8.00E02
   DISTOFF SECONDARY 2.70E01 3.00E01 8.00E02
   DISTOFF STREET 5.00E00 8.00E00 8.00E02
   DISTON
     FREEWAY 1.50E01
     SECONDARY 3.00E00
     STREET 3.00E00
     ADJACENT 4.00E00
   BDF 5.00E-02
   BRATE 3.30E-04
   CULVL 2.00E-01
   EVACUATION 1.00E00
   GECON 1.00E-04
   INTERDICT 4.00E01
   LCFCON 5.00E-04 4.00E-04
   SURVEY 1.00E01
   UBF 5.20E-01
   USWF 4.80E-01
   CAMPAIGN 8.33E-02
   MITDDIST 3.00E01
   MITDVEL 2.40E01
   RPD 6.00E00
   RR 1.00E00
   RU 1.80E-02
   RS 8.70E-01
   SMALLPKG 5.00E-01
   RPCTHYROID
     I129  5.77E06
EOF
LINK RURAL_AZ VEHICLE_1 46.8 88.9 1.5 3.2 530.0 1.32E-7 0.0712 R 1 1.0
LINK SUBURBN_AZ VEHICLE_1 0.3 88.9 1.5 135.8 760.0 1.32E-7 0.0712 S 1 1.0
LINK URBAN_AZ VEHICLE_1 0.0 88.9 1.5 0.0 2400.0 1.32E-7 0.0712 U 1 1.0
```

```
LINK RURAL_DE VEHICLE_1 7.6 88.9 1.5 7.3 530.0 5.18E-7 0.0108 R 1 1.0
LINK SUBURBN_DE VEHICLE_1 13.9 88.9 1.5 492.2 760.0 5.18E-7 0.0108 S 1 1.0
LINK URBAN_DE VEHICLE_1 5.3 88.9 1.5 2496.1 2400.0 5.18E-7 0.0108 U 1 1.0
LINK RURAL_IL VEHICLE_1 178.4 88.9 1.5 14.4 530.0 2.22E-7 0.0374 R 1 1.0
LINK SUBURBN_IL VEHICLE_1 73.0 88.9 1.5 323.6 760.0 2.22E-7 0.0374 S 1 1.0
LINK URBAN_IL VEHICLE_1 10.2 88.9 1.5 2379.1 2400.0 2.22E-7 0.0374 U 1 1.0
LINK RURAL_IN VEHICLE_1 136.7 88.9 1.5 19.9 530.0 2.25E-7 0.0298 R 1 1.0
LINK SUBURBN_IN VEHICLE_1 97.3 88.9 1.5 276.3 760.0 2.25E-7 0.0298 S 1 1.0
LINK URBAN_IN VEHICLE_1 9.4 88.9 1.5 2354.7 2400.0 2.25E-7 0.0298 U 1 1.0
LINK RURAL_IA VEHICLE_1 393.8 88.9 1.5 15.7 530.0 1.12E-7 0.0839 R 1 1.0
LINK SUBURBN_IA VEHICLE_1 95.4 88.9 1.5 268.0 760.0 1.12E-7 0.0839 S 1 1.0
LINK URBAN_IA VEHICLE_1 5.1 88.9 1.5 2185.2 2400.0 1.12E-7 0.0839 U 1 1.0
LINK RURAL_NE VEHICLE_1 652.2 88.9 1.5 10.0 530.0 3.19E-7 0.0429 R 1 1.0
LINK SUBURBN_NE VEHICLE_1 75.6 88.9 1.5 268.5 760.0 3.19E-7 0.0429 S 1 1.0
LINK URBAN_NE VEHICLE_1 7.0 88.9 1.5 2401.8 2400.0 3.19E-7 0.0429 U 1 1.0
LINK RURAL_NV VEHICLE_1 252.6 88.9 1.5 4.8 530.0 2.25E-7 0.0293 R 1 1.0
LINK SUBURBN_NV VEHICLE_1 15.5 88.9 1.5 267.6 760.0 2.25E-7 0.0293 S 1 1.0
LINK URBAN_NV VEHICLE_1 1.5 88.9 1.5 2318.5 2400.0 2.25E-7 0.0293 U 1 1.0
LINK RURAL_NJ VEHICLE_1 20.6 88.9 1.5 11.8 530.0 5.65E-7 0.0214 R 1 1.0
LINK SUBURBN_NJ VEHICLE_1 12.5 88.9 1.5 353.9 760.0 5.65E-7 0.0214 S 1 1.0
LINK URBAN_NJ VEHICLE_1 1.1 88.9 1.5 2025.9 2400.0 5.65E-7 0.0214 U 1 1.0
LINK RURAL_OH VEHICLE_1 213.1 88.9 1.5 19.7 530.0 1.64E-7 0.0238 R 1 1.0
LINK SUBURBN_OH VEHICLE_1 151.3 88.9 1.5 309.6 760.0 1.64E-7 0.0238 S 1 1.0
LINK URBAN_OH VEHICLE_1 14.8 88.9 1.5 2211.7 2400.0 1.64E-7 0.0238 U 1 1.0
LINK RURAL_PA VEHICLE_1 448.0 88.9 1.5 17.7 530.0 5.14E-7 0.0263 R 1 1.0
LINK SUBURBN_PA VEHICLE_1 258.1 88.9 1.5 299.3 760.0 5.14E-7 0.0263 S 1 1.0
LINK URBAN_PA VEHICLE_1 22.2 88.9 1.5 2413.1 2400.0 5.14E-7 0.0263 U 1 1.0
LINK RURAL_UT VEHICLE_1 471.6 88.9 1.5 9.9 530.0 2.9E-7 0.041 R 1 1.0
LINK SUBURBN_UT VEHICLE_1 106.5 88.9 1.5 362.6 760.0 2.9E-7 0.041 S 1 1.0
LINK URBAN_UT VEHICLE_1 32.2 88.9 1.5 2472.3 2400.0 2.9E-7 0.041 U 1 1.0
LINK RURAL_WY VEHICLE_1 607.2 88.9 1.5 4.9 530.0 6.74E-7 0.016 R 1 1.0
LINK SUBURBN_WY VEHICLE_1 33.9 88.9 1.5 399.4 760.0 6.74E-7 0.016 S 1 1.0
LINK URBAN_WY VEHICLE_1 3.4 88.9 1.5 1966.6 2400.0 6.74E-7 0.016 U 1 1.0

STOP STOP_1 VEHICLE_1 30000.0 1.0 10.0 1.0 6.0
STOP STOP_2 VEHICLE_1 340.0 10.0 800.0 0.2 6.0

HANDLING HANDLE_1 VEHICLE_1 5.0 1.0 0.5

EOF
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Calc-06944: Irradiated Fuel to Yucca Mt.: Fatalities

NON-RADIOLOGICAL DATA (ACCIDENTS and FATALITIES)
****

HIGHWAY

	ACCIDENT RATE	ACCIDENTS	FATALITIES
RURAL_AZ	1.32E-07	6.18E-06	4.40E-07
SUBURBN_AZ	1.32E-07	3.96E-08	2.82E-09
URBAN_AZ	1.32E-07	0.00E+00	0.00E+00
RURAL_DE	5.18E-07	3.94E-06	4.25E-08
SUBURBN_DE	5.18E-07	7.20E-06	7.78E-08
URBAN_DE	5.18E-07	2.75E-06	2.97E-08
RURAL_IL	2.22E-07	3.96E-05	1.48E-06
SUBURBN_IL	2.22E-07	1.62E-05	6.06E-07
URBAN_IL	2.22E-07	2.26E-06	8.47E-08
RURAL_IN	2.25E-07	3.08E-05	9.17E-07
SUBURBN_IN	2.25E-07	2.19E-05	6.52E-07
URBAN_IN	2.25E-07	2.12E-06	6.30E-08
RURAL_IA	1.12E-07	4.41E-05	3.70E-06
SUBURBN_IA	1.12E-07	1.07E-05	8.96E-07
URBAN_IA	1.12E-07	5.71E-07	4.79E-08
RURAL_NE	3.19E-07	2.08E-04	8.93E-06
SUBURBN_NE	3.19E-07	2.41E-05	1.03E-06
URBAN_NE	3.19E-07	2.23E-06	9.58E-08
RURAL_NV	2.25E-07	5.68E-05	1.67E-06
SUBURBN_NV	2.25E-07	3.49E-06	1.02E-07
URBAN_NV	2.25E-07	3.38E-07	9.89E-09
RURAL_NJ	5.65E-07	1.16E-05	2.49E-07
SUBURBN_NJ	5.65E-07	7.06E-06	1.51E-07
URBAN_NJ	5.65E-07	6.22E-07	1.33E-08
RURAL_OH	1.64E-07	3.49E-05	8.32E-07
SUBURBN_OH	1.64E-07	2.48E-05	5.91E-07
URBAN_OH	1.64E-07	2.43E-06	5.78E-08
RURAL_PA	5.14E-07	2.30E-04	6.06E-06
SUBURBN_PA	5.14E-07	1.33E-04	3.49E-06
URBAN_PA	5.14E-07	1.14E-05	3.00E-07
RURAL_UT	2.90E-07	1.37E-04	5.61E-06
SUBURBN_UT	2.90E-07	3.09E-05	1.27E-06
URBAN_UT	2.90E-07	9.34E-06	3.83E-07
RURAL_WY	6.74E-07	4.09E-04	6.55E-06
SUBURBN_WY	6.74E-07	2.28E-05	3.66E-07
URBAN_WY	6.74E-07	2.29E-06	3.67E-08
TOTALS:	1.19E-05	1.55E-03	4.68E-05

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Calc-06944: Irradiated Fuel to Yucca Mt.: Fatalities

REGULATORY CHECKS


FOR VEHICLE_1  THE DOSE RATE AT 2 METERS COULD EXCEED 0.1 MSV/HR
THE VEHICLE DOSE RATE HAS BEEN RESET TO EQUAL   0.13 MSV/HR
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Calc-06944: Irradiated Fuel to Yucca Mt.: Fatalities

CALCULATIONAL INFORMATION

FOR VEHICLE_1 AREAS WITH TOTAL CONTAMINATION RATIO GREATER THAN 40.000
(THE AREAS MARKED WITH AN 'X' ARE INTERDICTED AND HAVE
NO 50 YEAR GROUNDSHINE DOSE AND NO INGESTION DOSE.)

AREA/SEVERITY	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-
2	X	-	-	X	-	X	X	X	X	X	X	X	X	X	X	X	X	X	-
3	-	-	-	X	-	-	X	X	-	X	-	-	X	X	X	X	X	X	-
4	-	-	-	X	-	-	X	X	-	-	-	-	-	X	X	-	-	X	-
5	-	-	-	X	-	-	X	-	-	-	-	-	-	X	X	-	-	-	-
6	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-
7	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-
8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Calc-06944: Irradiated Fuel to Yucca Mt.: Fatalities

INCIDENT-FREE SUMMARY
******** **** *******
IN-TRANSIT POPULATION EXPOSURE IN PERSON-SV
*INPUT DATA WERE ALTERED WITH REGULATORY CHECKS

	PASSENGER	CREW	OFF LINK	ON LINK	TOTALS
RURAL_AZ	0.00E+00	2.07E-05	5.07E-08	3.26E-06	2.41E-05
SUBURBN_AZ	0.00E+00	1.33E-07	1.20E-08	3.00E-08	1.75E-07
URBAN_AZ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RURAL_DE	0.00E+00	3.37E-06	1.88E-08	5.30E-07	3.92E-06
SUBURBN_DE	0.00E+00	6.16E-06	2.02E-06	1.39E-06	9.57E-06
URBAN_DE	0.00E+00	2.35E-06	8.07E-08	1.67E-06	4.10E-06
RURAL_IL	0.00E+00	7.91E-05	8.70E-07	1.24E-05	9.24E-05
SUBURBN_IL	0.00E+00	3.24E-05	6.96E-06	7.30E-06	4.66E-05
URBAN_IL	0.00E+00	4.52E-06	1.48E-07	3.22E-06	7.89E-06
RURAL_IN	0.00E+00	6.06E-05	9.22E-07	9.53E-06	7.11E-05
SUBURBN_IN	0.00E+00	4.31E-05	7.92E-06	9.73E-06	6.08E-05
URBAN_IN	0.00E+00	4.17E-06	1.35E-07	2.97E-06	7.27E-06
RURAL_IA	0.00E+00	1.75E-04	2.09E-06	2.75E-05	2.04E-04
SUBURBN_IA	0.00E+00	4.23E-05	7.54E-06	9.54E-06	5.94E-05
URBAN_IA	0.00E+00	2.26E-06	6.80E-08	1.61E-06	3.94E-06
RURAL_NE	0.00E+00	2.89E-04	2.21E-06	4.55E-05	3.37E-04
SUBURBN_NE	0.00E+00	3.35E-05	5.98E-06	7.56E-06	4.71E-05
URBAN_NE	0.00E+00	3.10E-06	1.03E-07	2.21E-06	5.42E-06
RURAL_NV	0.00E+00	1.12E-04	4.11E-07	1.76E-05	1.30E-04
SUBURBN_NV	0.00E+00	6.87E-06	1.22E-06	1.55E-06	9.64E-06
URBAN_NV	0.00E+00	6.65E-07	2.12E-08	4.74E-07	1.16E-06
RURAL_NJ	0.00E+00	9.13E-06	8.24E-08	1.44E-06	1.07E-05
SUBURBN_NJ	0.00E+00	5.54E-06	1.30E-06	1.25E-06	8.09E-06
URBAN_NJ	0.00E+00	4.88E-07	1.36E-08	3.47E-07	8.49E-07
RURAL_OH	0.00E+00	9.45E-05	1.42E-06	1.49E-05	1.11E-04
SUBURBN_OH	0.00E+00	6.71E-05	1.38E-05	1.51E-05	9.60E-05
URBAN_OH	0.00E+00	6.56E-06	2.00E-07	4.67E-06	1.14E-05
RURAL_PA	0.00E+00	1.99E-04	2.69E-06	3.12E-05	2.33E-04
SUBURBN_PA	0.00E+00	1.14E-04	2.28E-05	2.58E-05	1.63E-04
URBAN_PA	0.00E+00	9.84E-06	3.27E-07	7.01E-06	1.72E-05
RURAL_UT	0.00E+00	2.09E-04	1.58E-06	3.29E-05	2.44E-04
SUBURBN_UT	0.00E+00	4.72E-05	1.14E-05	1.07E-05	6.92E-05
URBAN_UT	0.00E+00	1.43E-05	4.86E-07	1.02E-05	2.49E-05
RURAL_WY	0.00E+00	2.69E-04	1.01E-06	4.23E-05	3.13E-04
SUBURBN_WY	0.00E+00	1.50E-05	3.99E-06	3.39E-06	2.24E-05
URBAN_WY	0.00E+00	1.51E-06	4.08E-08	1.07E-06	2.62E-06
RURAL	0.00E+00	1.52E-03	1.34E-05	2.39E-04	1.77E-03
SUBURB	0.00E+00	4.14E-04	8.49E-05	9.33E-05	5.92E-04
URBAN	0.00E+00	4.97E-05	1.62E-06	3.54E-05	8.68E-05
TOTALS:	0.00E+00	1.98E-03	9.99E-05	3.68E-04	2.45E-03

MAXIMUM INDIVIDUAL IN-TRANSIT DOSE

VEHICLE_1 5.92E-09 SV

STOP EXPOSURE IN PERSON-SV

ANNULAR AREA	STOP_1	3.77E-03
ANNULAR AREA	STOP_2	1.63E-05
	TOTAL:	3.79E-03

HANDLING EXPOSURE IN PERSON-SV

HANDLING	VEHICLE	MATERIAL	METHOD	DOSE
HANDLE_1	VEHICLE_1	PACKAGE_1	LINE-SOURCE	1.16E-03
			TOTAL:	1.16E-03

Calc-06944: Irradiated Fuel to Yucca Mt.: Fatalities

ACCIDENT SUMMARY
******** *******

EXPECTED VALUES OF POPULATION RISK IN PERSON-SV

	GROUND	INHALED	RESUSPD	CLOUDSH	TOTAL
RURAL_AZ	2.31E-12	1.60E-13	5.67E-16	1.91E-16	2.47E-12
SUBURBN_AZ	6.28E-13	4.35E-14	1.54E-16	5.21E-17	6.72E-13
URBAN_AZ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RURAL_DE	3.36E-12	2.33E-13	8.24E-16	2.78E-16	3.59E-12
SUBURBN_DE	4.14E-10	2.87E-11	1.02E-13	3.43E-14	4.43E-10
URBAN_DE	2.33E-09	1.61E-10	5.71E-13	1.93E-13	2.49E-09
RURAL_IL	6.66E-11	4.62E-12	1.63E-14	5.52E-15	7.13E-11
SUBURBN_IL	6.13E-10	4.25E-11	1.50E-13	5.08E-14	6.55E-10
URBAN_IL	1.83E-09	1.27E-10	4.49E-13	1.52E-13	1.96E-09
RURAL_IN	7.15E-11	4.96E-12	1.75E-14	5.92E-15	7.65E-11
SUBURBN_IN	7.07E-10	4.90E-11	1.73E-13	5.85E-14	7.56E-10
URBAN_IN	1.69E-09	1.17E-10	4.15E-13	1.40E-13	1.81E-09
RURAL_IA	8.09E-11	5.61E-12	1.99E-14	6.70E-15	8.65E-11
SUBURBN_IA	3.35E-10	2.32E-11	8.21E-14	2.77E-14	3.58E-10
URBAN_IA	4.24E-10	2.94E-11	1.04E-13	3.51E-14	4.53E-10
RURAL_NE	2.43E-10	1.68E-11	5.96E-14	2.01E-14	2.60E-10
SUBURBN_NE	7.57E-10	5.24E-11	1.86E-13	6.27E-14	8.09E-10
URBAN_NE	1.82E-09	1.26E-10	4.47E-13	1.51E-13	1.95E-09
RURAL_NV	3.19E-11	2.21E-12	7.82E-15	2.64E-15	3.41E-11
SUBURBN_NV	1.09E-10	7.56E-12	2.68E-14	9.03E-15	1.17E-10
URBAN_NV	2.66E-10	1.84E-11	6.52E-14	2.20E-14	2.84E-10
RURAL_NJ	1.60E-11	1.11E-12	3.94E-15	1.33E-15	1.72E-11
SUBURBN_NJ	2.92E-10	2.02E-11	7.17E-14	2.42E-14	3.12E-10
URBAN_NJ	4.28E-10	2.96E-11	1.05E-13	3.54E-14	4.57E-10
RURAL_OH	8.05E-11	5.57E-12	1.97E-14	6.66E-15	8.61E-11
SUBURBN_OH	8.98E-10	6.22E-11	2.20E-13	7.44E-14	9.60E-10
URBAN_OH	1.82E-09	1.26E-10	4.47E-13	1.51E-13	1.95E-09
RURAL_PA	4.76E-10	3.30E-11	1.17E-13	3.95E-14	5.09E-10
SUBURBN_PA	4.64E-09	3.22E-10	1.14E-12	3.84E-13	4.96E-09
URBAN_PA	9.35E-09	6.48E-10	2.29E-12	7.75E-13	1.00E-08
RURAL_UT	1.58E-10	1.10E-11	3.88E-14	1.31E-14	1.69E-10
SUBURBN_UT	1.31E-09	9.07E-11	3.21E-13	1.08E-13	1.40E-09
URBAN_UT	7.84E-09	5.43E-10	1.92E-12	6.49E-13	8.39E-09
RURAL_WY	2.34E-10	1.62E-11	5.75E-14	1.94E-14	2.51E-10
SUBURBN_WY	1.07E-09	7.39E-11	2.62E-13	8.83E-14	1.14E-09
URBAN_WY	1.53E-09	1.06E-10	3.75E-13	1.27E-13	1.64E-09
RURAL	1.47E-09	1.02E-10	3.59E-13	1.21E-13	1.57E-09
SUBURB	1.11E-08	7.72E-10	2.73E-12	9.23E-13	1.19E-08
URBAN	2.93E-08	2.03E-09	7.20E-12	2.43E-12	3.14E-08
TOTALS:	4.19E-08	2.91E-09	1.03E-11	3.47E-12	4.49E-08

Calc-06944: Irradiated Fuel to Yucca Mt.: Fatalities

SOCIETAL INGESTION RISK - PERSON-SV

LINK	GONADS	EFFECTIVE
RURAL_AZ	1.36E-11	1.38E-11
RURAL_DE	8.68E-12	8.78E-12
RURAL_IL	8.73E-11	8.83E-11
RURAL_IN	6.78E-11	6.86E-11
RURAL_IA	9.72E-11	9.83E-11
RURAL_NE	4.59E-10	4.64E-10
RURAL_NV	1.25E-10	1.27E-10
RURAL_NJ	2.57E-11	2.59E-11
RURAL_OH	7.70E-11	7.79E-11
RURAL_PA	5.08E-10	5.13E-10
RURAL_UT	3.01E-10	3.05E-10
RURAL_WY	9.02E-10	9.12E-10
TOTAL	2.67E-09	2.70E-09

SOCIETAL INGESTION RISK BY ORGAN - PERSON-SV

LINK	BREAST	LUNGS	RED MARR	BONE SUR	THYROID	REMAINDER
RURAL_AZ	1.13E-11	1.15E-11	1.44E-11	2.43E-11	1.14E-11	1.51E-11
RURAL_DE	7.20E-12	7.33E-12	9.15E-12	1.55E-11	7.28E-12	9.60E-12
RURAL_IL	7.24E-11	7.38E-11	9.20E-11	1.56E-10	7.33E-11	9.65E-11
RURAL_IN	5.63E-11	5.73E-11	7.15E-11	1.21E-10	5.69E-11	7.50E-11
RURAL_IA	8.07E-11	8.21E-11	1.02E-10	1.73E-10	8.16E-11	1.07E-10
RURAL_NE	3.81E-10	3.87E-10	4.83E-10	8.17E-10	3.85E-10	5.07E-10
RURAL_NV	1.04E-10	1.06E-10	1.32E-10	2.23E-10	1.05E-10	1.39E-10
RURAL_NJ	2.13E-11	2.17E-11	2.70E-11	4.57E-11	2.15E-11	2.84E-11
RURAL_OH	6.39E-11	6.51E-11	8.12E-11	1.37E-10	6.46E-11	8.52E-11
RURAL_PA	4.21E-10	4.29E-10	5.35E-10	9.05E-10	4.26E-10	5.61E-10
RURAL_UT	2.50E-10	2.55E-10	3.18E-10	5.37E-10	2.53E-10	3.33E-10
RURAL_WY	7.49E-10	7.62E-10	9.51E-10	1.61E-09	7.57E-10	9.97E-10
TOTAL	2.22E-09	2.26E-09	2.82E-09	4.76E-09	2.24E-09	2.95E-09

RUN DATE: [15-FEB-13 AT 14:17:03] PAGE 12

Calc-06944: Irradiated Fuel to Yucca Mt.: Fatalities

EXPECTED RISK VALUES - OTHER

LINK	EARLY FATALITY	EARLY MORBIDITY
RURAL_AZ	0.00E+00	0.00E+00
SUBURBN_AZ	0.00E+00	0.00E+00
URBAN_AZ	0.00E+00	0.00E+00
RURAL_DE	0.00E+00	0.00E+00
SUBURBN_DE	0.00E+00	0.00E+00
URBAN_DE	0.00E+00	0.00E+00
RURAL_IL	0.00E+00	0.00E+00
SUBURBN_IL	0.00E+00	0.00E+00
URBAN_IL	0.00E+00	0.00E+00
RURAL_IN	0.00E+00	0.00E+00
SUBURBN_IN	0.00E+00	0.00E+00
URBAN_IN	0.00E+00	0.00E+00
RURAL_IA	0.00E+00	0.00E+00
SUBURBN_IA	0.00E+00	0.00E+00
URBAN_IA	0.00E+00	0.00E+00
RURAL_NE	0.00E+00	0.00E+00
SUBURBN_NE	0.00E+00	0.00E+00
URBAN_NE	0.00E+00	0.00E+00
RURAL_NV	0.00E+00	0.00E+00
SUBURBN_NV	0.00E+00	0.00E+00
URBAN_NV	0.00E+00	0.00E+00
RURAL_NJ	0.00E+00	0.00E+00
SUBURBN_NJ	0.00E+00	0.00E+00
URBAN_NJ	0.00E+00	0.00E+00
RURAL_OH	0.00E+00	0.00E+00
SUBURBN_OH	0.00E+00	0.00E+00
URBAN_OH	0.00E+00	0.00E+00
RURAL_PA	0.00E+00	0.00E+00
SUBURBN_PA	0.00E+00	0.00E+00
URBAN_PA	0.00E+00	0.00E+00
RURAL_UT	0.00E+00	0.00E+00
SUBURBN_UT	0.00E+00	0.00E+00
URBAN_UT	0.00E+00	0.00E+00
RURAL_WY	0.00E+00	0.00E+00
SUBURBN_WY	0.00E+00	0.00E+00
URBAN_WY	0.00E+00	0.00E+00
TOTAL	0.00E+00	0.00E+00

EOI
END OF RUN
SUCCESSFUL COMPLETION

6 RADTRAN INJURIES CASE OUTPUT

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                    RUN DATE: [ 15-FEB-13 AT 13:47:07 ]            PAGE    1


  RRRR    AAA   DDDD   TTTTT  RRRR    AAA   N   N  55555         6
  R   R  A   A  D   D    T    R   R  A   A  NN  N  5             6
  R   R  A   A  D   D    T    R   R  A   A  N N N  5             6
  RRRR   A   A  D   D    T    RRRR   A   A  N  NN  5555          6666
  R R    AAAAA  D   D    T    R R    AAAAA  N   N      5         6   6
  R  R   A   A  D   D    T    R  R   A   A  N   N  5   5         6   6
  R   R  A   A  DDDD     T    R   R  A   A  N   N  5555      *    666

                           RADTRAN 5.6   February 20, 2006

                                   INPUT ECHO
                                   ----------


 TITLE Calc-06944: Irradiated Fuel to Yucca Mt.: Injuries
 INPUT STANDARD
STD: 0 10 18                               && DIMEN=NSEV NRAD NAREAS
STD: 1 3 3 0                               && PARM=IRNKC IANA ISEN IPSQSB
STD: .TRUE. .FALSE.                        && FORM = UNIT, SI-UNITS?
STD: 2.3E12                                && NEVAL FOR CF252
STD: 9.25E5 5.77E6 1.27E6                  && RPCTHY FOR I125, I129, I131
STD: 0.0 0.0 0.0 0.0 0.0                   && TRANSFER GAMMA
STD: 7.42E-3 2.02E-2 6.17E-5 3.17E-8 0.0   && TRANSFER NEUTRON
STD: 30  24                                && MITDDIST  MITDVEL
STD: 1  2   .0018                          && ITRAIN FMINCL DDRWEF
STD:    33    68    105   244   369                && CENTER LINE
STD:   561  1018   1628  2308  4269                && DISTANCES
STD:  5468 11136  13097 21334 40502                && FOR AVERAGE
STD: 69986 89860 120878 0 0 0 0 0 0 0 0 0 0 0 0   && US CLOUD
STD: 4.59E+02 1.53E+03 3.94E+03 1.25E+04 3.04E+04 6.85E+04 1.76E+05 4.45E+05
STD: 8.59E+05 2.55E+06 4.45E+06 1.03E+07 2.16E+07 5.52E+07 1.77E+08 4.89E+08
STD: 8.12E+08 1.35E+09 0 0 0 0 0 0 0 0 0 0 0 0 0     && AREADA
STD: 3.42E-03 1.72E-03 8.58E-04 3.42E-04 1.72E-04 8.58E-05 3.42E-05 1.72E-05
STD:  8.58E-06 3.42E-06 1.72E-06 8.58E-07 3.42E-07 1.72E-07 8.58E-08 5.42E-08
STD:  4.30E-08 3.42E-08 0 0 0 0 0 0 0 0 0 0 0 0 0     && DFLEV
STD: 3 6 9 12 15 30 61 91 152 305 0 0 0 0 0
STD: 3 6 9 12 15 30 61 91 152 305 0 0 0 0 0
STD: 3 6 9 12 15 30 61 91 152 305 0 0 0 0 0 && RADIST
STD: 0.5                               && SMLPKG
STD: 1.0  0.87  0.018                  && SHIELDING FACTORS RR  RS  RU
STD:  30  30  800                      && OFFLINK {FREEWAY}
STD:  27  30  800                      && OFFLINK {NON-FREEWAY}
STD:   5   8  800                      && OFFLINK {CITY STREETS}
STD:  30  30  800                      && OFFLINK {RAILWAY}
STD: 200 200 1000                      && OFFLINK {WATERWAY}
STD: 15  3  3  3  4                    && ONLINK {FWAY NONFWY STREET RAIL ADJ}
STD: 6.0  4  40.0                      && RPD FNOATT INTERDICT
STD: 0.05   0.2   3.3E-4               && BDF CULVL BRATE
STD: 0.9   0.1                         && UBF USWF
STD: 1.0  10.0 1.0                     && EVACUATION SURVEY CAMPAIGN
```

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             Calc-06944: Irradiated Fuel to Yucca Mt.: Injuries

STD: 0.0  0.0     1.5E-8  5.3E-8      && HIGHWAY - RURAL - NONRAD
STD: 0.0  0.0     3.7E-9  1.3E-8      && HIGHWAY - SUBURBAN - NONRAD
STD: 0.0  0.0     2.1E-9  7.5E-9      && HIGHWAY - URBAN - NONRAD
STD: 0.0  0.0    1.81E-9  2.64E-8     && GENERAL FREIGHT - R - NONRAD
STD: 0.0  0.0    1.81E-9  2.64E-8     && GENERAL FREIGHT - S - NONRAD
STD: 0.0  0.0    1.81E-9  2.64E-8     && GENERAL FREIGHT - U - NONRAD
STD: 0.0  0.0    1.27E-7  1.85E-6     && DEDICATED RAIL - R - NONRAD
STD: 0.0  0.0    1.27E-7  1.85E-6     && DEDICATED RAIL - S - NONRAD
STD: 0.0  0.0    1.27E-7  1.85E-6     && DEDICATED RAIL - U - NONRAD
STD: 0.0 0.0 0.0 0.0 0.0 0.0          && PSPROB
STD: 0.67  0.67  0.42                 && TIMENDE NON-DISPERSAL EVAC TIME (LCF&EARLY)
STD: 2 2 1                            && FLAGS=IUOPT IACC REGCHECK
STD: 5E-4, 4E-4, 1.0E-4               && LCFCON(1), LCFCON(2), GECON
STD: R5INGEST.BIN                     && INGESTION FILE
 OUTPUT BQ_SV
 FORM UNIT
 DIMEN 19 10 18
 PARM 1 3 1 0
 SEVERITY
    NPOP=1
       NMODE=1
        1.53E-8
  5.88E-5 1.81E-6 7.49E-8 4.65E-7 3.31E-9
  0.0 1.13E-8 8.03E-11 0.0 1.44E-10
  1.02E-12 0.0 7.49E-11 0.0 0.0
  0.0 5.86E-6 0.99993
    NPOP=2
       NMODE=1
        1.53E-8
  5.88E-5 1.81E-6 7.49E-8 4.65E-7 3.31E-9
  0.0 1.13E-8 8.03E-11 0.0 1.44E-10
  1.02E-12 0.0 7.49E-11 0.0 0.0
  0.0 5.86E-6 0.99993
    NPOP=3
       NMODE=1
        1.53E-8
  5.88E-5 1.81E-6 7.49E-8 4.65E-7 3.31E-9
  0.0 1.13E-8 8.03E-11 0.0 1.44E-10
  1.02E-12 0.0 7.49E-11 0.0 0.0
  0.0 5.86E-6 0.99993
 RELEASE
    GROUP=Part
       RFRAC
          6.0E-7
  1.0E-7 1.3E-7 3.8E-6 3.2E-7 3.7E-7
  2.1E-6 6.1E-7 6.7E-7 6.8E-7 6.1E-7
  6.7E-7 6.8E-7 1.8E-5 9.0E-6 6.8E-7
  6.8E-7 6.7E-8 0.0
       AERSOL
          1.0
```

Calc-06944: Irradiated Fuel to Yucca Mt.: Injuries

```
1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0
     RESP
        1.0
1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0
     LOS
        0.0
0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0
     DEPVEL 0.01
  GROUP=Cs
     RFRAC
        2.4E-8
4.1E-9 5.4E-9 3.6E-5 1.3E-8 1.5E-8
2.7E-5 2.4E-8 2.7E-8 5.9E-6 2.4E-8
2.7E-8 5.9E-6 9.6E-5 5.5E-5 5.9E-6
5.9E-6 1.7E-5 0.0
     AERSOL
        1.0
1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0
     RESP
        1.0
1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0
     LOS
        0.0
0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0
     DEPVEL 0.01
  GROUP=Ru
     RFRAC
        6.0E-7
1.0E-7 1.3E-7 3.8E-6 3.2E-7 3.7E-7
2.1E-6 6.1E-7 6.7E-7 6.8E-7 6.1E-7
6.7E-7 6.8E-7 8.4E-5 5.0E-5 6.4E-6
6.4E-6 6.7E-8 0.0
     AERSOL
        1.0
1.0 1.0 1.0 1.0 1.0
```

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                  RUN DATE: [ 15-FEB-13 AT 13:47:07 ]            PAGE    4

             Calc-06944: Irradiated Fuel to Yucca Mt.: Injuries

 1.0 1.0 1.0 1.0 1.0
 1.0 1.0 1.0 1.0 1.0
 1.0 1.0 1.0
      RESP
         1.0
 1.0 1.0 1.0 1.0 1.0
 1.0 1.0 1.0 1.0 1.0
 1.0 1.0 1.0 1.0 1.0
 1.0 1.0 1.0
      LOS
         0.0
 0.0 0.0 0.0 0.0 0.0
 0.0 0.0 0.0 0.0 0.0
 0.0 0.0 0.0 0.0 0.0
 0.0 0.0 0.0
      DEPVEL 0.01
   GROUP=Cor
      RFRAC
         0.0020
 0.0014 0.0018 0.0032 0.0018 0.0021
 0.0031 0.02 0.0022 0.0025 0.0020
 0.0022 0.0025 0.0064 0.0059 0.0033
 0.0033 0.0025 0.0
      AERSOL
         1.0
 1.0 1.0 1.0 1.0 1.0
 1.0 1.0 1.0 1.0 1.0
 1.0 1.0 1.0 1.0 1.0
 1.0 1.0 1.0
      RESP
         1.0
 1.0 1.0 1.0 1.0 1.0
 1.0 1.0 1.0 1.0 1.0
 1.0 1.0 1.0 1.0 1.0
 1.0 1.0 1.0
      LOS
         0.0
 0.0 0.0 0.0 0.0 0.0
 0.0 0.0 0.0 0.0 0.0
 0.0 0.0 0.0 0.0 0.0
 0.0 0.0 0.0
      DEPVEL 0.01
PACKAGE PACKAGE_1 13.9 1.0 0.0 5.2
   AM241 1440.0 Part
   AM242M 33.0 Part
   CM245 2.0 Part
   CM244 13500.0 Part
   CM243 62.0 Part
   CM242 62.0 Part
   CE144 13200.0 Part
   AM243 60.0 Part
   EU154 15600.0 Part
   EU155 8270.0 Part
```

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RUN DATE: [ 15-FEB-13 AT 13:47:07 ]          PAGE    5

        Calc-06944: Irradiated Fuel to Yucca Mt.: Injuries

   PM147 31300.0 Part
   PU238 10900.0 Part
   PU239 427.0 Part
   PU240 852.0 Part
   PU241 135000.0 Part
   PU242 3.0 Part
   SB125 7170.0 Part
   SR90 106000.0 Part
   Y90 106000.0 Part
   CS134 77600.0 Cs
   CS137 158000.0 Cs
   RU106 22900.0 Ru
   CO60 169.0 Cor
END
VEHICLE -1 VEHICLE_1 1.39E01 1.0 0.0 5.2 1.0 2.0 4.0 1.0 1.0
      PACKAGE_1 1.0
FLAGS
   IACC 2
   IUOPT 2
   REGCHECK 1
MODSTD
   DISTOFF FREEWAY 3.00E01 3.00E01 8.00E02
   DISTOFF SECONDARY 2.70E01 3.00E01 8.00E02
   DISTOFF STREET 5.00E00 8.00E00 8.00E02
   DISTON
     FREEWAY 1.50E01
     SECONDARY 3.00E00
     STREET 3.00E00
     ADJACENT 4.00E00
   BDF 5.00E-02
   BRATE 3.30E-04
   CULVL 2.00E-01
   EVACUATION 1.00E00
   GECON 1.00E-04
   INTERDICT 4.00E01
   LCFCON 5.00E-04 4.00E-04
   SURVEY 1.00E01
   UBF 5.20E-01
   USWF 4.80E-01
   CAMPAIGN 8.33E-02
   MITDDIST 3.00E01
   MITDVEL 2.40E01
   RPD 6.00E00
   RR 1.00E00
   RU 1.80E-02
   RS 8.70E-01
   SMALLPKG 5.00E-01
   RPCTHYROID
     I129  5.77E06
EOF
LINK RURAL_AZ VEHICLE_1 46.8 88.9 1.5 3.2 530.0 1.32E-7 0.886 R 1 1.0
LINK SUBURBN_AZ VEHICLE_1 0.3 88.9 1.5 135.8 760.0 1.32E-7 0.886 S 1 1.0
LINK URBAN_AZ VEHICLE_1 0.0 88.9 1.5 0.0 2400.0 1.32E-7 0.886 U 1 1.0
```

```
LINK RURAL_DE VEHICLE_1 7.6 88.9 1.5 7.3 530.0 5.18E-7 0.66 R 1 1.0
LINK SUBURBN_DE VEHICLE_1 13.9 88.9 1.5 492.2 760.0 5.18E-7 0.66 S 1 1.0
LINK URBAN_DE VEHICLE_1 5.3 88.9 1.5 2496.1 2400.0 5.18E-7 0.66 U 1 1.0
LINK RURAL_IL VEHICLE_1 178.4 88.9 1.5 14.4 530.0 2.22E-7 0.676 R 1 1.0
LINK SUBURBN_IL VEHICLE_1 73.0 88.9 1.5 323.6 760.0 2.22E-7 0.676 S 1 1.0
LINK URBAN_IL VEHICLE_1 10.2 88.9 1.5 2379.1 2400.0 2.22E-7 0.676 U 1 1.0
LINK RURAL_IN VEHICLE_1 136.7 88.9 1.5 19.9 530.0 2.25E-7 0.622 R 1 1.0
LINK SUBURBN_IN VEHICLE_1 97.3 88.9 1.5 276.3 760.0 2.25E-7 0.622 S 1 1.0
LINK URBAN_IN VEHICLE_1 9.4 88.9 1.5 2354.7 2400.0 2.25E-7 0.622 U 1 1.0
LINK RURAL_IA VEHICLE_1 393.8 88.9 1.5 15.7 530.0 1.12E-7 0.768 R 1 1.0
LINK SUBURBN_IA VEHICLE_1 95.4 88.9 1.5 268.0 760.0 1.12E-7 0.768 S 1 1.0
LINK URBAN_IA VEHICLE_1 5.1 88.9 1.5 2185.2 2400.0 1.12E-7 0.768 U 1 1.0
LINK RURAL_NE VEHICLE_1 652.2 88.9 1.5 10.0 530.0 3.19E-7 0.618 R 1 1.0
LINK SUBURBN_NE VEHICLE_1 75.6 88.9 1.5 268.5 760.0 3.19E-7 0.618 S 1 1.0
LINK URBAN_NE VEHICLE_1 7.0 88.9 1.5 2401.8 2400.0 3.19E-7 0.618 U 1 1.0
LINK RURAL_NV VEHICLE_1 252.6 88.9 1.5 4.8 530.0 2.25E-7 0.658 R 1 1.0
LINK SUBURBN_NV VEHICLE_1 15.5 88.9 1.5 267.6 760.0 2.25E-7 0.658 S 1 1.0
LINK URBAN_NV VEHICLE_1 1.5 88.9 1.5 2318.5 2400.0 2.25E-7 0.658 U 1 1.0
LINK RURAL_NJ VEHICLE_1 20.6 88.9 1.5 11.8 530.0 5.65E-7 0.692 R 1 1.0
LINK SUBURBN_NJ VEHICLE_1 12.5 88.9 1.5 353.9 760.0 5.65E-7 0.692 S 1 1.0
LINK URBAN_NJ VEHICLE_1 1.1 88.9 1.5 2025.9 2400.0 5.65E-7 0.692 U 1 1.0
LINK RURAL_OH VEHICLE_1 213.1 88.9 1.5 19.7 530.0 1.64E-7 0.854 R 1 1.0
LINK SUBURBN_OH VEHICLE_1 151.3 88.9 1.5 309.6 760.0 1.64E-7 0.854 S 1 1.0
LINK URBAN_OH VEHICLE_1 14.8 88.9 1.5 2211.7 2400.0 1.64E-7 0.854 U 1 1.0
LINK RURAL_PA VEHICLE_1 448.0 88.9 1.5 17.7 530.0 5.14E-7 0.745 R 1 1.0
LINK SUBURBN_PA VEHICLE_1 258.1 88.9 1.5 299.3 760.0 5.14E-7 0.745 S 1 1.0
LINK URBAN_PA VEHICLE_1 22.2 88.9 1.5 2413.1 2400.0 5.14E-7 0.745 U 1 1.0
LINK RURAL_UT VEHICLE_1 471.6 88.9 1.5 9.9 530.0 2.9E-7 0.872 R 1 1.0
LINK SUBURBN_UT VEHICLE_1 106.5 88.9 1.5 362.6 760.0 2.9E-7 0.872 S 1 1.0
LINK URBAN_UT VEHICLE_1 32.2 88.9 1.5 2472.3 2400.0 2.9E-7 0.872 U 1 1.0
LINK RURAL_WY VEHICLE_1 607.2 88.9 1.5 4.9 530.0 6.74E-7 0.479 R 1 1.0
LINK SUBURBN_WY VEHICLE_1 33.9 88.9 1.5 399.4 760.0 6.74E-7 0.479 S 1 1.0
LINK URBAN_WY VEHICLE_1 3.4 88.9 1.5 1966.6 2400.0 6.74E-7 0.479 U 1 1.0

STOP STOP_1 VEHICLE_1 30000.0 1.0 10.0 1.0 6.0
STOP STOP_2 VEHICLE_1 340.0 10.0 800.0 0.2 6.0

HANDLING HANDLE_1 VEHICLE_1 5.0 1.0 0.5

EOF
```

RUN DATE: [15-FEB-13 AT 13:47:07] PAGE 6

Calc-06944: Irradiated Fuel to Yucca Mt.: Injuries

NON-RADIOLOGICAL DATA (ACCIDENTS and FATALITIES)
****

HIGHWAY

	ACCIDENT RATE	ACCIDENTS	FATALITIES
RURAL_AZ	1.32E-07	6.18E-06	5.47E-06
SUBURBN_AZ	1.32E-07	3.96E-08	3.51E-08
URBAN_AZ	1.32E-07	0.00E+00	0.00E+00
RURAL_DE	5.18E-07	3.94E-06	2.60E-06
SUBURBN_DE	5.18E-07	7.20E-06	4.75E-06
URBAN_DE	5.18E-07	2.75E-06	1.81E-06
RURAL_IL	2.22E-07	3.96E-05	2.68E-05
SUBURBN_IL	2.22E-07	1.62E-05	1.10E-05
URBAN_IL	2.22E-07	2.26E-06	1.53E-06
RURAL_IN	2.25E-07	3.08E-05	1.91E-05
SUBURBN_IN	2.25E-07	2.19E-05	1.36E-05
URBAN_IN	2.25E-07	2.12E-06	1.32E-06
RURAL_IA	1.12E-07	4.41E-05	3.39E-05
SUBURBN_IA	1.12E-07	1.07E-05	8.21E-06
URBAN_IA	1.12E-07	5.71E-07	4.39E-07
RURAL_NE	3.19E-07	2.08E-04	1.29E-04
SUBURBN_NE	3.19E-07	2.41E-05	1.49E-05
URBAN_NE	3.19E-07	2.23E-06	1.38E-06
RURAL_NV	2.25E-07	5.68E-05	3.74E-05
SUBURBN_NV	2.25E-07	3.49E-06	2.29E-06
URBAN_NV	2.25E-07	3.38E-07	2.22E-07
RURAL_NJ	5.65E-07	1.16E-05	8.05E-06
SUBURBN_NJ	5.65E-07	7.06E-06	4.89E-06
URBAN_NJ	5.65E-07	6.22E-07	4.30E-07
RURAL_OH	1.64E-07	3.49E-05	2.98E-05
SUBURBN_OH	1.64E-07	2.48E-05	2.12E-05
URBAN_OH	1.64E-07	2.43E-06	2.07E-06
RURAL_PA	5.14E-07	2.30E-04	1.72E-04
SUBURBN_PA	5.14E-07	1.33E-04	9.88E-05
URBAN_PA	5.14E-07	1.14E-05	8.50E-06
RURAL_UT	2.90E-07	1.37E-04	1.19E-04
SUBURBN_UT	2.90E-07	3.09E-05	2.69E-05
URBAN_UT	2.90E-07	9.34E-06	8.14E-06
RURAL_WY	6.74E-07	4.09E-04	1.96E-04
SUBURBN_WY	6.74E-07	2.28E-05	1.09E-05
URBAN_WY	6.74E-07	2.29E-06	1.10E-06
TOTALS:	1.19E-05	1.55E-03	1.02E-03

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RUN DATE: [ 15-FEB-13 AT 13:47:07 ]            PAGE    7

Calc-06944: Irradiated Fuel to Yucca Mt.: Injuries

REGULATORY CHECKS


FOR VEHICLE_1  THE DOSE RATE AT 2 METERS COULD EXCEED 0.1 MSV/HR
THE VEHICLE DOSE RATE HAS BEEN RESET TO EQUAL   0.13 MSV/HR
```

RUN DATE: [15-FEB-13 AT 13:47:07] PAGE 8

Calc-06944: Irradiated Fuel to Yucca Mt.: Injuries

CALCULATIONAL INFORMATION

FOR VEHICLE_1 AREAS WITH TOTAL CONTAMINATION RATIO GREATER THAN 40.000
(THE AREAS MARKED WITH AN 'X' ARE INTERDICTED AND HAVE
NO 50 YEAR GROUNDSHINE DOSE AND NO INGESTION DOSE.)

AREA/SEVERITY	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-
2	X	-	-	X	-	X	X	X	X	X	X	X	X	X	X	X	X	X	-
3	-	-	-	X	-	-	X	X	-	X	-	-	X	X	X	X	X	X	-
4	-	-	-	X	-	-	X	X	-	-	-	-	-	X	X	-	-	X	-
5	-	-	-	X	-	-	X	-	-	-	-	-	-	X	X	-	-	-	-
6	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-
7	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-
8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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Calc-06944: Irradiated Fuel to Yucca Mt.: Injuries

INCIDENT-FREE SUMMARY
******** **** *******

IN-TRANSIT POPULATION EXPOSURE IN PERSON-SV
*INPUT DATA WERE ALTERED WITH REGULATORY CHECKS

	PASSENGER	CREW	OFF LINK	ON LINK	TOTALS
RURAL_AZ	0.00E+00	2.07E-05	5.07E-08	3.26E-06	2.41E-05
SUBURBN_AZ	0.00E+00	1.33E-07	1.20E-08	3.00E-08	1.75E-07
URBAN_AZ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RURAL_DE	0.00E+00	3.37E-06	1.88E-08	5.30E-07	3.92E-06
SUBURBN_DE	0.00E+00	6.16E-06	2.02E-06	1.39E-06	9.57E-06
URBAN_DE	0.00E+00	2.35E-06	8.07E-08	1.67E-06	4.10E-06
RURAL_IL	0.00E+00	7.91E-05	8.70E-07	1.24E-05	9.24E-05
SUBURBN_IL	0.00E+00	3.24E-05	6.96E-06	7.30E-06	4.66E-05
URBAN_IL	0.00E+00	4.52E-06	1.48E-07	3.22E-06	7.89E-06
RURAL_IN	0.00E+00	6.06E-05	9.22E-07	9.53E-06	7.11E-05
SUBURBN_IN	0.00E+00	4.31E-05	7.92E-06	9.73E-06	6.08E-05
URBAN_IN	0.00E+00	4.17E-06	1.35E-07	2.97E-06	7.27E-06
RURAL_IA	0.00E+00	1.75E-04	2.09E-06	2.75E-05	2.04E-04
SUBURBN_IA	0.00E+00	4.23E-05	7.54E-06	9.54E-06	5.94E-05
URBAN_IA	0.00E+00	2.26E-06	6.80E-08	1.61E-06	3.94E-06
RURAL_NE	0.00E+00	2.89E-04	2.21E-06	4.55E-05	3.37E-04
SUBURBN_NE	0.00E+00	3.35E-05	5.98E-06	7.56E-06	4.71E-05
URBAN_NE	0.00E+00	3.10E-06	1.03E-07	2.21E-06	5.42E-06
RURAL_NV	0.00E+00	1.12E-04	4.11E-07	1.76E-05	1.30E-04
SUBURBN_NV	0.00E+00	6.87E-06	1.22E-06	1.55E-06	9.64E-06
URBAN_NV	0.00E+00	6.65E-07	2.12E-08	4.74E-07	1.16E-06
RURAL_NJ	0.00E+00	9.13E-06	8.24E-08	1.44E-06	1.07E-05
SUBURBN_NJ	0.00E+00	5.54E-06	1.30E-06	1.25E-06	8.09E-06
URBAN_NJ	0.00E+00	4.88E-07	1.36E-08	3.47E-07	8.49E-07
RURAL_OH	0.00E+00	9.45E-05	1.42E-06	1.49E-05	1.11E-04
SUBURBN_OH	0.00E+00	6.71E-05	1.38E-05	1.51E-05	9.60E-05
URBAN_OH	0.00E+00	6.56E-06	2.00E-07	4.67E-06	1.14E-05
RURAL_PA	0.00E+00	1.99E-04	2.69E-06	3.12E-05	2.33E-04
SUBURBN_PA	0.00E+00	1.14E-04	2.28E-05	2.58E-05	1.63E-04
URBAN_PA	0.00E+00	9.84E-06	3.27E-07	7.01E-06	1.72E-05
RURAL_UT	0.00E+00	2.09E-04	1.58E-06	3.29E-05	2.44E-04
SUBURBN_UT	0.00E+00	4.72E-05	1.14E-05	1.07E-05	6.92E-05
URBAN_UT	0.00E+00	1.43E-05	4.86E-07	1.02E-05	2.49E-05
RURAL_WY	0.00E+00	2.69E-04	1.01E-06	4.23E-05	3.13E-04
SUBURBN_WY	0.00E+00	1.50E-05	3.99E-06	3.39E-06	2.24E-05
URBAN_WY	0.00E+00	1.51E-06	4.08E-08	1.07E-06	2.62E-06
RURAL	0.00E+00	1.52E-03	1.34E-05	2.39E-04	1.77E-03
SUBURB	0.00E+00	4.14E-04	8.49E-05	9.33E-05	5.92E-04
URBAN	0.00E+00	4.97E-05	1.62E-06	3.54E-05	8.68E-05
TOTALS:	0.00E+00	1.98E-03	9.99E-05	3.68E-04	2.45E-03

MAXIMUM INDIVIDUAL IN-TRANSIT DOSE

VEHICLE_1 5.92E-09 SV

STOP EXPOSURE IN PERSON-SV

ANNULAR AREA	STOP_1	3.77E-03
ANNULAR AREA	STOP_2	1.63E-05
	TOTAL:	3.79E-03

HANDLING EXPOSURE IN PERSON-SV

HANDLING	VEHICLE	MATERIAL	METHOD	DOSE
HANDLE_1	VEHICLE_1	PACKAGE_1	LINE-SOURCE	1.16E-03
			TOTAL:	1.16E-03

RUN DATE: [15-FEB-13 AT 13:47:07]   PAGE   10

Calc-06944: Irradiated Fuel to Yucca Mt.: Injuries

ACCIDENT SUMMARY
******** *******
EXPECTED VALUES OF POPULATION RISK IN PERSON-SV

	GROUND	INHALED	RESUSPD	CLOUDSH	TOTAL
RURAL_AZ	2.31E-12	1.60E-13	5.67E-16	1.91E-16	2.47E-12
SUBURBN_AZ	6.28E-13	4.35E-14	1.54E-16	5.21E-17	6.72E-13
URBAN_AZ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RURAL_DE	3.36E-12	2.33E-13	8.24E-16	2.78E-16	3.59E-12
SUBURBN_DE	4.14E-10	2.87E-11	1.02E-13	3.43E-14	4.43E-10
URBAN_DE	2.33E-09	1.61E-10	5.71E-13	1.93E-13	2.49E-09
RURAL_IL	6.66E-11	4.62E-12	1.63E-14	5.52E-15	7.13E-11
SUBURBN_IL	6.13E-10	4.25E-11	1.50E-13	5.08E-14	6.55E-10
URBAN_IL	1.83E-09	1.27E-10	4.49E-13	1.52E-13	1.96E-09
RURAL_IN	7.15E-11	4.96E-12	1.75E-14	5.92E-15	7.65E-11
SUBURBN_IN	7.07E-10	4.90E-11	1.73E-13	5.85E-14	7.56E-10
URBAN_IN	1.69E-09	1.17E-10	4.15E-13	1.40E-13	1.81E-09
RURAL_IA	8.09E-11	5.61E-12	1.99E-14	6.70E-15	8.65E-11
SUBURBN_IA	3.35E-10	2.32E-11	8.21E-14	2.77E-14	3.58E-10
URBAN_IA	4.24E-10	2.94E-11	1.04E-13	3.51E-14	4.53E-10
RURAL_NE	2.43E-10	1.68E-11	5.96E-14	2.01E-14	2.60E-10
SUBURBN_NE	7.57E-10	5.24E-11	1.86E-13	6.27E-14	8.09E-10
URBAN_NE	1.82E-09	1.26E-10	4.47E-13	1.51E-13	1.95E-09
RURAL_NV	3.19E-11	2.21E-12	7.82E-15	2.64E-15	3.41E-11
SUBURBN_NV	1.09E-10	7.56E-12	2.68E-14	9.03E-15	1.17E-10
URBAN_NV	2.66E-10	1.84E-11	6.52E-14	2.20E-14	2.84E-10
RURAL_NJ	1.60E-11	1.11E-12	3.94E-15	1.33E-15	1.72E-11
SUBURBN_NJ	2.92E-10	2.02E-11	7.17E-14	2.42E-14	3.12E-10
URBAN_NJ	4.28E-10	2.96E-11	1.05E-13	3.54E-14	4.57E-10
RURAL_OH	8.05E-11	5.57E-12	1.97E-14	6.66E-15	8.61E-11
SUBURBN_OH	8.98E-10	6.22E-11	2.20E-13	7.44E-14	9.60E-10
URBAN_OH	1.82E-09	1.26E-10	4.47E-13	1.51E-13	1.95E-09
RURAL_PA	4.76E-10	3.30E-11	1.17E-13	3.95E-14	5.09E-10
SUBURBN_PA	4.64E-09	3.22E-10	1.14E-12	3.84E-13	4.96E-09
URBAN_PA	9.35E-09	6.48E-10	2.29E-12	7.75E-13	1.00E-08
RURAL_UT	1.58E-10	1.10E-11	3.88E-14	1.31E-14	1.69E-10
SUBURBN_UT	1.31E-09	9.07E-11	3.21E-13	1.08E-13	1.40E-09
URBAN_UT	7.84E-09	5.43E-10	1.92E-12	6.49E-13	8.39E-09
RURAL_WY	2.34E-10	1.62E-11	5.75E-14	1.94E-14	2.51E-10
SUBURBN_WY	1.07E-09	7.39E-11	2.62E-13	8.83E-14	1.14E-09
URBAN_WY	1.53E-09	1.06E-10	3.75E-13	1.27E-13	1.64E-09
RURAL	1.47E-09	1.02E-10	3.59E-13	1.21E-13	1.57E-09
SUBURB	1.11E-08	7.72E-10	2.73E-12	9.23E-13	1.19E-08
URBAN	2.93E-08	2.03E-09	7.20E-12	2.43E-12	3.14E-08
TOTALS:	4.19E-08	2.91E-09	1.03E-11	3.47E-12	4.49E-08

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Calc-06944: Irradiated Fuel to Yucca Mt.: Injuries

SOCIETAL INGESTION RISK - PERSON-SV

LINK	GONADS	EFFECTIVE
RURAL_AZ	1.36E-11	1.38E-11
RURAL_DE	8.68E-12	8.78E-12
RURAL_IL	8.73E-11	8.83E-11
RURAL_IN	6.78E-11	6.86E-11
RURAL_IA	9.72E-11	9.83E-11
RURAL_NE	4.59E-10	4.64E-10
RURAL_NV	1.25E-10	1.27E-10
RURAL_NJ	2.57E-11	2.59E-11
RURAL_OH	7.70E-11	7.79E-11
RURAL_PA	5.08E-10	5.13E-10
RURAL_UT	3.01E-10	3.05E-10
RURAL_WY	9.02E-10	9.12E-10
TOTAL	2.67E-09	2.70E-09

SOCIETAL INGESTION RISK BY ORGAN - PERSON-SV

LINK	BREAST	LUNGS	RED MARR	BONE SUR	THYROID	REMAINDER
RURAL_AZ	1.13E-11	1.15E-11	1.44E-11	2.43E-11	1.14E-11	1.51E-11
RURAL_DE	7.20E-12	7.33E-12	9.15E-12	1.55E-11	7.28E-12	9.60E-12
RURAL_IL	7.24E-11	7.38E-11	9.20E-11	1.56E-10	7.33E-11	9.65E-11
RURAL_IN	5.63E-11	5.73E-11	7.15E-11	1.21E-10	5.69E-11	7.50E-11
RURAL_IA	8.07E-11	8.21E-11	1.02E-10	1.73E-10	8.16E-11	1.07E-10
RURAL_NE	3.81E-10	3.87E-10	4.83E-10	8.17E-10	3.85E-10	5.07E-10
RURAL_NV	1.04E-10	1.06E-10	1.32E-10	2.23E-10	1.05E-10	1.39E-10
RURAL_NJ	2.13E-11	2.17E-11	2.70E-11	4.57E-11	2.15E-11	2.84E-11
RURAL_OH	6.39E-11	6.51E-11	8.12E-11	1.37E-10	6.46E-11	8.52E-11
RURAL_PA	4.21E-10	4.29E-10	5.35E-10	9.05E-10	4.26E-10	5.61E-10
RURAL_UT	2.50E-10	2.55E-10	3.18E-10	5.37E-10	2.53E-10	3.33E-10
RURAL_WY	7.49E-10	7.62E-10	9.51E-10	1.61E-09	7.57E-10	9.97E-10
TOTAL	2.22E-09	2.26E-09	2.82E-09	4.76E-09	2.24E-09	2.95E-09

RUN DATE: [15-FEB-13 AT 13:47:07]   PAGE   12

Calc-06944: Irradiated Fuel to Yucca Mt.: Injuries

EXPECTED RISK VALUES - OTHER

LINK	EARLY FATALITY	EARLY MORBIDITY
RURAL_AZ	0.00E+00	0.00E+00
SUBURBN_AZ	0.00E+00	0.00E+00
URBAN_AZ	0.00E+00	0.00E+00
RURAL_DE	0.00E+00	0.00E+00
SUBURBN_DE	0.00E+00	0.00E+00
URBAN_DE	0.00E+00	0.00E+00
RURAL_IL	0.00E+00	0.00E+00
SUBURBN_IL	0.00E+00	0.00E+00
URBAN_IL	0.00E+00	0.00E+00
RURAL_IN	0.00E+00	0.00E+00
SUBURBN_IN	0.00E+00	0.00E+00
URBAN_IN	0.00E+00	0.00E+00
RURAL_IA	0.00E+00	0.00E+00
SUBURBN_IA	0.00E+00	0.00E+00
URBAN_IA	0.00E+00	0.00E+00
RURAL_NE	0.00E+00	0.00E+00
SUBURBN_NE	0.00E+00	0.00E+00
URBAN_NE	0.00E+00	0.00E+00
RURAL_NV	0.00E+00	0.00E+00
SUBURBN_NV	0.00E+00	0.00E+00
URBAN_NV	0.00E+00	0.00E+00
RURAL_NJ	0.00E+00	0.00E+00
SUBURBN_NJ	0.00E+00	0.00E+00
URBAN_NJ	0.00E+00	0.00E+00
RURAL_OH	0.00E+00	0.00E+00
SUBURBN_OH	0.00E+00	0.00E+00
URBAN_OH	0.00E+00	0.00E+00
RURAL_PA	0.00E+00	0.00E+00
SUBURBN_PA	0.00E+00	0.00E+00
URBAN_PA	0.00E+00	0.00E+00
RURAL_UT	0.00E+00	0.00E+00
SUBURBN_UT	0.00E+00	0.00E+00
URBAN_UT	0.00E+00	0.00E+00
RURAL_WY	0.00E+00	0.00E+00
SUBURBN_WY	0.00E+00	0.00E+00
URBAN_WY	0.00E+00	0.00E+00
TOTAL	0.00E+00	0.00E+00

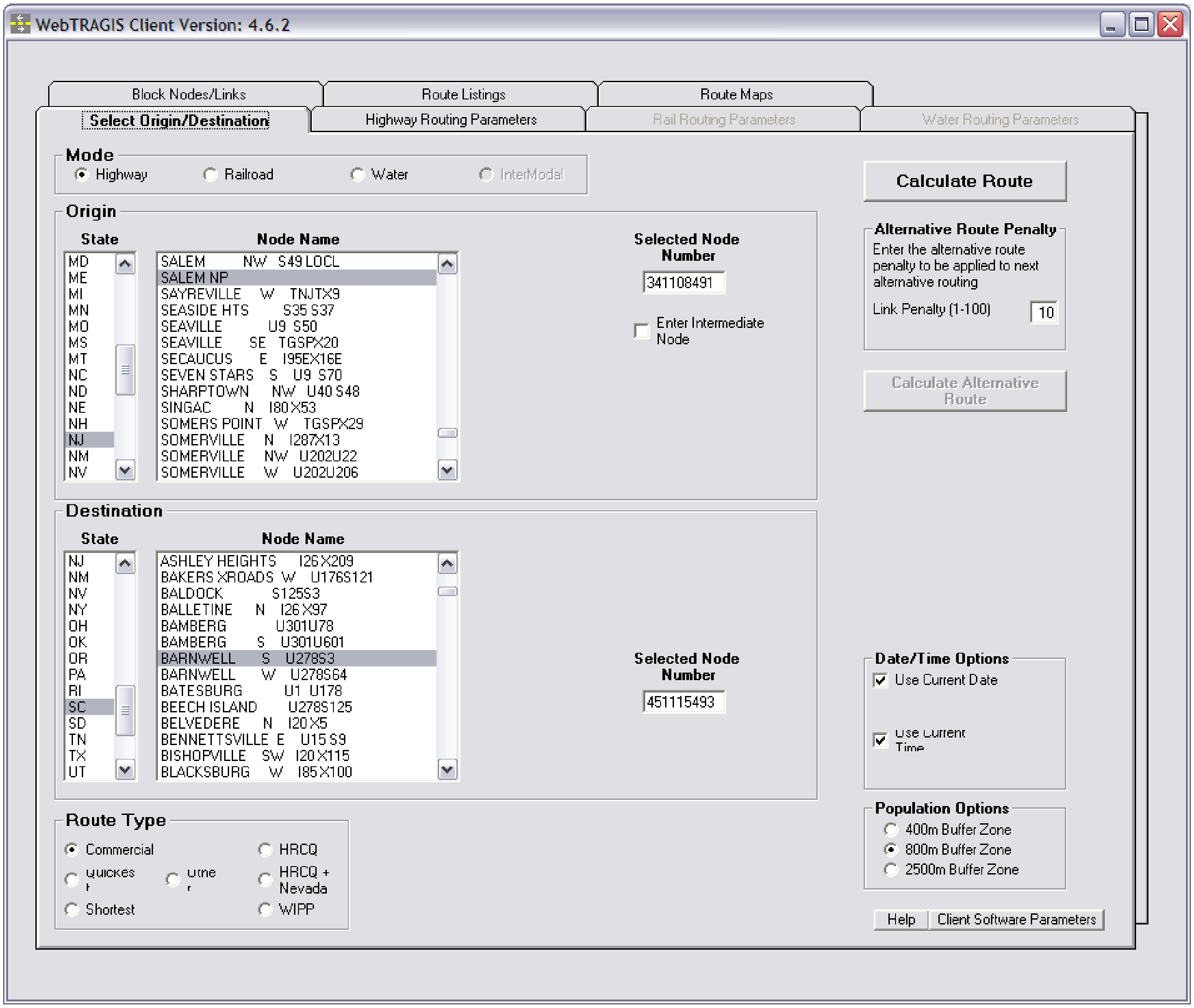
EOI
END OF RUN
SUCCESSFUL COMPLETION

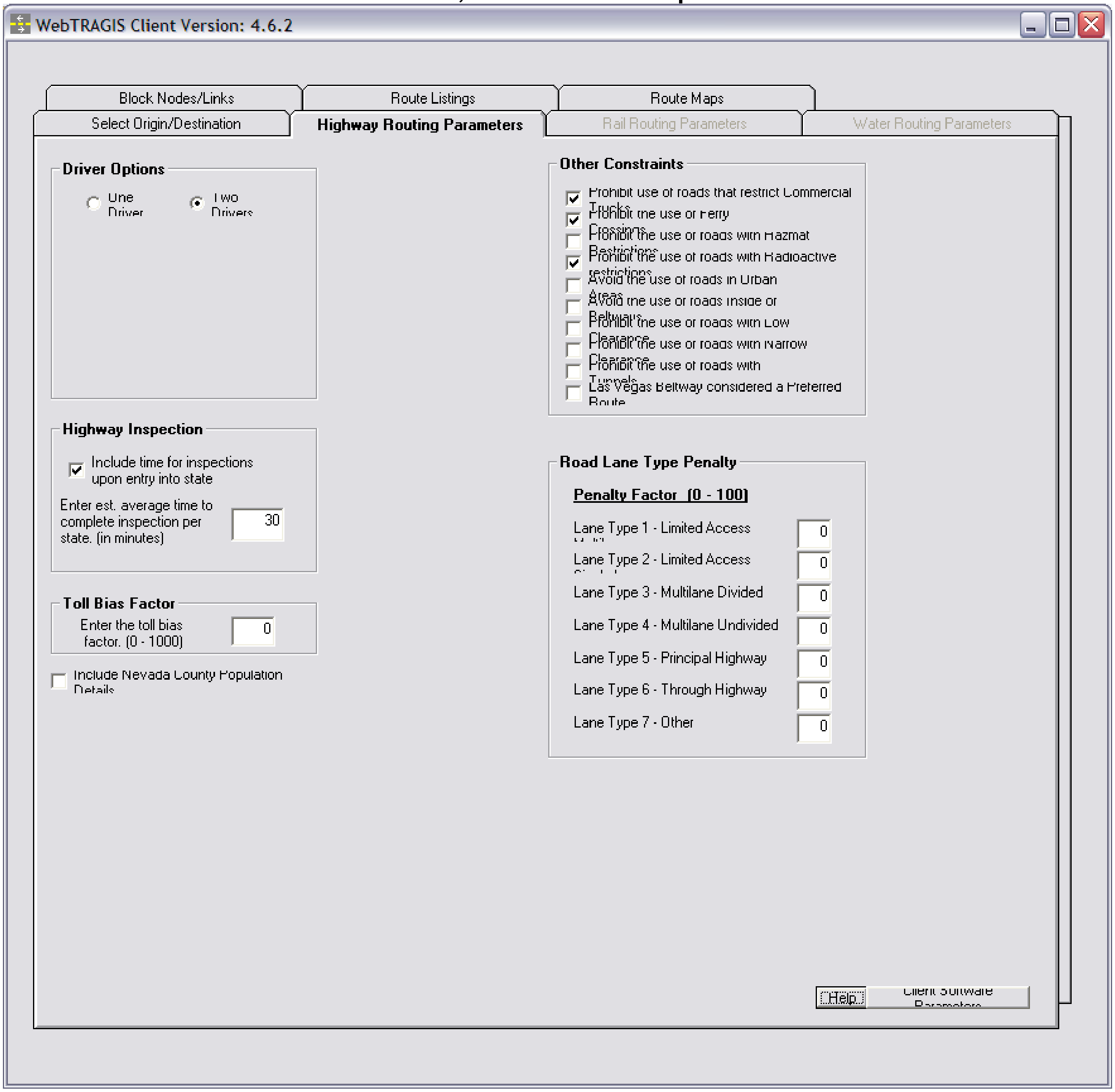
7A.2 RADWASTE ANALYSIS

This attachment contains the TRAGIS and RADCAT/RADTRAN input and output for one radwaste shipment from the PSEG Site to Barnwell, SC. The nuclide inventories are the total annual production for the bounding technology, which is the US-APWR.

1 TRAGIS INPUT

The TRAGIS input screens are reproduced below.




WebTRAGIS Client Version: 4.6.2
Block Nodes/Links
Route Listings
Route Maps
Select Origin/Destination
Highway Routing Parameters
Rail Routing Parameters
Water Routing Parameters
Driver Options
One Driver
Two Drivers
Other Constraints
Prohibit use of roads that restrict Commercial Trucks
Prohibit the use of Ferry Crossings
Prohibit the use of roads with Hazmat Restrictions
Prohibit the use of roads with Radioactive restrictions
Avoid the use of roads in Urban Areas
Avoid the use of roads inside of Beltways
Prohibit the use of roads with Low Clearance
Prohibit the use of roads with Narrow Clearance
Prohibit the use of roads with Tunnels
Las Vegas Beltway considered a Preferred Route
Highway Inspection
Include time for inspections upon entry into state
Enter est. average time to complete inspection per state. (in minutes)
30
Toll Bias Factor
Enter the toll bias factor. (0 - 1000)
0
Include Nevada County Population Details
Road Lane Type Penalty
Penalty Factor (0 - 100)
Lane Type 1 - Limited Access
0
Lane Type 2 - Limited Access
0
Lane Type 3 - Multilane Divided
0
Lane Type 4 - Multilane Undivided
0
Lane Type 5 - Principal Highway
0
Lane Type 6 - Through Highway
0
Lane Type 7 - Other
0
Help
Client Software Parameters

2 TRAGIS OUTPUT

```
TRAGIS Routing Engine Version 1.5.4        -- Highway Data Network   4.0

FROM:    SALEM NP                    NJ         Leaving  : 06/25/09 16:12
TO  :    BARNWELL       S    U278S3   SC              Arriving : 06/26/09 07:39


Routing parameters used to calculate the route-

  Routing type: Commercial with 2 driver(s)
    Time bias: 0.70 Mile bias: 0.30, Toll bias: 1.00

  Constraints used on route:
    Prohibit use of links prohibiting truck use
    Prohibit use of ferry crossing
    Prohibit use of roads with Radioactive materials prohibition


  Miles  Hwy Sign      City           Dir  Junction  State   Dist  Time Date     Hour
------------------------------------------------------------------------------------
    0.0                SALEM NP                          NJ      0.0 0:00 06/25/09 16:12
   12.3  LOCAL         SALEM          NW   S49 LOCL    NJ     12.3 0:24 06/25/09 16:36
    3.0  S49           PENNSVILLE     S    S49 C551    NJ     15.3 0:29 06/25/09 16:41
    4.7  C551          DEEPWATER      SE   TNJTI295    NJ     19.9 0:36 06/25/09 16:48
    0.4  I295$  TNJT$  DEEPWATER      S    I295X1      NJ     20.3 0:37 06/25/09 16:49
    0.9  I295#         crossing state border DE/NJ     BD     21.3 1:07 06/25/09 17:19
                       State Inspection took 30 minutes
    2.5  I295#         NEW CASTLE     N    I295S9      DE     23.8 1:10 06/25/09 17:22
    2.1  I295          NEWPORT        SE   I295I95     DE     25.9 1:12 06/25/09 17:24
    0.7  I95           NEWPORT        S    I95 X5      DE     26.6 1:13 06/25/09 17:25
    8.7  I95 $         NEWARK         S    I95 X1      DE     35.3 1:21 06/25/09 17:33
    2.3  I95 $         crossing state border DE/MD     BD     37.6 1:53 06/25/09 18:05
                       State Inspection took 30 minutes
    0.8  I95 $         ELK MILLS      SE   I95 X109    MD     38.3 1:54 06/25/09 18:06
   14.8  I95           AIKEN          N    I95 X93     MD     53.2 2:08 06/25/09 18:20
    8.9  S222          CONOWINGO           U1  S222    MD     62.1 2:21 06/25/09 18:33
   30.0  U1            FULLERTON      SW   I695X32     MD     92.1 3:00 06/25/09 19:12
    8.2  I695          TIMONIUM       S    I695I83     MD    100.3 3:09 06/25/09 19:21
    1.5  I695   I83    BALTIMORE      N    I695I83     MD    101.8 3:11 06/25/09 19:23
   10.1  I695          BALTIMORE      W    I695I70     MD    112.0 3:22 06/25/09 19:34
    4.6  I70           DANIELS        S    I70 X87     MD    116.6 3:26 06/25/09 19:38
   23.1  U29           FOUR CORNERS   SW   I495X30     MD    139.7 3:53 06/25/09 20:05
                       Rest  30 minutes
    9.5  I495          EMERY CORNERS  E    I495X39     MD    149.2 4:34 06/25/09 20:46
    2.3  I495          crossing state border MD/VA     BD    151.4 5:06 06/25/09 21:18
                       State Inspection took 30 minutes
   14.6  I495          SPRINGFIELD    N    I495I95     VA    166.1 5:22 06/25/09 21:34
   92.3  I95           RICHMOND       NW   I64 I95     VA    258.3 6:50 06/25/09 23:02
    3.4  I64    I95    RICHMOND       N    I64 I95     VA    261.7 6:53 06/25/09 23:05
   65.0  I95           EMPORIA        N    I95 X11     VA    326.7 7:58 06/26/09 00:10
   11.2  I95           crossing state border NC/VA     BD    337.9 8:38 06/26/09 00:50
                       Rest  30 minutes
                       State Inspection took 30 minutes
  182.1  I95           ROWLAND        SW   I95 X2      NC    520.0 11:45 06/26/09 03:57
    0.1  I95           crossing state border NC/SC     BD    520.1 12:15 06/26/09 04:27
                       State Inspection took 30 minutes
                       Rest  30 minutes
  102.4  I95           SANTEE         S    I95 X97     SC    622.4 14:12 06/26/09 06:24
   22.3  U301          ORANGEBURG          U301U601    SC    644.7 14:35 06/26/09 06:47
   18.4  U301   U601   BAMBERG             U301U78     SC    663.1 14:53 06/26/09 07:05
   14.9  U78           BLACKVILLE          U78 S3      SC    678.0 15:11 06/26/09 07:23
   10.8  S3            BARNWELL       S    U278S3      SC    688.8 15:27 06/26/09 07:39
```

Total elapsed time: 15:27   Total trip mileage: 688.8   Impedance: 688.0

Mileage by State :
DE: 16.3   MD: 113.9   NC: 182.1   NJ: 21.3   SC: 168.8   VA: 186.5

Mileage by Sign Type:
1-INTERSTATE: 540.5   2-US: 108.7   3-STATE: 22.7   5-COUNTY: 4.7
6-LOCAL: 12.3

Mileage by Lane Type:
1-Multi-Lane Controlled Access: 540.5   3-Multi-Lane Divided Highway: 63.8
5-Principle Road: 56.8   6-Through Road: 10.8
7-Other: 17.0

Mileage by Tribal Lands:
Total Outside Tribal Lands   :   688.8
Total Inside Tribal Lands   :   0.0

TRAGIS Routing Engine Version 1.5.4   --   2000 Census Data

POPULATION DENSITY within   800 meter Buffer Zone:
FROM: SALEM NP   NJ
TO : BARNWELL   S   U278S3   SC

ST	MILES	0	>0.0 -22.7	22.7 -59.7	59.7 -139	139 -326	326 -821	821 -1861	1861 -3326	3326 -5815	5815 -9996	>9996
DE	16.3	0.94	0.24	0.93	1.55	2.04	3.38	3.56	1.53	1.34	0.60	0.14
MD	113.9	4.50	1.53	8.92	14.06	13.87	13.95	13.03	16.63	14.86	8.61	3.91
NJ	21.3	4.37	3.43	2.66	2.36	1.85	3.25	1.70	0.99	0.55	0.14	0.00
NC	182.1	9.05	27.62	42.00	30.09	27.49	26.36	13.94	4.44	1.05	0.06	0.00
SC	168.8	22.05	42.19	30.51	15.61	20.55	20.09	11.81	4.66	1.20	0.06	0.07
VA	186.5	9.45	14.99	20.88	25.55	25.70	33.45	27.00	14.91	9.51	3.36	1.73
TOTALS												
	688.8	50.36	90.00	105.90	89.22	91.50	100.48	71.04	43.16	28.51	12.83	5.85
PERCENTAGES												
		7.31	13.07	15.37	12.95	13.28	14.59	10.31	6.27	4.14	1.86	0.85

BASIS: 2000 Census data

RADTRAN Input Data	RURAL	SUBURBAN	URBAN	
WEIGHTED POPULATION				
People/sq. mi.	43.1	934.4	6274.3	
People/sq. km.	16.7	360.8	2422.5	
DISTANCE				TOTALS
Miles	335.5	306.2	47.2	688.8
Kilometers	539.9	492.7	75.9	1108.5
Percentages	48.7	44.5	6.9	
BASIS (people/sq mi.)	<139	139-3326	>3326	

Population within   800 meter Buffer Zone by State:
DE 20882 MD 218122 NJ   8552 NC 46512 SC 42498 VA 157765

Total Population within   800 meter Buffer Zone: 494331

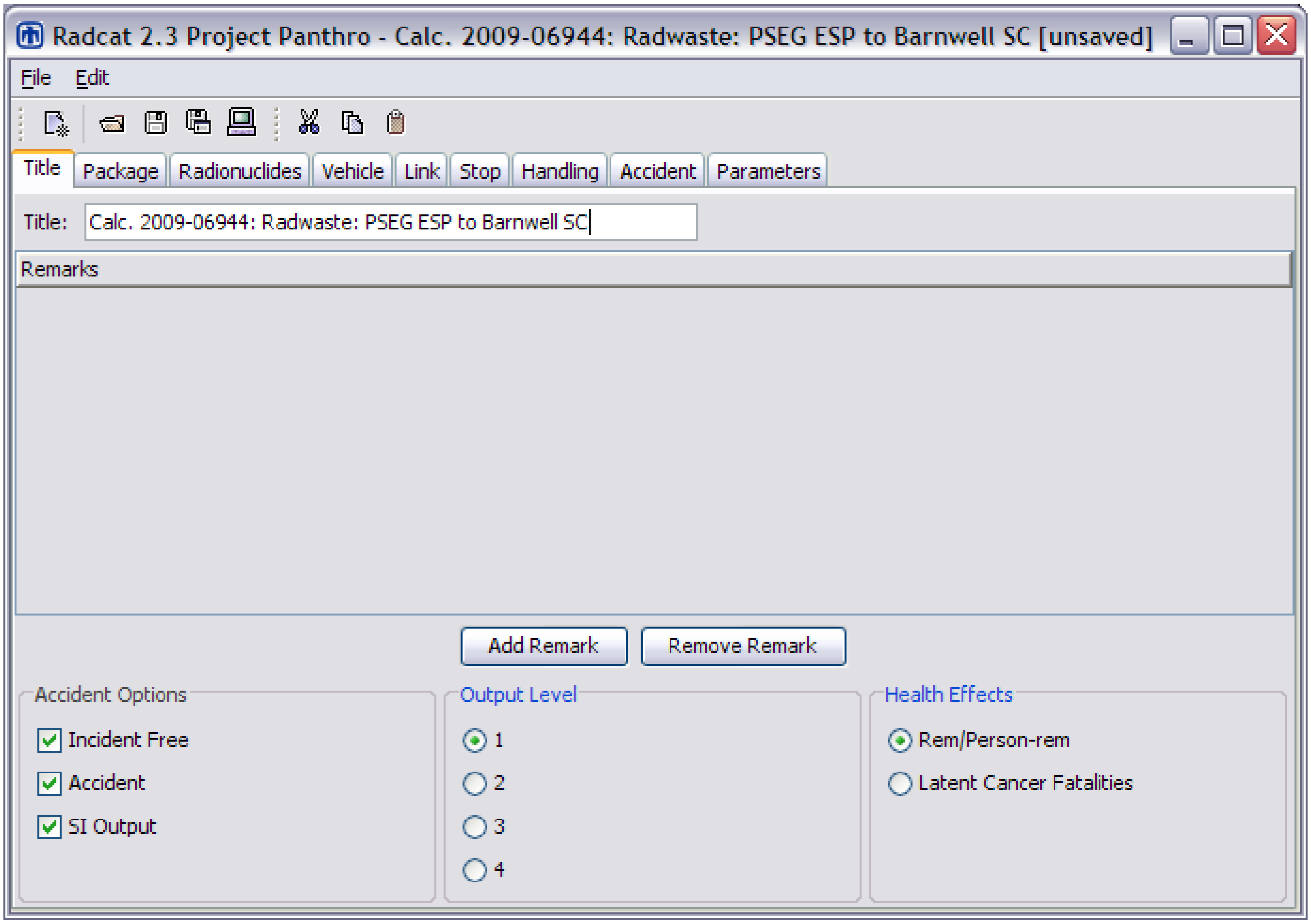
3 TRAGIS GENERATED INPUT FOR RADTRAN

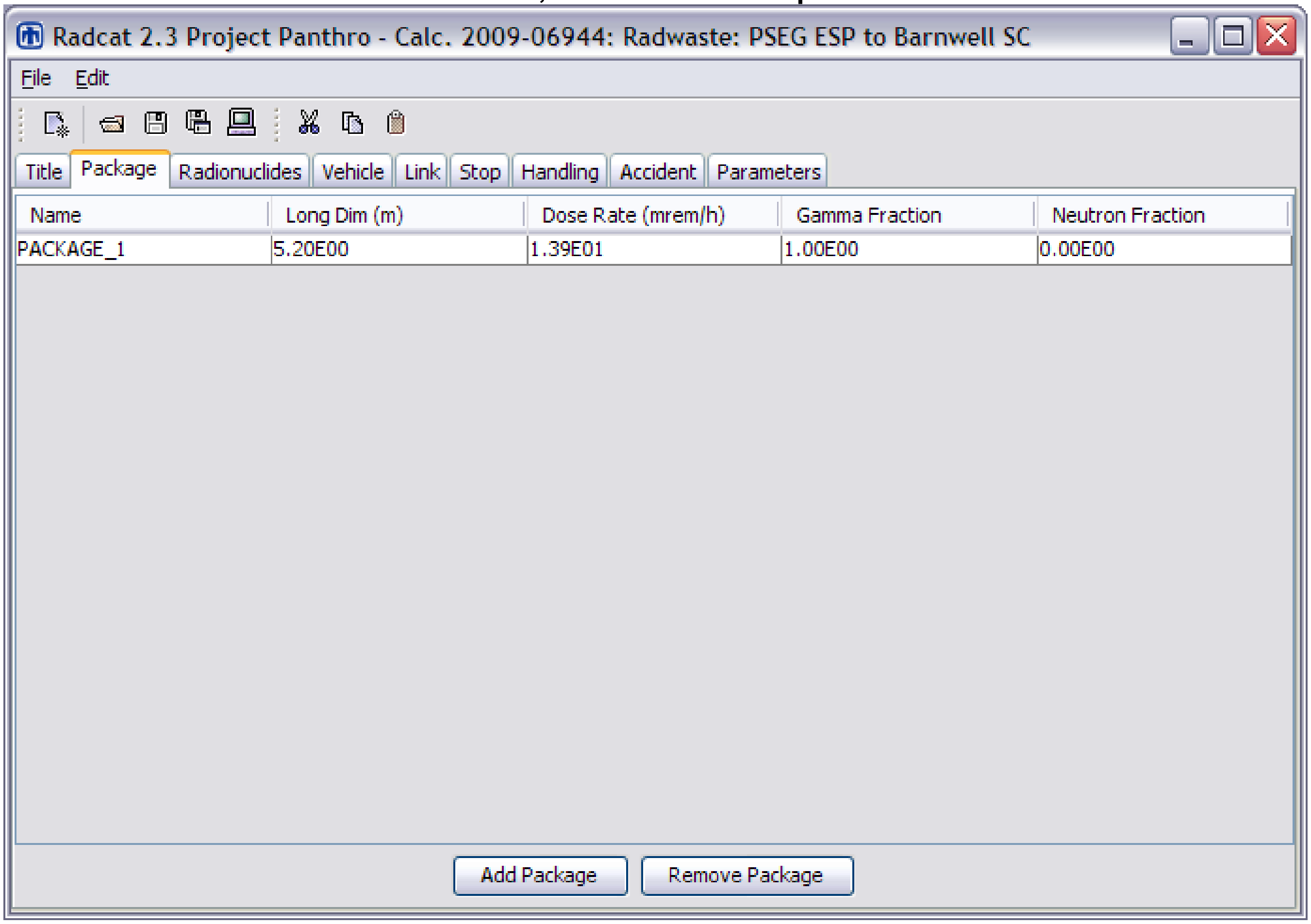
```
[TRAGIS]
TRAGIS Version=1.5.4
Mode=H
Network Version=4.0
Census Data=2000
Buffer Zone=800
[ROUTEINFO]
From CITY=SALEM NP
From STATE=NJ
From SUBNET=
To CITY=BARNWELL       S    U278S3
To STATE=SC
To SUBNET=
[DE]
Rural - KM=   5.9
Suburban - KM=  16.9
Urban - KM=   3.3
Total - KM=  26.2
Rural Pop Density=  20.6
Suburban Pop Density= 409.8
Urban Pop Density=2303.2
[MD]
Rural - KM=  46.7
Suburban - KM=  92.5
Urban - KM=  44.1
Total - KM= 183.3
Rural Pop Density=  23.8
Suburban Pop Density= 482.5
Urban Pop Density=2524.1
[NJ]
Rural - KM=  20.6
Suburban - KM=  12.5
Urban - KM=   1.1
Total - KM=  34.3
Rural Pop Density=  11.8
Suburban Pop Density= 353.9
Urban Pop Density=2025.9
[NC]
Rural - KM= 175.0
Suburban - KM= 116.2
Urban - KM=   1.8
Total - KM= 293.1
Rural Pop Density=  18.1
Suburban Pop Density= 276.5
Urban Pop Density=1834.3
[SC]
Rural - KM= 177.6
Suburban - KM=  91.9
Urban - KM=   2.1
Total - KM= 271.6
Rural Pop Density=  11.9
Suburban Pop Density= 299.0
Urban Pop Density=1953.4
[VA]
Rural - KM= 114.1
```

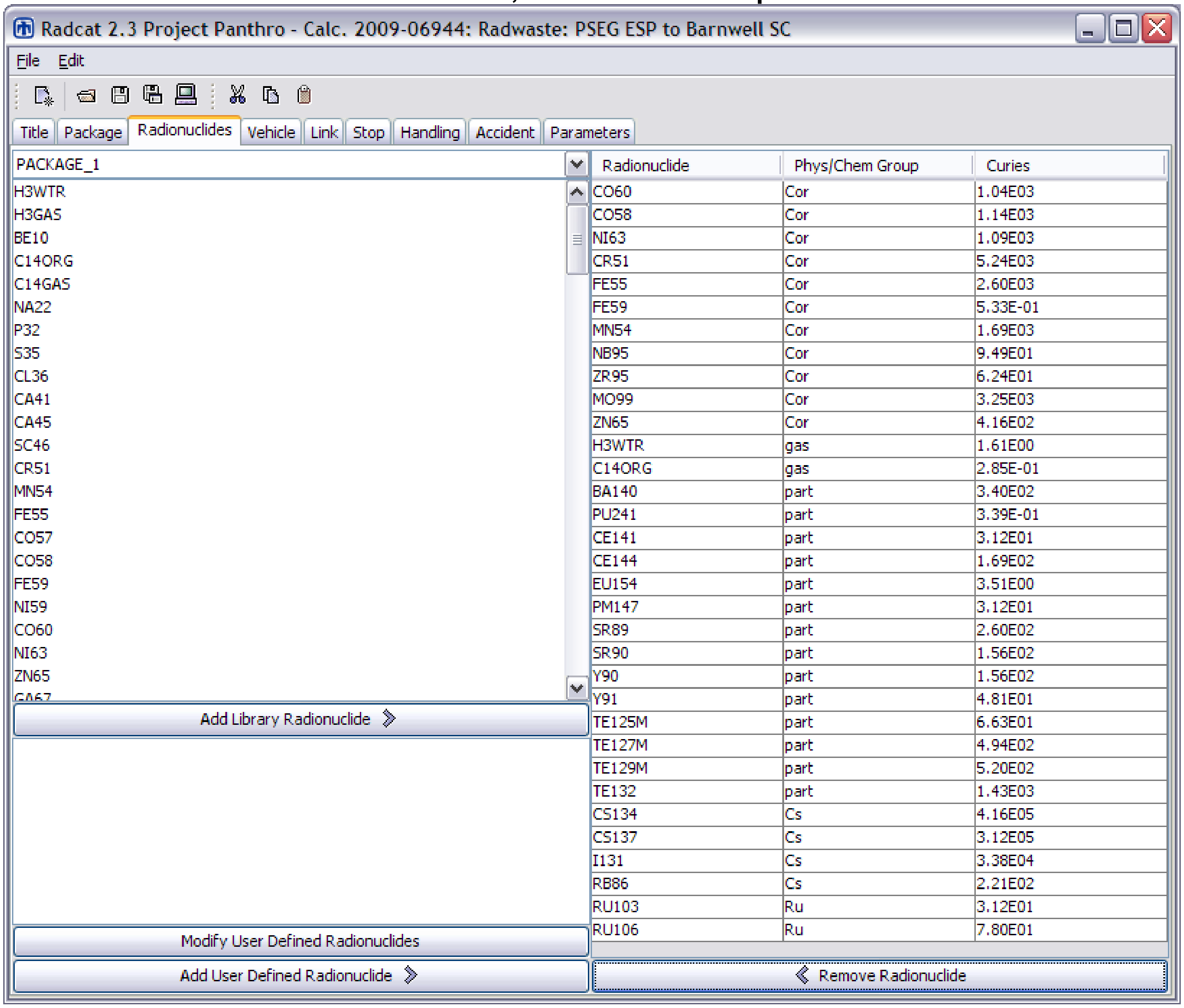
```
Suburban - KM= 162.6
Urban - KM=  23.5
Total - KM= 300.1
Rural Pop Density=  19.6
Suburban Pop Density= 382.2
Urban Pop Density=2355.2
[Total]
Rural - KM= 539.9
Suburban - KM= 492.7
Urban - KM=  75.9
Total - KM=1108.5
Rural Pop Density=  16.7
Suburban Pop Density= 360.8
Urban Pop Density=2422.5
```

4 RADTRAN INPUT

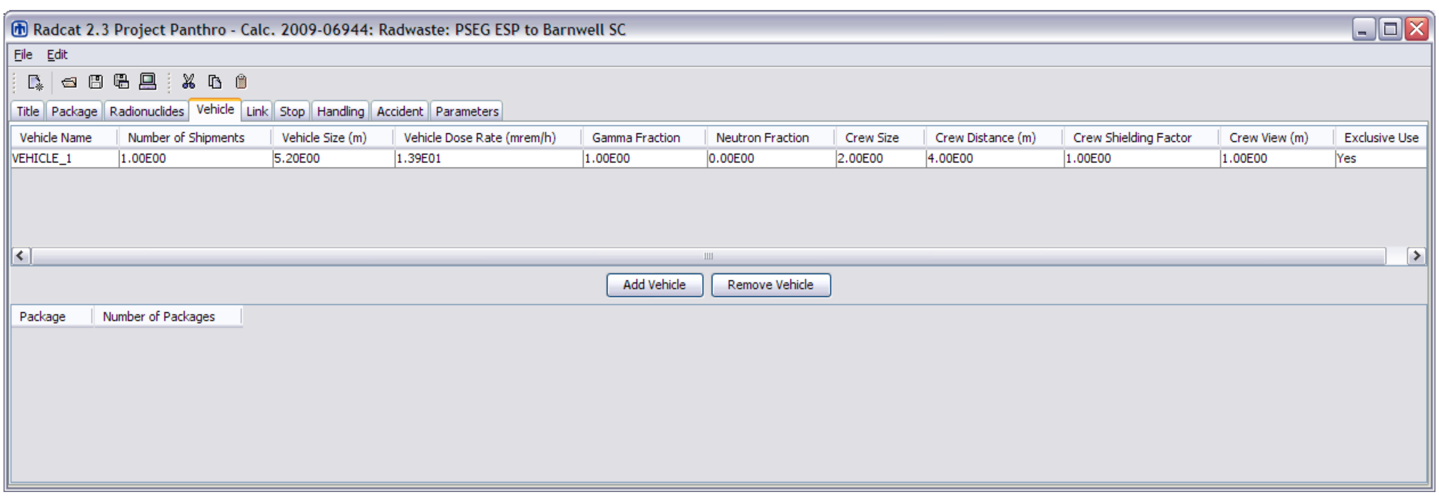
The RADCAT input screens are reproduced below.



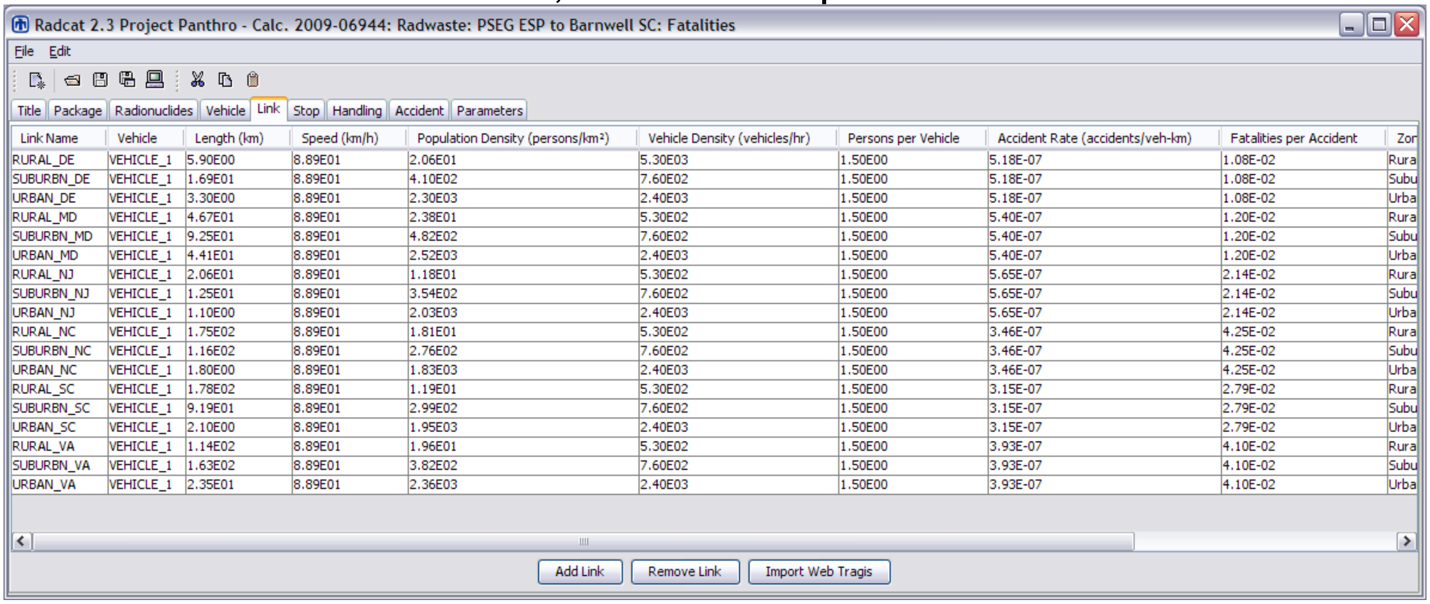

Radcat 2.3 Project Panthro - Calc. 2009-06944: Radwaste: PSEG ESP to Barnwell SC
File
Edit
Title
Package
Radionuclides
Vehicle
Link
Stop
Handling
Accident
Parameters
Name
Long Dim (m)
Dose Rate (mrem/h)
Gamma Fraction
Neutron Fraction
PACKAGE_1
5.20E00
1.39E01
1.00E00
0.00E00
Add Package
Remove Package



Radionuclide	Phys/Chem Group	Curies
CO60	Cor	1.04E03
CO58	Cor	1.14E03
NI63	Cor	1.09E03
CR51	Cor	5.24E03
FE55	Cor	2.60E03
FE59	Cor	5.33E-01
MN54	Cor	1.69E03
NB95	Cor	9.49E01
ZR95	Cor	6.24E01
MO99	Cor	3.25E03
ZN65	Cor	4.16E02
H3WTR	gas	1.61E00
C14ORG	gas	2.85E-01
BA140	part	3.40E02
PU241	part	3.39E-01
CE141	part	3.12E01
CE144	part	1.69E02
EU154	part	3.51E00
PM147	part	3.12E01
SR89	part	2.60E02
SR90	part	1.56E02
Y90	part	1.56E02
Y91	part	4.81E01
TE125M	part	6.63E01
TE127M	part	4.94E02
TE129M	part	5.20E02
TE132	part	1.43E03
CS134	Cs	4.16E05
CS137	Cs	3.12E05
I131	Cs	3.38E04
RB86	Cs	2.21E02
RU103	Ru	3.12E01
RU106	Ru	7.80E01



Vehicle Name	Number of Shipments	Vehicle Size (m)	Vehicle Dose Rate (mrem/h)	Gamma Fraction	Neutron Fraction	Crew Size	Crew Distance (m)	Crew Shielding Factor	Crew View (m)	Exclusive Use
VEHICLE_1	1.00E00	5.20E00	1.39E01	1.00E00	0.00E00	2.00E00	4.00E00	1.00E00	1.00E00	Yes



Radcat 2.3 Project Panthro - Calc. 2009-06944: Radwaste: PSEG ESP to Barnwell SC: Fatalities

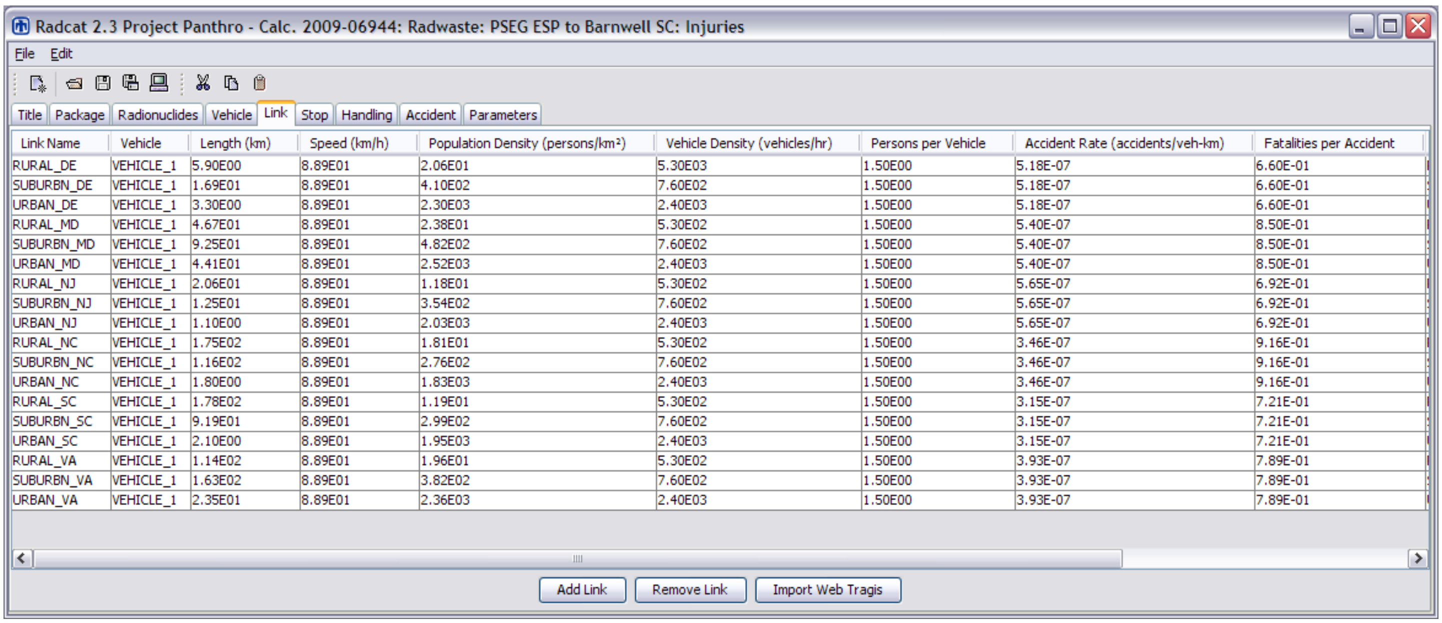
File Edit

Title | Package | Radionuclides | Vehicle | Link | Stop | Handling | Accident | Parameters

Link Name	Vehicle	Length (km)	Speed (km/h)	Population Density (persons/km²)	Vehicle Density (vehicles/hr)	Persons per Vehicle	Accident Rate (accidents/veh-km)	Fatalities per Accident	Zor
RURAL_DE	VEHICLE_1	5.90E00	8.89E01	2.06E01	5.30E03	1.50E00	5.18E-07	1.08E-02	Rura
SUBURBN_DE	VEHICLE_1	1.69E01	8.89E01	4.10E02	7.60E02	1.50E00	5.18E-07	1.08E-02	Subu
URBAN_DE	VEHICLE_1	3.30E00	8.89E01	2.30E03	2.40E03	1.50E00	5.18E-07	1.08E-02	Urba
RURAL_MD	VEHICLE_1	4.67E01	8.89E01	2.38E01	5.30E02	1.50E00	5.40E-07	1.20E-02	Rura
SUBURBN_MD	VEHICLE_1	9.25E01	8.89E01	4.82E02	7.60E02	1.50E00	5.40E-07	1.20E-02	Subu
URBAN_MD	VEHICLE_1	4.41E01	8.89E01	2.52E03	2.40E03	1.50E00	5.40E-07	1.20E-02	Urba
RURAL_NJ	VEHICLE_1	2.06E01	8.89E01	1.18E01	5.30E02	1.50E00	5.65E-07	2.14E-02	Rura
SUBURBN_NJ	VEHICLE_1	1.25E01	8.89E01	3.54E02	7.60E02	1.50E00	5.65E-07	2.14E-02	Subu
URBAN_NJ	VEHICLE_1	1.10E00	8.89E01	2.03E03	2.40E03	1.50E00	5.65E-07	2.14E-02	Urba
RURAL_NC	VEHICLE_1	1.75E02	8.89E01	1.81E01	5.30E02	1.50E00	3.46E-07	4.25E-02	Rura
SUBURBN_NC	VEHICLE_1	1.16E02	8.89E01	2.76E02	7.60E02	1.50E00	3.46E-07	4.25E-02	Subu
URBAN_NC	VEHICLE_1	1.80E00	8.89E01	1.83E03	2.40E03	1.50E00	3.46E-07	4.25E-02	Urba
RURAL_SC	VEHICLE_1	1.78E02	8.89E01	1.19E01	5.30E02	1.50E00	3.15E-07	2.79E-02	Rura
SUBURBN_SC	VEHICLE_1	9.19E01	8.89E01	2.99E02	7.60E02	1.50E00	3.15E-07	2.79E-02	Subu
URBAN_SC	VEHICLE_1	2.10E00	8.89E01	1.95E03	2.40E03	1.50E00	3.15E-07	2.79E-02	Urba
RURAL_VA	VEHICLE_1	1.14E02	8.89E01	1.96E01	5.30E02	1.50E00	3.93E-07	4.10E-02	Rura
SUBURBN_VA	VEHICLE_1	1.63E02	8.89E01	3.82E02	7.60E02	1.50E00	3.93E-07	4.10E-02	Subu
URBAN_VA	VEHICLE_1	2.35E01	8.89E01	2.36E03	2.40E03	1.50E00	3.93E-07	4.10E-02	Urba

Add Link | Remove Link | Import Web Tragis

Injuries per Accident in Column Labeled "Fatalities per Accident"



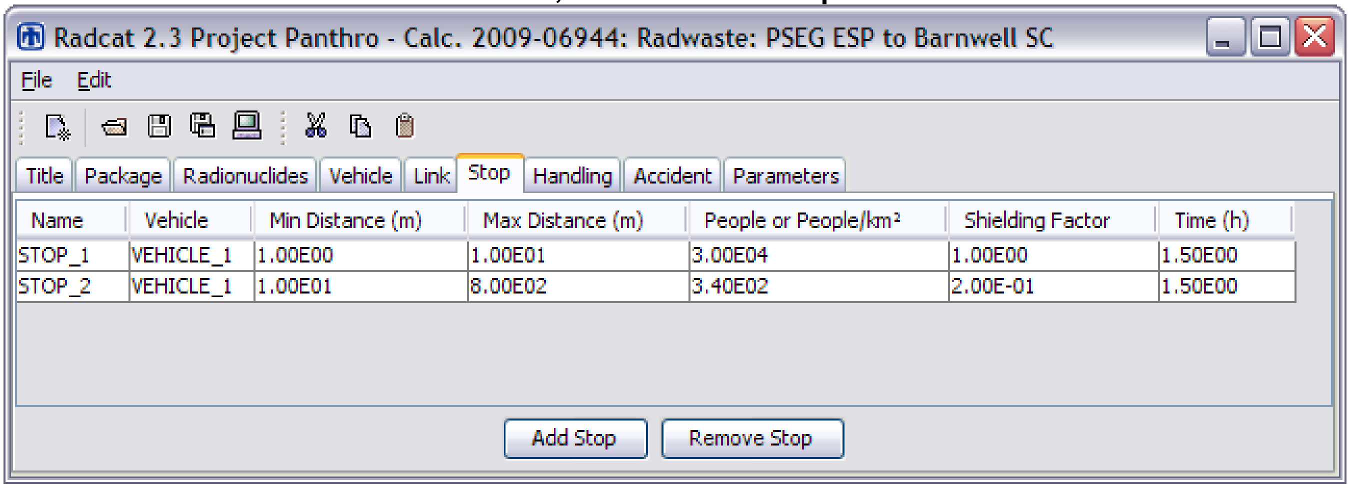
Radcat 2.3 Project Panthro - Calc. 2009-06944: Radwaste: PSEG ESP to Barnwell SC: Injuries

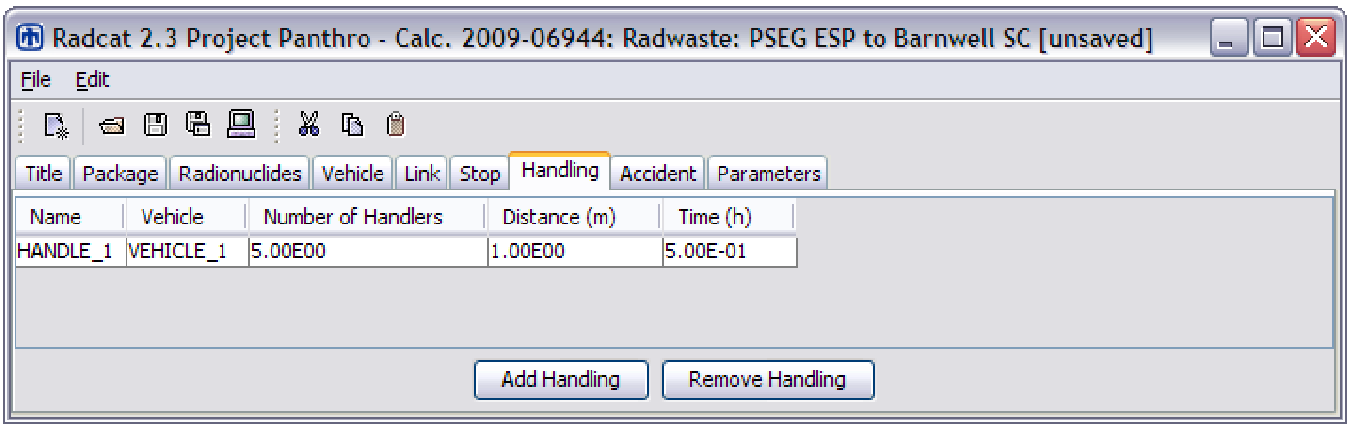
File Edit

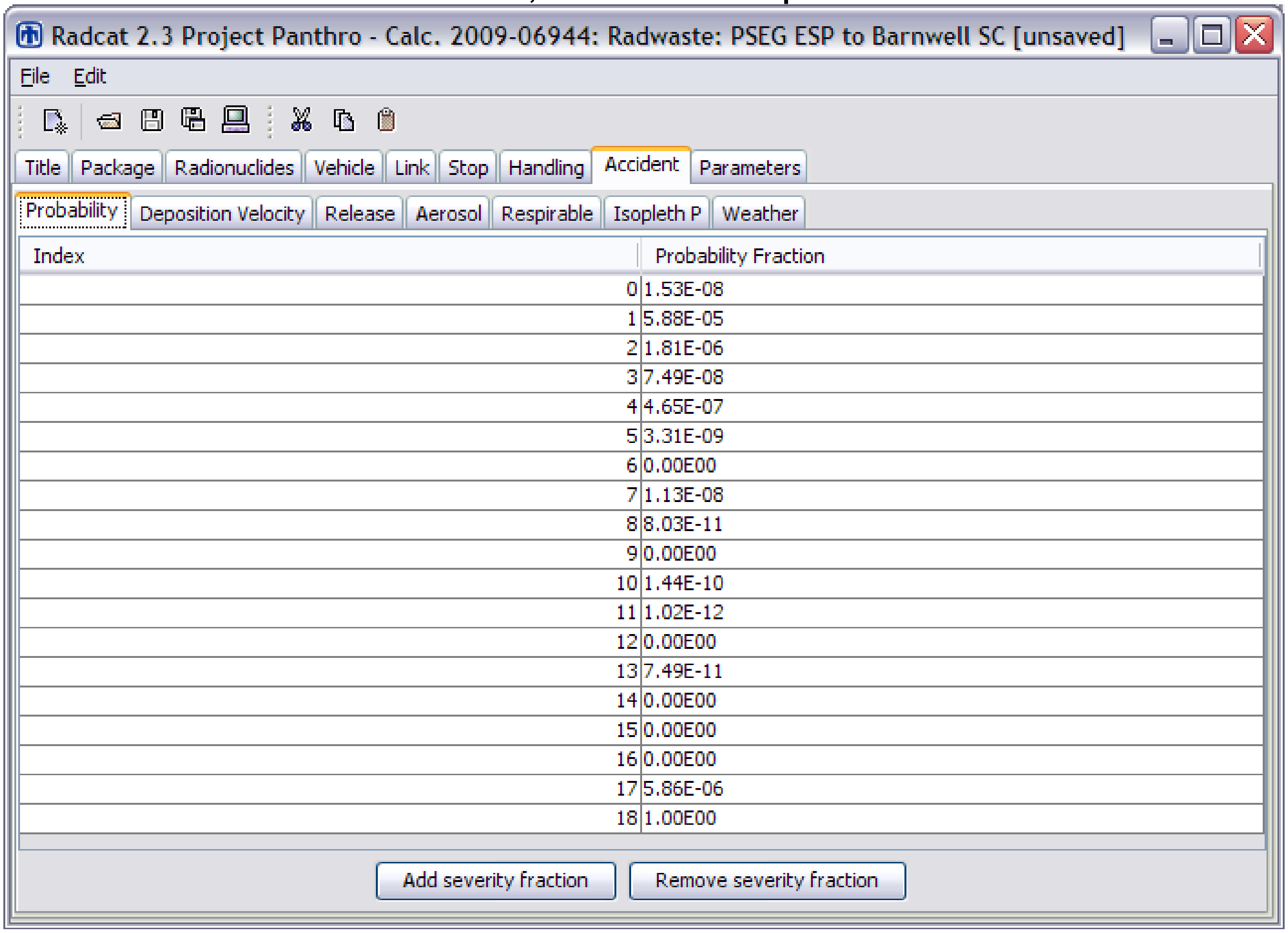
Title | Package | Radionuclides | Vehicle | Link | Stop | Handling | Accident | Parameters

Link Name	Vehicle	Length (km)	Speed (km/h)	Population Density (persons/km²)	Vehicle Density (vehicles/hr)	Persons per Vehicle	Accident Rate (accidents/veh-km)	Fatalities per Accident
RURAL_DE	VEHICLE_1	5.90E00	8.89E01	2.06E01	5.30E03	1.50E00	5.18E-07	6.60E-01
SUBURBN_DE	VEHICLE_1	1.69E01	8.89E01	4.10E02	7.60E02	1.50E00	5.18E-07	6.60E-01
URBAN_DE	VEHICLE_1	3.30E00	8.89E01	2.30E03	2.40E03	1.50E00	5.18E-07	6.60E-01
RURAL_MD	VEHICLE_1	4.67E01	8.89E01	2.38E01	5.30E02	1.50E00	5.40E-07	8.50E-01
SUBURBN_MD	VEHICLE_1	9.25E01	8.89E01	4.82E02	7.60E02	1.50E00	5.40E-07	8.50E-01
URBAN_MD	VEHICLE_1	4.41E01	8.89E01	2.52E03	2.40E03	1.50E00	5.40E-07	8.50E-01
RURAL_NJ	VEHICLE_1	2.06E01	8.89E01	1.18E01	5.30E02	1.50E00	5.65E-07	6.92E-01
SUBURBN_NJ	VEHICLE_1	1.25E01	8.89E01	3.54E02	7.60E02	1.50E00	5.65E-07	6.92E-01
URBAN_NJ	VEHICLE_1	1.10E00	8.89E01	2.03E03	2.40E03	1.50E00	5.65E-07	6.92E-01
RURAL_NC	VEHICLE_1	1.75E02	8.89E01	1.81E01	5.30E02	1.50E00	3.46E-07	9.16E-01
SUBURBN_NC	VEHICLE_1	1.16E02	8.89E01	2.76E02	7.60E02	1.50E00	3.46E-07	9.16E-01
URBAN_NC	VEHICLE_1	1.80E00	8.89E01	1.83E03	2.40E03	1.50E00	3.46E-07	9.16E-01
RURAL_SC	VEHICLE_1	1.78E02	8.89E01	1.19E01	5.30E02	1.50E00	3.15E-07	7.21E-01
SUBURBN_SC	VEHICLE_1	9.19E01	8.89E01	2.99E02	7.60E02	1.50E00	3.15E-07	7.21E-01
URBAN_SC	VEHICLE_1	2.10E00	8.89E01	1.95E03	2.40E03	1.50E00	3.15E-07	7.21E-01
RURAL_VA	VEHICLE_1	1.14E02	8.89E01	1.96E01	5.30E02	1.50E00	3.93E-07	7.89E-01
SUBURBN_VA	VEHICLE_1	1.63E02	8.89E01	3.82E02	7.60E02	1.50E00	3.93E-07	7.89E-01
URBAN_VA	VEHICLE_1	2.35E01	8.89E01	2.36E03	2.40E03	1.50E00	3.93E-07	7.89E-01

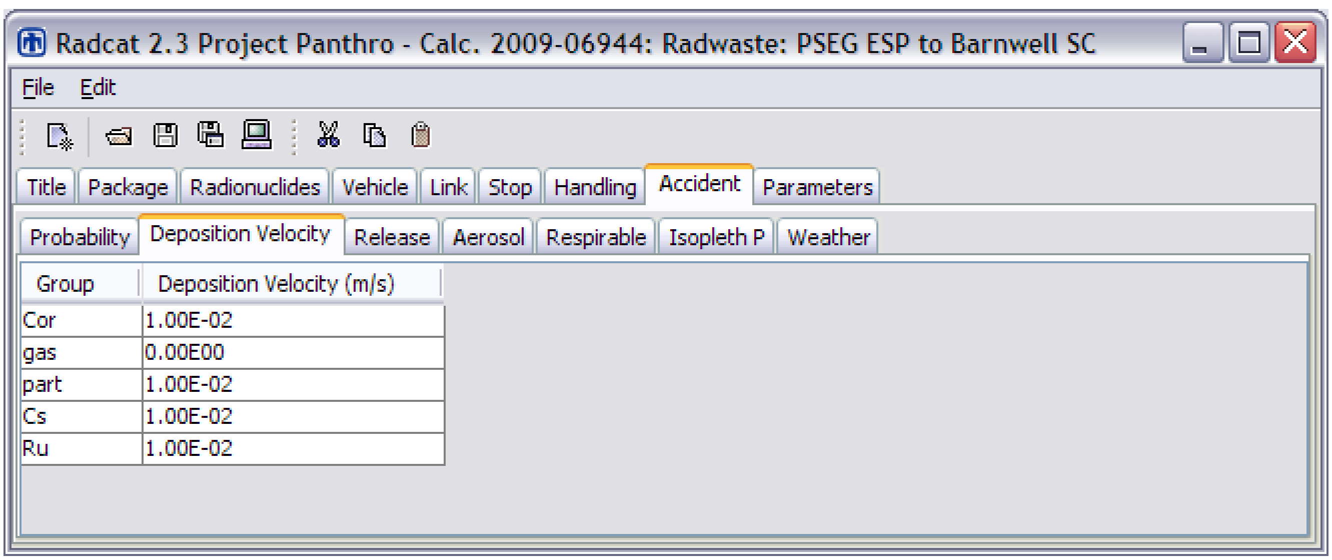
Add Link | Remove Link | Import Web Tragis


Radcat 2.3 Project Panthro - Calc. 2009-06944: Radwaste: PSEG ESP to Barnwell SC
File
Edit
Title
Package
Radionuclides
Vehicle
Link
Stop
Handling
Accident
Parameters
Name
Vehicle
Min Distance (m)
Max Distance (m)
People or People/km²
Shielding Factor
Time (h)
STOP_1
VEHICLE_1
1.00E00
1.00E01
3.00E04
1.00E00
1.50E00
STOP_2
VEHICLE_1
1.00E01
8.00E02
3.40E02
2.00E-01
1.50E00
Add Stop
Remove Stop

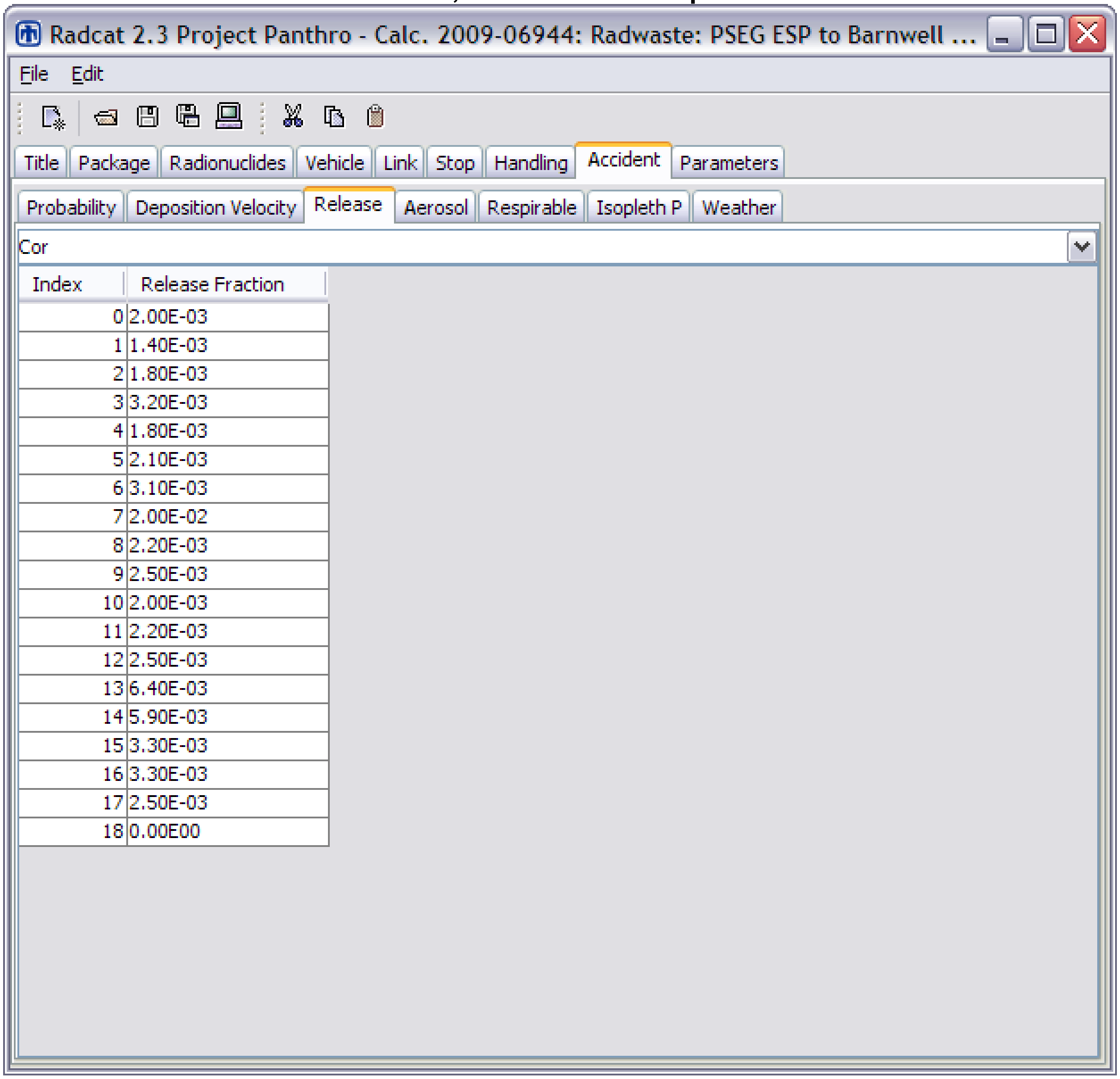

Radcat 2.3 Project Panthro - Calc. 2009-06944: Radwaste: PSEG ESP to Barnwell SC [unsaved]
File
Edit
Title
Package
Radionuclides
Vehicle
Link
Stop
Handling
Accident
Parameters
Name
Vehicle
Number of Handlers
Distance (m)
Time (h)
HANDLE_1
VEHICLE_1
5.00E00
1.00E00
5.00E-01
Add Handling
Remove Handling



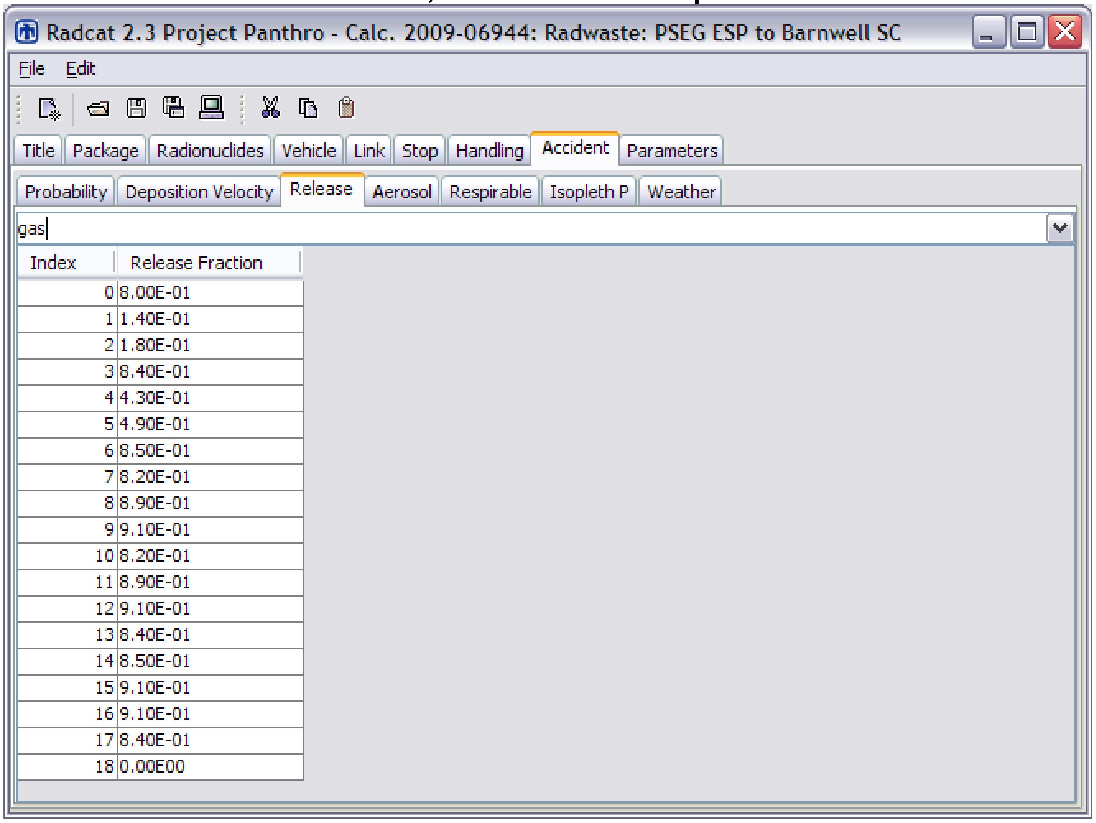
Index	Probability Fraction
0	1.53E-08
1	5.88E-05
2	1.81E-06
3	7.49E-08
4	4.65E-07
5	3.31E-09
6	0.00E00
7	1.13E-08
8	8.03E-11
9	0.00E00
10	1.44E-10
11	1.02E-12
12	0.00E00
13	7.49E-11
14	0.00E00
15	0.00E00
16	0.00E00
17	5.86E-06
18	1.00E00

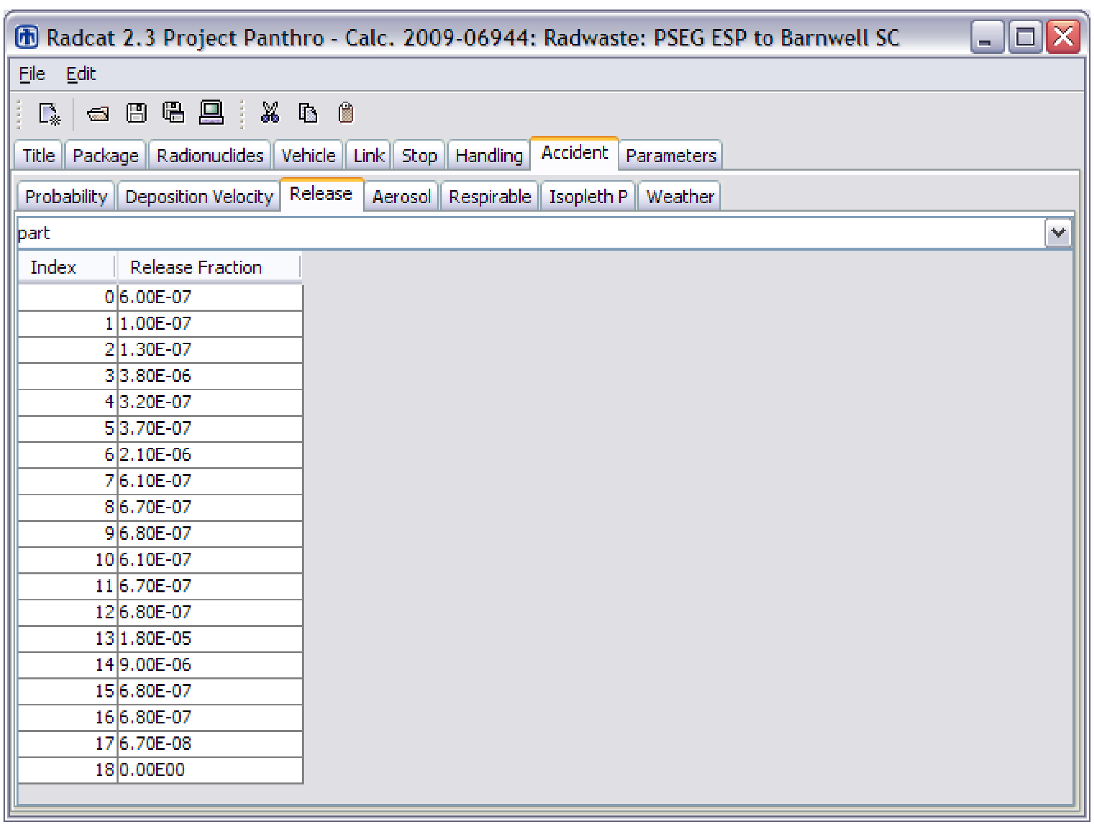


Group	Deposition Velocity (m/s)
Cor	1.00E-02
gas	0.00E00
part	1.00E-02
Cs	1.00E-02
Ru	1.00E-02



Index	Release Fraction
0	2.00E-03
1	1.40E-03
2	1.80E-03
3	3.20E-03
4	1.80E-03
5	2.10E-03
6	3.10E-03
7	2.00E-02
8	2.20E-03
9	2.50E-03
10	2.00E-03
11	2.20E-03
12	2.50E-03
13	6.40E-03
14	5.90E-03
15	3.30E-03
16	3.30E-03
17	2.50E-03
18	0.00E00


Radcat 2.3 Project Panthro - Calc. 2009-06944: Radwaste: PSEG ESP to Barnwell SC
File Edit
Title Package Radionuclides Vehicle Link Stop Handling Accident Parameters
Probability Deposition Velocity Release Aerosol Respirable Isopleth P Weather
gas
Index Release Fraction
0 8.00E-01
1 1.40E-01
2 1.80E-01
3 8.40E-01
4 4.30E-01
5 4.90E-01
6 8.50E-01
7 8.20E-01
8 8.90E-01
9 9.10E-01
10 8.20E-01
11 8.90E-01
12 9.10E-01
13 8.40E-01
14 8.50E-01
15 9.10E-01
16 9.10E-01
17 8.40E-01
18 0.00E00


Radcat 2.3 Project Panthro - Calc. 2009-06944: Radwaste: PSEG ESP to Barnwell SC
File Edit
Title Package Radionuclides Vehicle Link Stop Handling Accident Parameters
Probability Deposition Velocity Release Aerosol Respirable Isopleth P Weather
part
Index Release Fraction
0 6.00E-07
1 1.00E-07
2 1.30E-07
3 3.80E-06
4 3.20E-07
5 3.70E-07
6 2.10E-06
7 6.10E-07
8 6.70E-07
9 6.80E-07
10 6.10E-07
11 6.70E-07
12 6.80E-07
13 1.80E-05
14 9.00E-06
15 6.80E-07
16 6.80E-07
17 6.70E-08
18 0.00E00

Radcat 2.3 Project Panthro - Calc. 2009-06944: Radwaste: PSEG ESP to Barnwell SC

File Edit

Title | Package | Radionuclides | Vehicle | Link | Stop | Handling | Accident | Parameters

Probability | Deposition Velocity | Release | Aerosol | Respirable | Isopleth P | Weather

Cs

Index	Release Fraction
0	2.40E-08
1	4.10E-09
2	5.40E-09
3	3.60E-05
4	1.30E-08
5	1.50E-08
6	2.70E-05
7	2.40E-08
8	2.70E-08
9	5.90E-06
10	2.40E-08
11	2.70E-08
12	5.90E-06
13	9.60E-05
14	5.50E-05
15	5.90E-06
16	5.90E-06
17	1.70E-05
18	0.00E00

Radcat 2.3 Project Panthro - Calc. 2009-06944: Radwaste: PSEG ESP to Barnwell SC

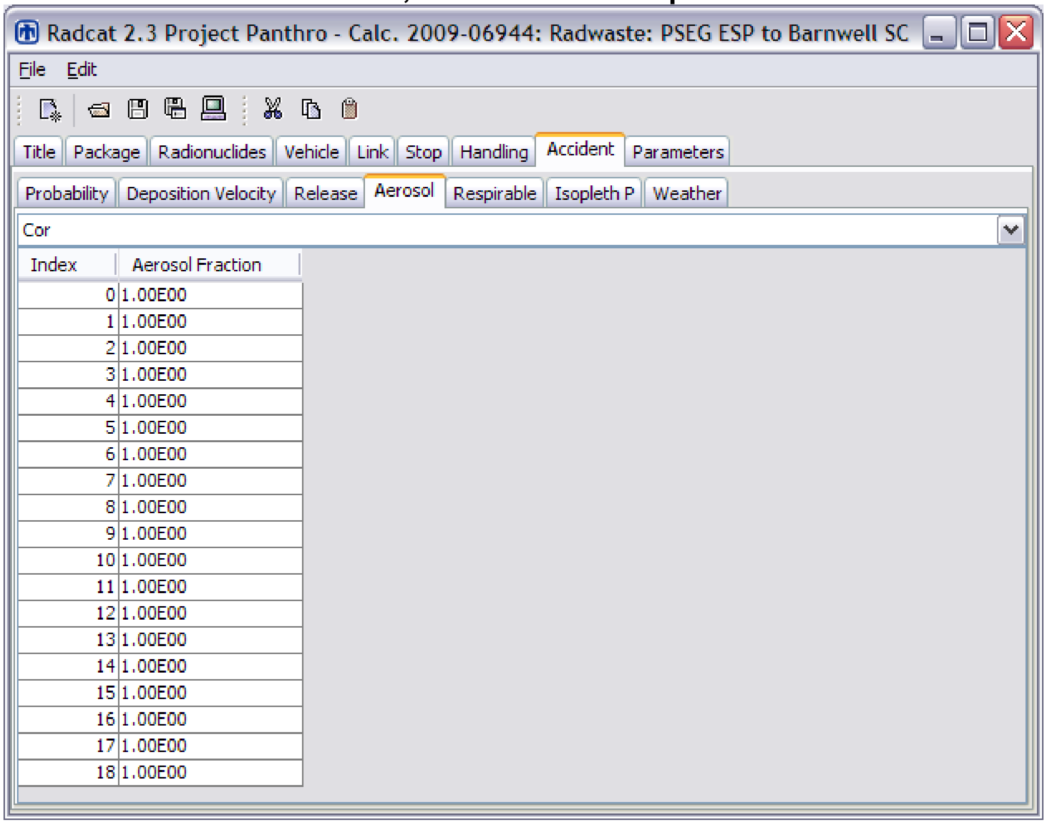
File Edit

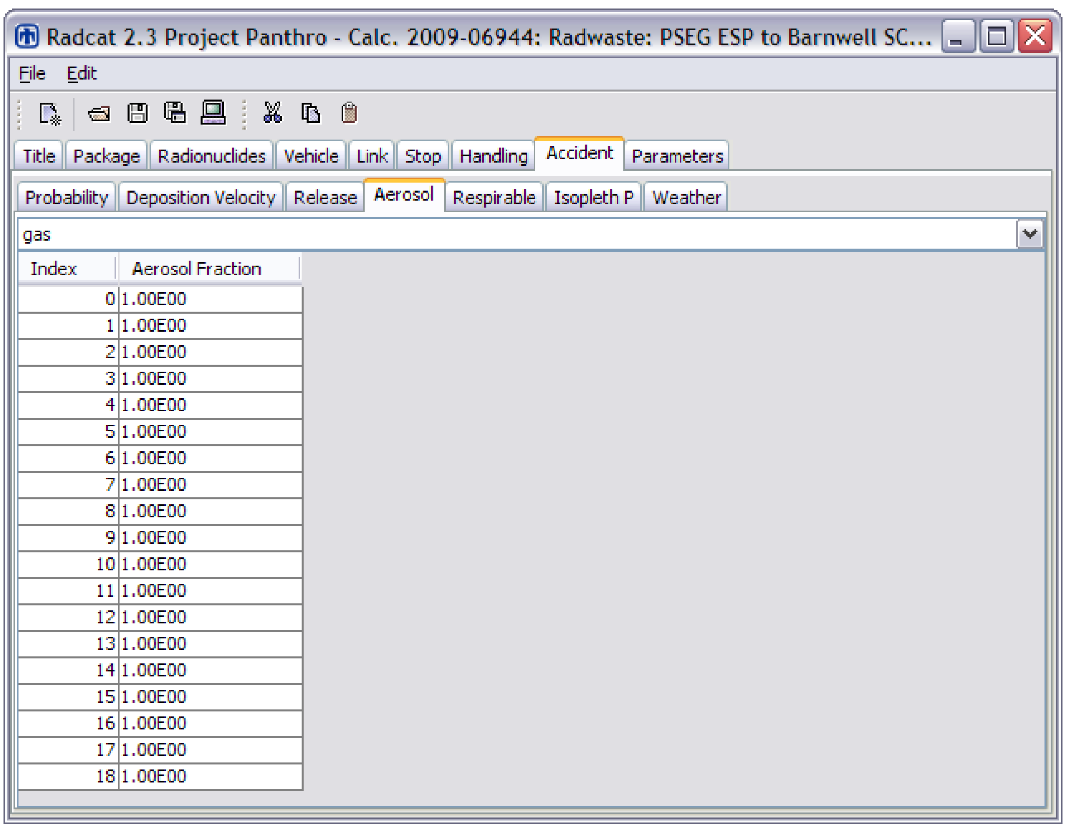
Title | Package | Radionuclides | Vehicle | Link | Stop | Handling | Accident | Parameters

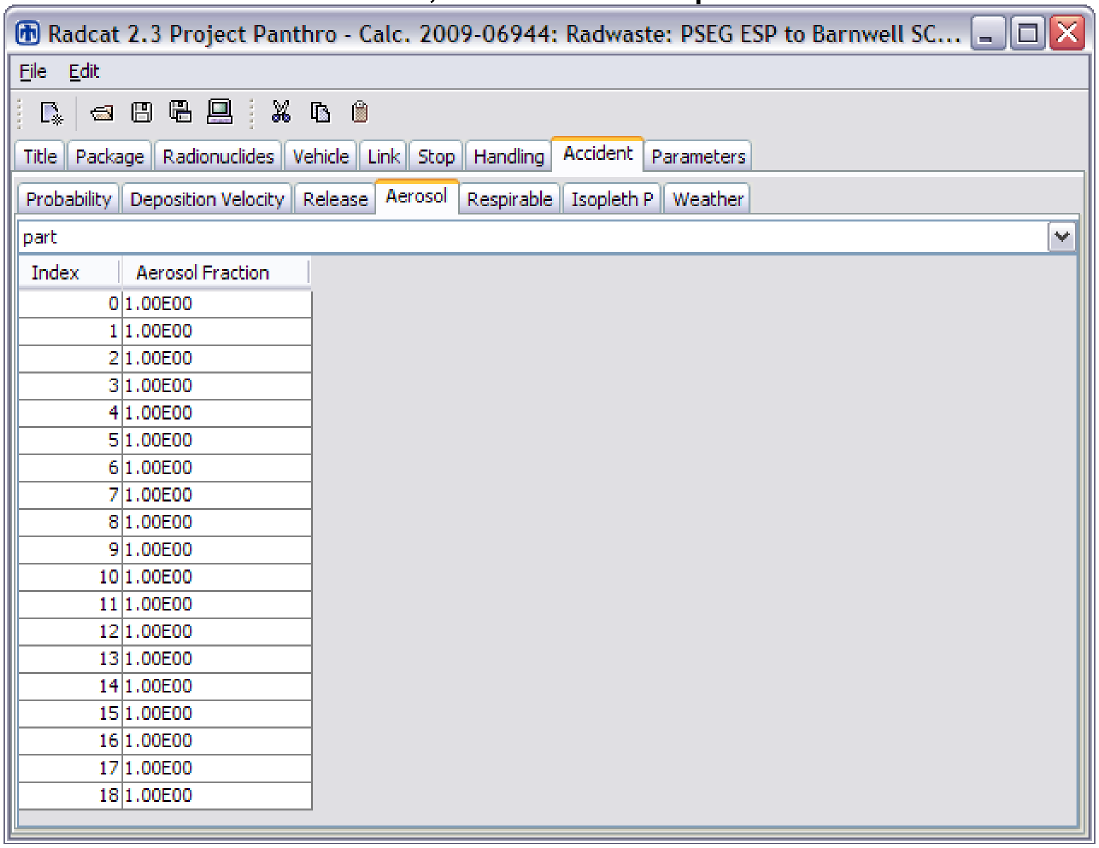
Probability | Deposition Velocity | Release | Aerosol | Respirable | Isopleth P | Weather

Ru

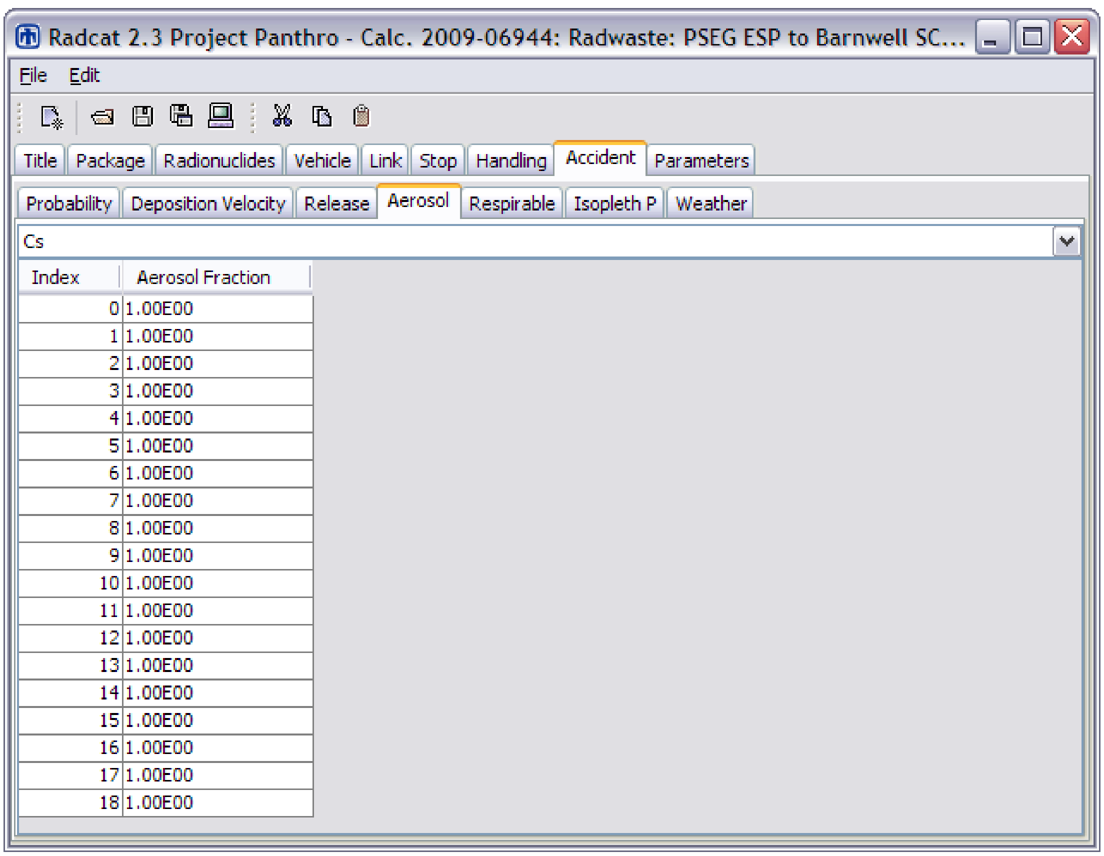
Index	Release Fraction
0	6.00E-07
1	1.00E-07
2	1.30E-07
3	3.80E-06
4	3.20E-07
5	3.70E-07
6	2.10E-06
7	6.10E-07
8	6.70E-07
9	6.80E-07
10	6.10E-07
11	6.70E-07
12	6.80E-07
13	1.80E-05
14	9.00E-06
15	6.80E-07
16	6.80E-07
17	6.70E-08
18	0.00E00


Radcat 2.3 Project Panthro - Calc. 2009-06944: Radwaste: PSEG ESP to Barnwell SC
File Edit
Title Package Radionuclides Vehicle Link Stop Handling Accident Parameters
Probability Deposition Velocity Release Aerosol Respirable Isopleth P Weather
Cor
Index Aerosol Fraction
0 1.00E00
1 1.00E00
2 1.00E00
3 1.00E00
4 1.00E00
5 1.00E00
6 1.00E00
7 1.00E00
8 1.00E00
9 1.00E00
10 1.00E00
11 1.00E00
12 1.00E00
13 1.00E00
14 1.00E00
15 1.00E00
16 1.00E00
17 1.00E00
18 1.00E00

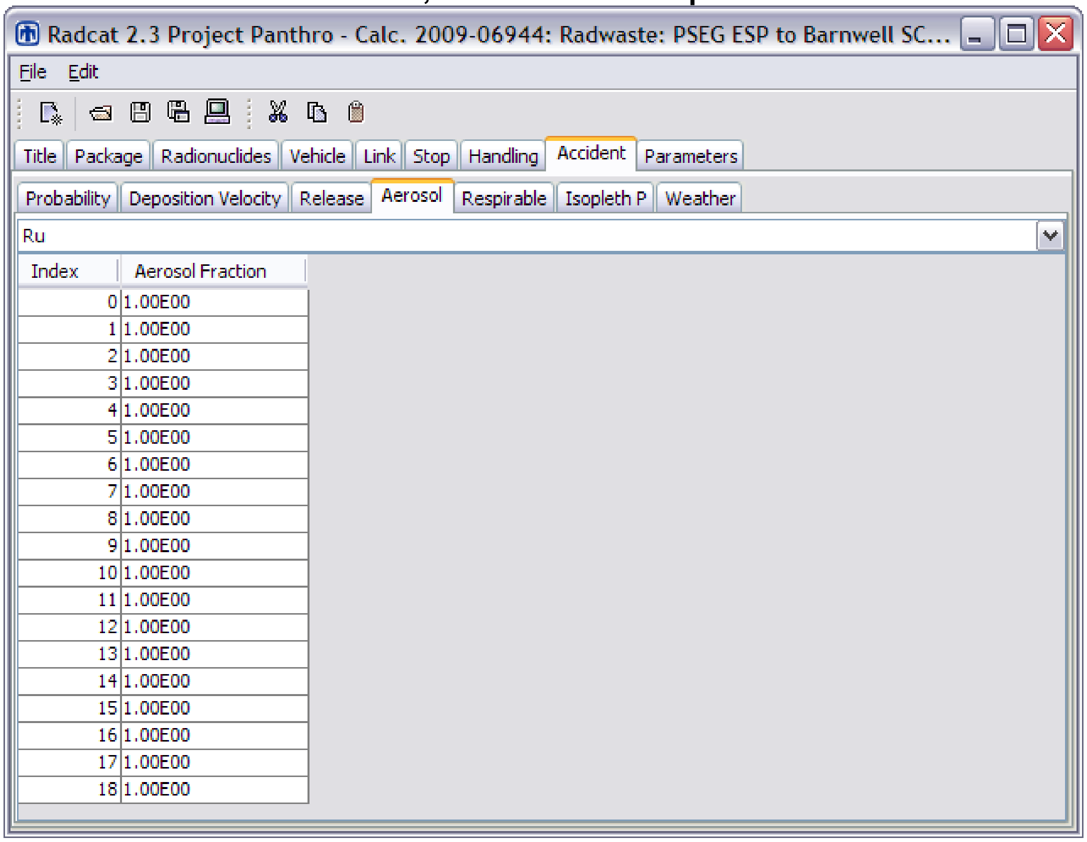

Radcat 2.3 Project Panthro - Calc. 2009-06944: Radwaste: PSEG ESP to Barnwell SC...
File Edit
Title Package Radionuclides Vehicle Link Stop Handling Accident Parameters
Probability Deposition Velocity Release Aerosol Respirable Isopleth P Weather
gas
Index Aerosol Fraction
0 1.00E00
1 1.00E00
2 1.00E00
3 1.00E00
4 1.00E00
5 1.00E00
6 1.00E00
7 1.00E00
8 1.00E00
9 1.00E00
10 1.00E00
11 1.00E00
12 1.00E00
13 1.00E00
14 1.00E00
15 1.00E00
16 1.00E00
17 1.00E00
18 1.00E00



Index	Aerosol Fraction
0	1.00E00
1	1.00E00
2	1.00E00
3	1.00E00
4	1.00E00
5	1.00E00
6	1.00E00
7	1.00E00
8	1.00E00
9	1.00E00
10	1.00E00
11	1.00E00
12	1.00E00
13	1.00E00
14	1.00E00
15	1.00E00
16	1.00E00
17	1.00E00
18	1.00E00



Index	Aerosol Fraction
0	1.00E00
1	1.00E00
2	1.00E00
3	1.00E00
4	1.00E00
5	1.00E00
6	1.00E00
7	1.00E00
8	1.00E00
9	1.00E00
10	1.00E00
11	1.00E00
12	1.00E00
13	1.00E00
14	1.00E00
15	1.00E00
16	1.00E00
17	1.00E00
18	1.00E00


Radcat 2.3 Project Panthro - Calc. 2009-06944: Radwaste: PSEG ESP to Barnwell SC...
File Edit
Title Package Radionuclides Vehicle Link Stop Handling Accident Parameters
Probability Deposition Velocity Release Aerosol Respirable Isopleth P Weather
Ru
Index Aerosol Fraction
0 1.00E00
1 1.00E00
2 1.00E00
3 1.00E00
4 1.00E00
5 1.00E00
6 1.00E00
7 1.00E00
8 1.00E00
9 1.00E00
10 1.00E00
11 1.00E00
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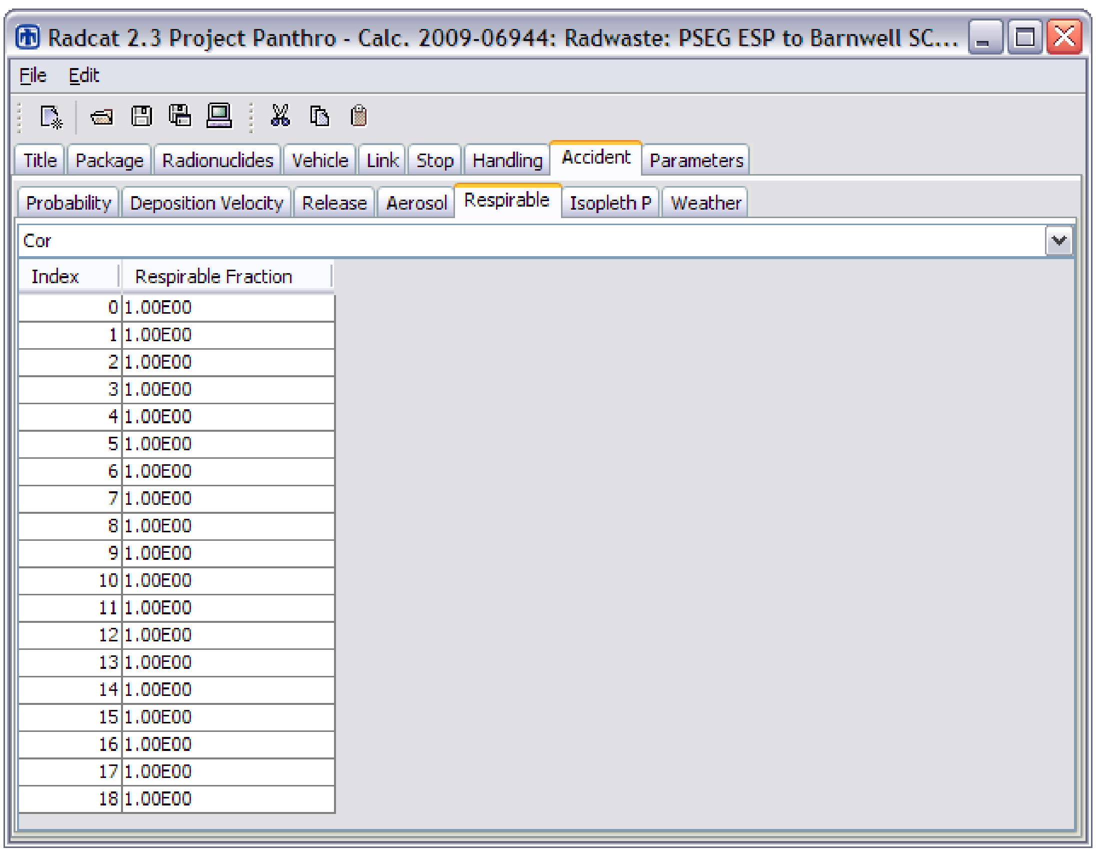
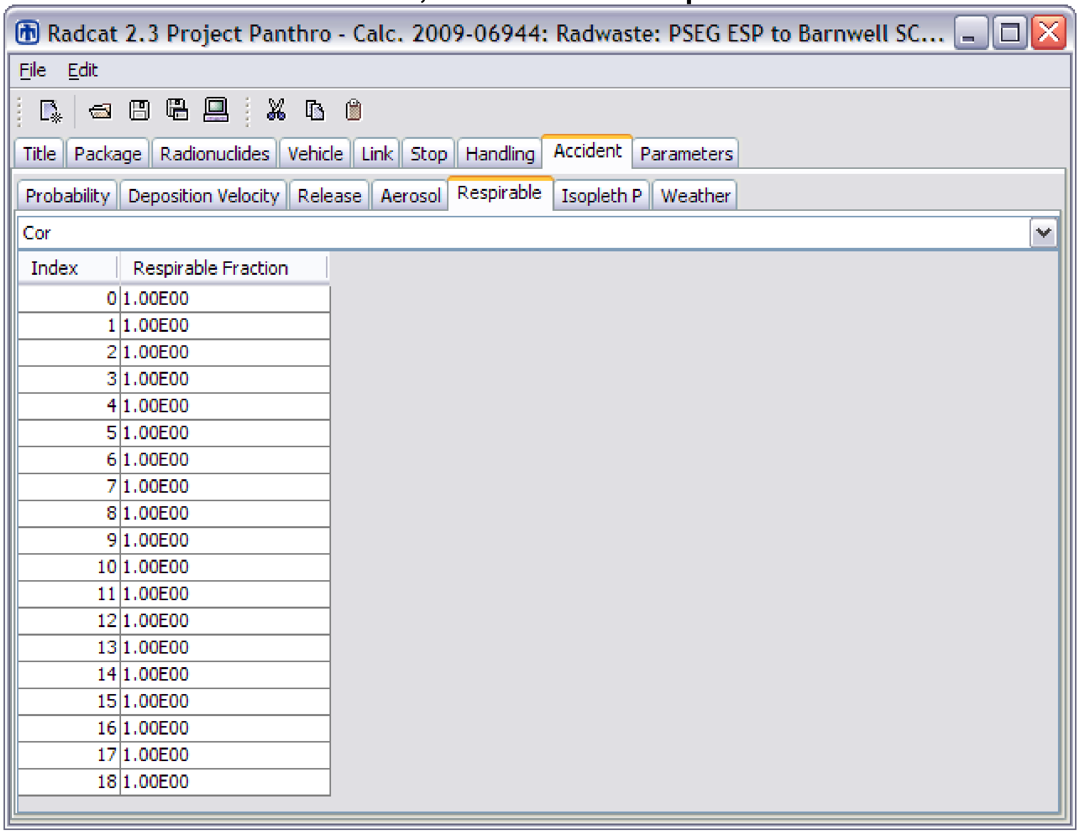
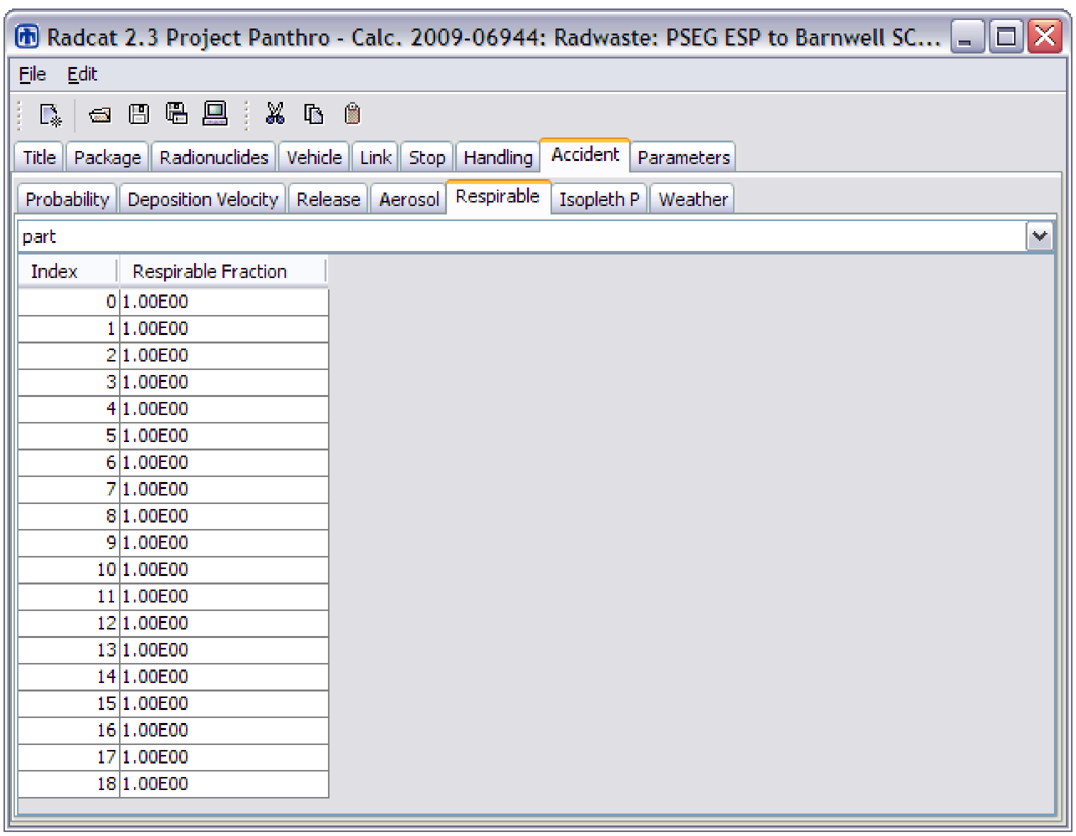
17 1.00E00
18 1.00E00


Radcat 2.3 Project Panthro - Calc. 2009-06944: Radwaste: PSEG ESP to Barnwell SC...
File Edit
Title Package Radionuclides Vehicle Link Stop Handling Accident Parameters
Probability Deposition Velocity Release Aerosol Respirable Isopleth P Weather
Cor
Index Respirable Fraction
0 1.00E00
1 1.00E00
2 1.00E00
3 1.00E00
4 1.00E00
5 1.00E00
6 1.00E00
7 1.00E00
8 1.00E00
9 1.00E00
10 1.00E00
11 1.00E00
12 1.00E00
13 1.00E00
14 1.00E00
15 1.00E00
16 1.00E00
17 1.00E00
18 1.00E00



Index	Respirable Fraction
0	1.00E00
1	1.00E00
2	1.00E00
3	1.00E00
4	1.00E00
5	1.00E00
6	1.00E00
7	1.00E00
8	1.00E00
9	1.00E00
10	1.00E00
11	1.00E00
12	1.00E00
13	1.00E00
14	1.00E00
15	1.00E00
16	1.00E00
17	1.00E00
18	1.00E00



Index	Respirable Fraction
0	1.00E00
1	1.00E00
2	1.00E00
3	1.00E00
4	1.00E00
5	1.00E00
6	1.00E00
7	1.00E00
8	1.00E00
9	1.00E00
10	1.00E00
11	1.00E00
12	1.00E00
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14	1.00E00
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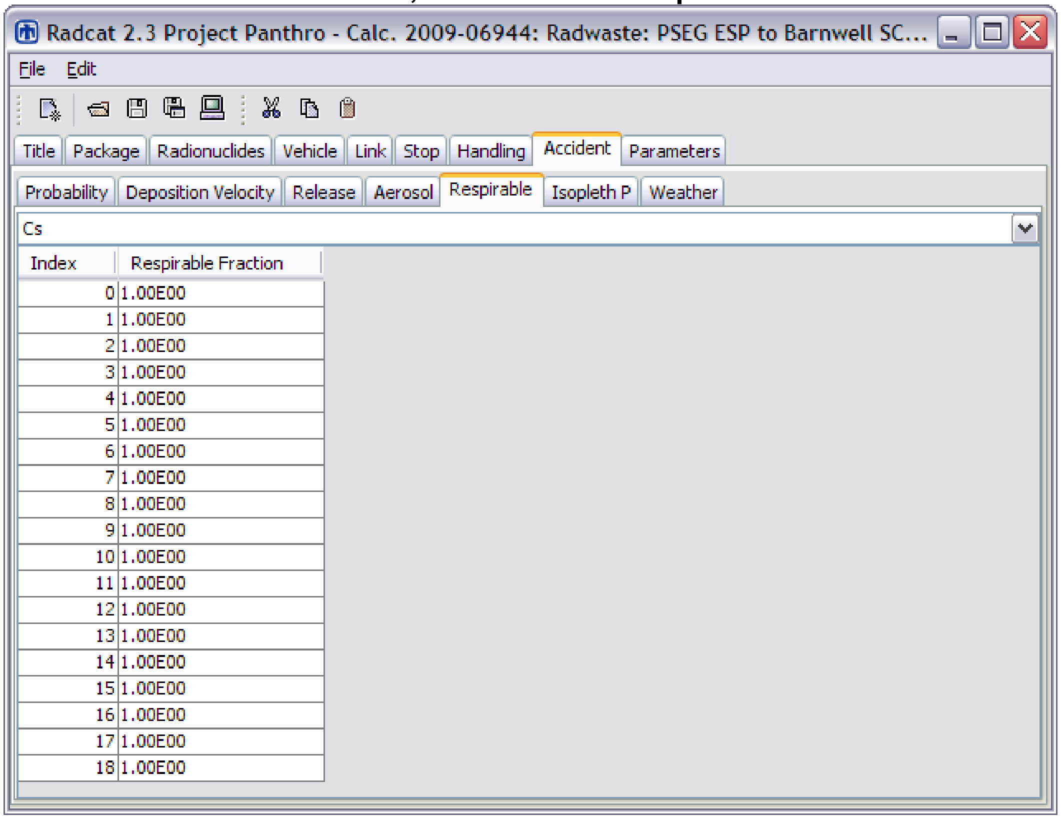
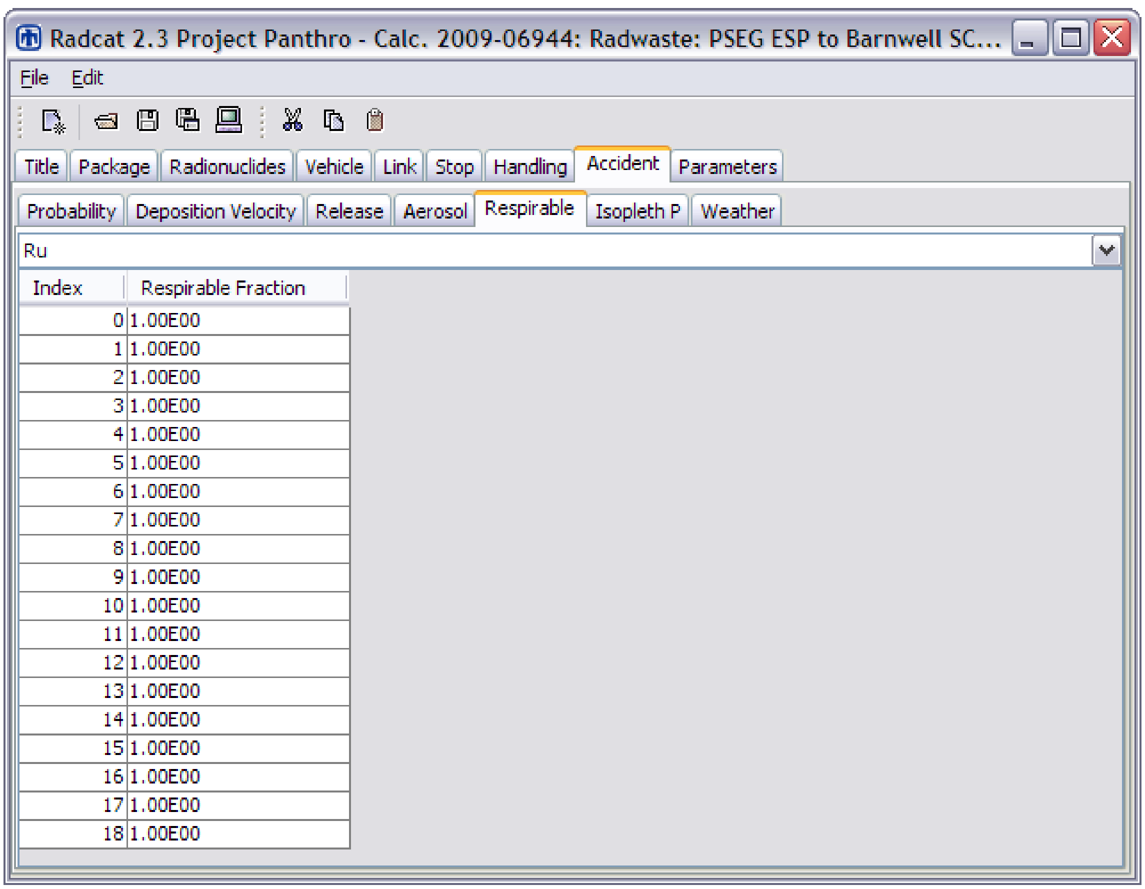
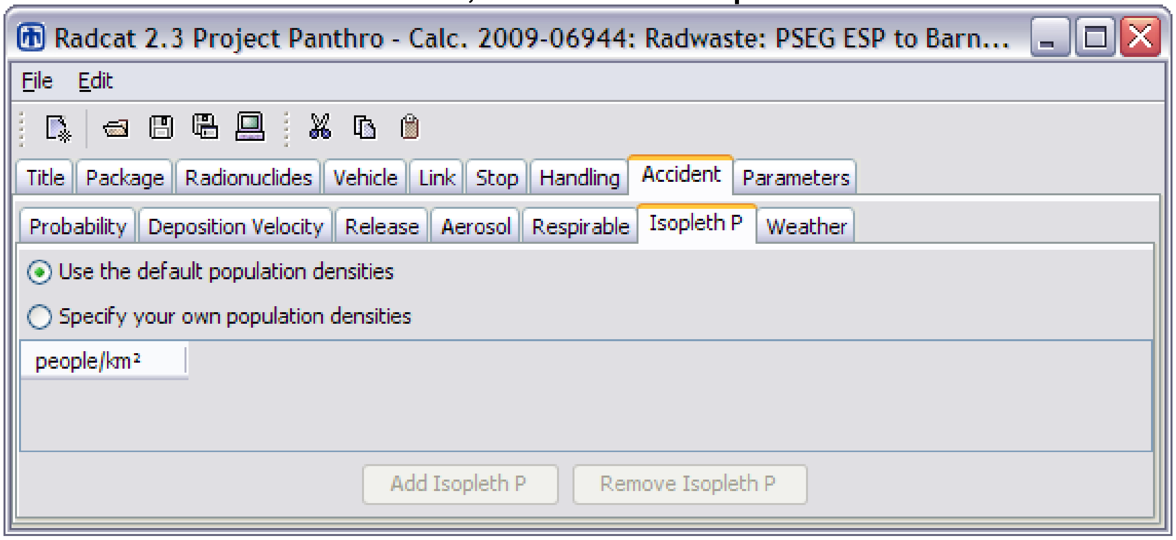
16	1.00E00
17	1.00E00
18	1.00E00

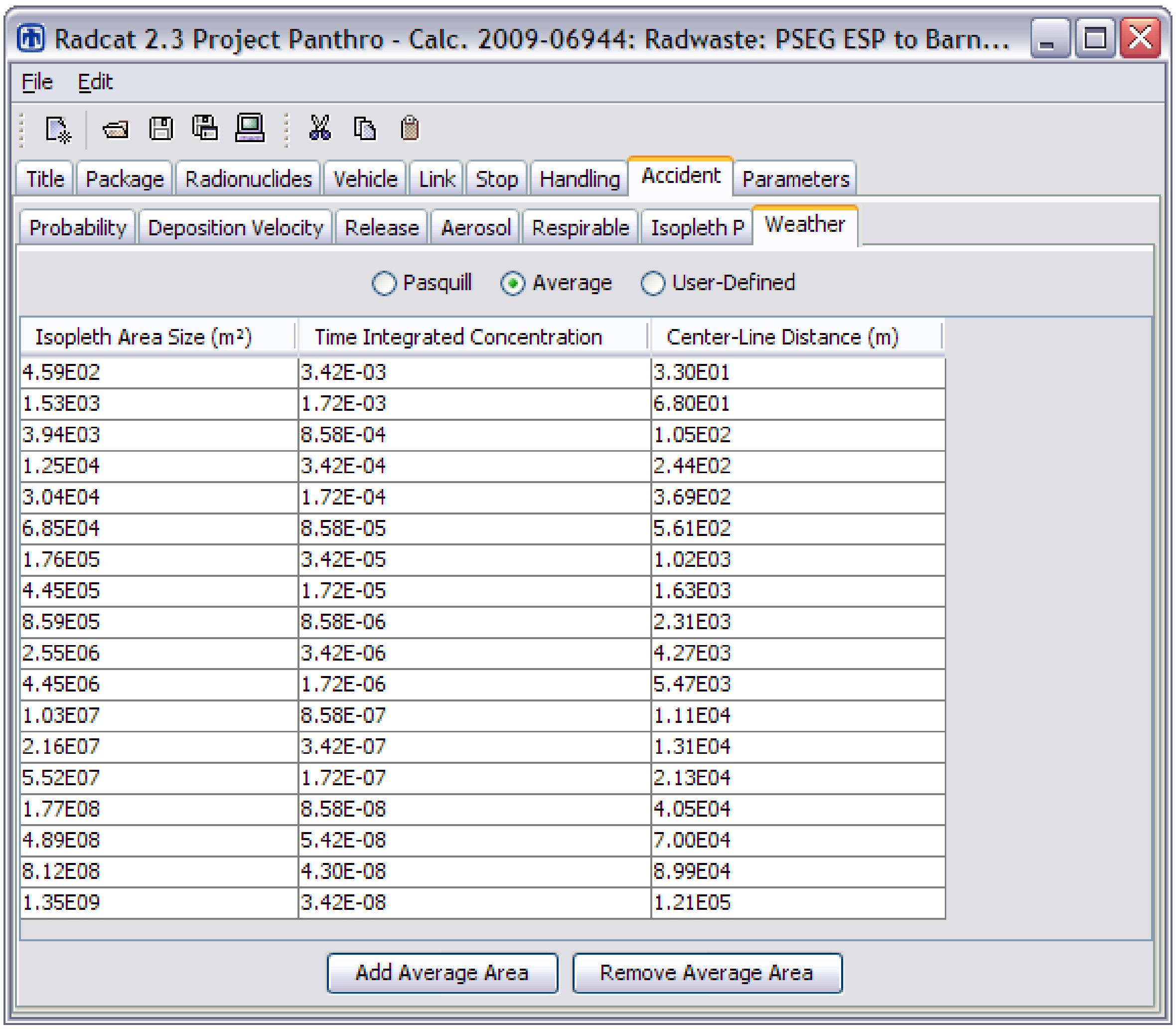


Index	Respirable Fraction
0	1.00E00
1	1.00E00
2	1.00E00
3	1.00E00
4	1.00E00
5	1.00E00
6	1.00E00
7	1.00E00
8	1.00E00
9	1.00E00
10	1.00E00
11	1.00E00
12	1.00E00
13	1.00E00
14	1.00E00
15	1.00E00
16	1.00E00
17	1.00E00
18	1.00E00



Index	Respirable Fraction
0	1.00E00
1	1.00E00
2	1.00E00
3	1.00E00
4	1.00E00
5	1.00E00
6	1.00E00
7	1.00E00
8	1.00E00
9	1.00E00
10	1.00E00
11	1.00E00
12	1.00E00
13	1.00E00
14	1.00E00
15	1.00E00
16	1.00E00
17	1.00E00
18	1.00E00





Isopleth Area Size (m²)	Time Integrated Concentration	Center-Line Distance (m)
4.59E02	3.42E-03	3.30E01
1.53E03	1.72E-03	6.80E01
3.94E03	8.58E-04	1.05E02
1.25E04	3.42E-04	2.44E02
3.04E04	1.72E-04	3.69E02
6.85E04	8.58E-05	5.61E02
1.76E05	3.42E-05	1.02E03
4.45E05	1.72E-05	1.63E03
8.59E05	8.58E-06	2.31E03
2.55E06	3.42E-06	4.27E03
4.45E06	1.72E-06	5.47E03
1.03E07	8.58E-07	1.11E04
2.16E07	3.42E-07	1.31E04
5.52E07	1.72E-07	2.13E04
1.77E08	8.58E-08	4.05E04
4.89E08	5.42E-08	7.00E04
8.12E08	4.30E-08	8.99E04
1.35E09	3.42E-08	1.21E05

Radcat 2.3 Project Panthro - Calc. 2009-06944: Radwaste: PSEG ESP to Barn...

File Edit

Title | Package | Radionuclides | Vehicle | Link | Stop | Handling | Accident | Parameters

Parameter	Value
Shielding factor for rural residents	1.00E00
Shielding factor for suburban residents	8.70E-01
Shielding factor for urban residents	1.80E-02
Fraction of outside air in urban buildings	5.00E-02
Fraction of urban population occupying the sidewalk	4.80E-01
Fraction of urban population inside buildings	5.20E-01
Ratio of pedestrians/km² to residential population/km²	6.00E00
Minimum small package dimension for handling (m)	5.00E-01
Distance from shipment for maximum exposure (m)	3.00E01
Vehicle speed for maximum exposure (km/hr)	2.40E01
Imposed regulatory limit on vehicle external dose	Yes
Average breathing rate (m³/sec)	3.30E-04
Cleanup Level (microcuries/m²)	2.00E-01
Interdiction Threshold	4.00E01
Evacuation time for groundshine (days)	1.00E00
Survey interval for groudshine (days)	1.00E01
Occupational latent cancer fatalities per person-rem	4.00E-04
Public latent cancer fatalities per person-rem	5.00E-04
Genetic effects per person-rem (public)	1.00E-04
Campaign (year)	8.33E-02
Iodine	I131
Rem per curie thyroid via inhalation (Rem/Ci)	1.27E06
Distance of freeway vehicle carrying radioactive cargo to pede...	3.00E01
Distance of freeway vehicle carrying radioactive cargo to right-...	3.00E01
Distance of freeway vehicle carrying radioactive cargo to maxi...	8.00E02
Distance of non-freeway vehicle carrying radioactive cargo to p...	2.70E01
Distance of non-freeway vehicle carrying radioactive cargo to ri...	3.00E01
Distance of non-freeway vehicle carrying radioactive cargo to ...	8.00E02
Distance of city street vehicle carrying radioactive cargo to ped...	5.00E00
Distance of city street vehicle carrying radioactive cargo to righ...	8.00E00
Distance of city street vehicle carrying radioactive cargo to ma...	8.00E02
Perpendicular distance to freeway vehicle going in opposite dire...	1.50E01
Perpendicular distance to non-freeway vehicle going in opposit...	3.00E00
Perpendicular distance to city vehicle going in opposite direction...	3.00E00
Perpendicular distance to all vehicles going in same direction (m)	4.00E00

5 RADTRAN FATALITIES CASE OUTPUT

```
                                                                RUN DATE: [ 29-JUL-09
AT 20:49:42 ]            PAGE    1


  RRRR    AAA   DDDD   TTTTT  RRRR    AAA   N   N  55555        6
  R   R  A   A  D   D    T    R   R  A   A  NN  N  5            6
  R   R  A   A  D   D    T    R   R  A   A  N N N  5            6
  RRRR   A   A  D   D    T    RRRR   A   A  N  NN  5555         6666
  R R    AAAAA  D   D    T    R R    AAAAA  N   N      5        6   6
  R  R   A   A  D   D    T    R  R   A   A  N   N  5   5        6   6
  R   R  A   A  DDDD     T    R   R  A   A  N   N  5555     *    666

                           RADTRAN 5.6   February 20, 2006

                                   INPUT ECHO
                                   ----------


 TITLE Calc. 2009-06944: Radwaste: PSEG ESP to Barnwell SC: Fatalities
 INPUT STANDARD
STD: 0 10 18                              && DIMEN=NSEV NRAD NAREAS
STD: 1 3 3 0                              && PARM=IRNKC IANA ISEN IPSQSB
STD: .TRUE. .FALSE.                       && FORM = UNIT, SI-UNITS?
STD: 2.3E12                               && NEVAL FOR CF252
STD: 9.25E5 5.77E6 1.27E6                 && RPCTHY FOR I125, I129, I131
STD: 0.0 0.0 0.0 0.0 0.0                  && TRANSFER GAMMA
STD: 7.42E-3 2.02E-2 6.17E-5 3.17E-8 0.0  && TRANSFER NEUTRON
STD: 30  24                               && MITDDIST  MITDVEL
STD: 1  2   .0018                         && ITRAIN FMINCL DDRWEF
STD:    33    68    105   244   369               && CENTER LINE
STD:   561  1018   1628  2308  4269               && DISTANCES
STD:  5468 11136  13097 21334 40502               && FOR AVERAGE
STD: 69986 89860 120878 0 0 0 0 0 0 0 0 0 0 0 0   && US CLOUD
STD: 4.59E+02 1.53E+03 3.94E+03 1.25E+04 3.04E+04 6.85E+04 1.76E+05 4.45E+05
STD: 8.59E+05 2.55E+06 4.45E+06 1.03E+07 2.16E+07 5.52E+07 1.77E+08 4.89E+08
STD: 8.12E+08 1.35E+09 0 0 0 0 0 0 0 0 0 0 0 0     && AREADA
STD: 3.42E-03 1.72E-03 8.58E-04 3.42E-04 1.72E-04 8.58E-05 3.42E-05 1.72E-05
STD:  8.58E-06 3.42E-06 1.72E-06 8.58E-07 3.42E-07 1.72E-07 8.58E-08 5.42E-08
STD:  4.30E-08 3.42E-08 0 0 0 0 0 0 0 0 0 0 0 0     && DFLEV
STD: 3 6 9 12 15 30 61 91 152 305 0 0 0 0 0
STD: 3 6 9 12 15 30 61 91 152 305 0 0 0 0 0
STD: 3 6 9 12 15 30 61 91 152 305 0 0 0 0 0 && RADIST
STD: 0.5                              && SMLPKG
STD: 1.0  0.87  0.018                 && SHIELDING FACTORS RR  RS  RU
STD:  30  30  800                     && OFFLINK {FREEWAY}
STD:  27  30  800                     && OFFLINK {NON-FREEWAY}
STD:   5   8  800                     && OFFLINK {CITY STREETS}
STD:  30  30  800                     && OFFLINK {RAILWAY}
STD: 200 200 1000                     && OFFLINK {WATERWAY}
STD: 15  3  3  3  4                   && ONLINK {FWAY NONFWY STREET RAIL ADJ}
STD: 6.0  4  40.0                     && RPD FNOATT INTERDICT
STD: 0.05   0.2   3.3E-4              && BDF CULVL BRATE
STD: 0.9   0.1                        && UBF USWF
STD: 1.0  10.0 1.0                    && EVACUATION SURVEY CAMPAIGN
```

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RUN DATE: [ 29-JUL-09 AT 20:49:42 ]          PAGE    2

      Calc. 2009-06944: Radwaste: PSEG ESP to Barnwell SC: Fatalities

STD: 0.0  0.0     1.5E-8  5.3E-8      && HIGHWAY - RURAL - NONRAD
STD: 0.0  0.0     3.7E-9  1.3E-8      && HIGHWAY - SUBURBAN - NONRAD
STD: 0.0  0.0     2.1E-9  7.5E-9      && HIGHWAY - URBAN - NONRAD
STD: 0.0  0.0    1.81E-9  2.64E-8     && GENERAL FREIGHT - R - NONRAD
STD: 0.0  0.0    1.81E-9  2.64E-8     && GENERAL FREIGHT - S - NONRAD
STD: 0.0  0.0    1.81E-9  2.64E-8     && GENERAL FREIGHT - U - NONRAD
STD: 0.0  0.0    1.27E-7  1.85E-6     && DEDICATED RAIL - R - NONRAD
STD: 0.0  0.0    1.27E-7  1.85E-6     && DEDICATED RAIL - S - NONRAD
STD: 0.0  0.0    1.27E-7  1.85E-6     && DEDICATED RAIL - U - NONRAD
STD: 0.0 0.0 0.0 0.0 0.0 0.0          && PSPROB
STD: 0.67  0.67  0.42                 && TIMENDE NON-DISPERSAL EVAC TIME
(LCF&EARLY)
STD: 2 2 1                            && FLAGS=IUOPT IACC REGCHECK
STD: 5E-4, 4E-4, 1.0E-4               && LCFCON(1), LCFCON(2), GECON
STD: R5INGEST.BIN                     && INGESTION FILE
 OUTPUT BQ_SV
 FORM UNIT
 DIMEN 19 10 18
 PARM 1 3 1 0
 SEVERITY
    NPOP=1
       NMODE=1
        1.53E-8
  5.88E-5 1.81E-6 7.49E-8 4.65E-7 3.31E-9
  0.0 1.13E-8 8.03E-11 0.0 1.44E-10
  1.02E-12 0.0 7.49E-11 0.0 0.0
  0.0 5.86E-6 0.99993
    NPOP=2
       NMODE=1
        1.53E-8
  5.88E-5 1.81E-6 7.49E-8 4.65E-7 3.31E-9
  0.0 1.13E-8 8.03E-11 0.0 1.44E-10
  1.02E-12 0.0 7.49E-11 0.0 0.0
  0.0 5.86E-6 0.99993
    NPOP=3
       NMODE=1
        1.53E-8
  5.88E-5 1.81E-6 7.49E-8 4.65E-7 3.31E-9
  0.0 1.13E-8 8.03E-11 0.0 1.44E-10
  1.02E-12 0.0 7.49E-11 0.0 0.0
  0.0 5.86E-6 0.99993
 RELEASE
    GROUP=Cor
       RFRAC
          0.0020
  0.0014 0.0018 0.0032 0.0018 0.0021
  0.0031 0.02 0.0022 0.0025 0.0020
  0.0022 0.0025 0.0064 0.0059 0.0033
  0.0033 0.0025 0.0
       AERSOL
          1.0
```

Calc. 2009-06944: Radwaste: PSEG ESP to Barnwell SC: Fatalities

```
1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0
     RESP
        1.0
1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0
     LOS
        0.0
0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0
     DEPVEL 0.01
  GROUP=gas
     RFRAC
        0.8
0.14 0.18 0.84 0.43 0.49
0.85 0.82 0.89 0.91 0.82
0.89 0.91 0.84 0.85 0.91
0.91 0.84 0.0
     AERSOL
        1.0
1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0
     RESP
        1.0
1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0
     LOS
        0.0
0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0
     DEPVEL 0.0
  GROUP=part
     RFRAC
        6.0E-7
1.0E-7 1.3E-7 3.8E-6 3.2E-7 3.7E-7
2.1E-6 6.1E-7 6.7E-7 6.8E-7 6.1E-7
6.7E-7 6.8E-7 1.8E-5 9.0E-6 6.8E-7
6.8E-7 6.7E-8 0.0
     AERSOL
        1.0
1.0 1.0 1.0 1.0 1.0
```

Calc. 2009-06944: Radwaste: PSEG ESP to Barnwell SC: Fatalities

```
1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0
     RESP
        1.0
1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0
     LOS
        0.0
0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0
     DEPVEL 0.01
  GROUP=Cs
     RFRAC
        2.4E-8
4.1E-9 5.4E-9 3.6E-5 1.3E-8 1.5E-8
2.7E-5 2.4E-8 2.7E-8 5.9E-6 2.4E-8
2.7E-8 5.9E-6 9.6E-5 5.5E-5 5.9E-6
5.9E-6 1.7E-5 0.0
     AERSOL
        1.0
1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0
     RESP
        1.0
1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0
     LOS
        0.0
0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0
     DEPVEL 0.01
  GROUP=Ru
     RFRAC
        6.0E-7
1.0E-7 1.3E-7 3.8E-6 3.2E-7 3.7E-7
2.1E-6 6.1E-7 6.7E-7 6.8E-7 6.1E-7
6.7E-7 6.8E-7 1.8E-5 9.0E-6 6.8E-7
6.8E-7 6.7E-8 0.0
     AERSOL
        1.0
1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0
```

Calc. 2009-06944: Radwaste: PSEG ESP to Barnwell SC: Fatalities

```
 1.0 1.0 1.0 1.0 1.0
 1.0 1.0 1.0
      RESP
         1.0
 1.0 1.0 1.0 1.0 1.0
 1.0 1.0 1.0 1.0 1.0
 1.0 1.0 1.0 1.0 1.0
 1.0 1.0 1.0
      LOS
         0.0
 0.0 0.0 0.0 0.0 0.0
 0.0 0.0 0.0 0.0 0.0
 0.0 0.0 0.0 0.0 0.0
 0.0 0.0 0.0
      DEPVEL 0.01
PACKAGE PACKAGE_1 13.9 0.5 0.5 5.2
   CO60 1040.0 Cor
   CO58 1140.0 Cor
   NI63 1090.0 Cor
   CR51 5240.0 Cor
   FE55 2600.0 Cor
   FE59 0.533 Cor
   MN54 1690.0 Cor
   NB95 94.9 Cor
   ZR95 62.4 Cor
   MO99 3250.0 Cor
   ZN65 416.0 Cor
   H3WTR 1.61 gas
   C14ORG 0.285 gas
   BA140 340.0 part
   PU241 0.339 part
   CE141 31.2 part
   CE144 169.0 part
   EU154 3.51 part
   PM147 31.2 part
   SR89 260.0 part
   SR90 156.0 part
   Y90 156.0 part
   Y91 48.1 part
   TE125M 66.3 part
   TE127M 494.0 part
   TE129M 520.0 part
   TE132 1430.0 part
   CS134 416000.0 Cs
   CS137 312000.0 Cs
   I131 33800.0 Cs
   RB86 221.0 Cs
   RU103 31.2 Ru
   RU106 78.0 Ru
END
VEHICLE -1 VEHICLE_1 1.39E01 1.0 0.0 5.2 1.0 2.0 4.0 1.0 1.0
      PACKAGE_1 1.0
FLAGS
```

```
               RUN DATE: [ 29-JUL-09 AT 20:49:42 ]            PAGE    6

      Calc. 2009-06944: Radwaste: PSEG ESP to Barnwell SC: Fatalities

   IACC 2
   IUOPT 2
   REGCHECK 1
MODSTD
   DISTOFF FREEWAY 3.00E01 3.00E01 8.00E02
   DISTOFF SECONDARY 2.70E01 3.00E01 8.00E02
   DISTOFF STREET 5.00E00 8.00E00 8.00E02
   DISTON
     FREEWAY 1.50E01
     SECONDARY 3.00E00
     STREET 3.00E00
     ADJACENT 4.00E00
   BDF 5.00E-02
   BRATE 3.30E-04
   CULVL 2.00E-01
   EVACUATION 1.00E00
   GECON 1.00E-04
   INTERDICT 4.00E01
   LCFCON 5.00E-04 4.00E-04
   SURVEY 1.00E01
   UBF 5.20E-01
   USWF 4.80E-01
   CAMPAIGN 8.33E-02
   MITDDIST 3.00E01
   MITDVEL 2.40E01
   RPD 6.00E00
   RR 1.00E00
   RU 1.80E-02
   RS 8.70E-01
   SMALLPKG 5.00E-01
   RPCTHYROID
     I131  1.27E06
EOF
LINK RURAL_DE VEHICLE_1 5.9 88.9 1.5 20.6 5301.5 5.18E-7 0.0108 R 1 1.0
LINK SUBURBN_DE VEHICLE_1 16.9 88.9 1.5 409.8 760.0 5.18E-7 0.0108 S 1 1.0
LINK URBAN_DE VEHICLE_1 3.3 88.9 1.5 2303.2 2400.0 5.18E-7 0.0108 U 1 1.0
LINK RURAL_MD VEHICLE_1 46.7 88.9 1.5 23.8 530.0 5.4E-7 0.012 R 1 1.0
LINK SUBURBN_MD VEHICLE_1 92.5 88.9 1.5 482.5 760.0 5.4E-7 0.012 S 1 1.0
LINK URBAN_MD VEHICLE_1 44.1 88.9 1.5 2524.1 2400.0 5.4E-7 0.012 U 1 1.0
LINK RURAL_NJ VEHICLE_1 20.6 88.9 1.5 11.8 530.0 5.65E-7 0.0214 R 1 1.0
LINK SUBURBN_NJ VEHICLE_1 12.5 88.9 1.5 353.9 760.0 5.65E-7 0.0214 S 1 1.0
LINK URBAN_NJ VEHICLE_1 1.1 88.9 1.5 2025.9 2400.0 5.65E-7 0.0214 U 1 1.0
LINK RURAL_NC VEHICLE_1 175.0 88.9 1.5 18.1 530.0 3.46E-7 0.0425 R 1 1.0
LINK SUBURBN_NC VEHICLE_1 116.2 88.9 1.5 276.5 760.0 3.46E-7 0.0425 S 1 1.0
LINK URBAN_NC VEHICLE_1 1.8 88.9 1.5 1834.3 2400.0 3.46E-7 0.0425 U 1 1.0
LINK RURAL_SC VEHICLE_1 177.6 88.9 1.5 11.9 530.0 3.15E-7 0.0279 R 1 1.0
LINK SUBURBN_SC VEHICLE_1 91.9 88.9 1.5 299.0 760.0 3.15E-7 0.0279 S 1 1.0
LINK URBAN_SC VEHICLE_1 2.1 88.9 1.5 1953.4 2400.0 3.15E-7 0.0279 U 1 1.0
LINK RURAL_VA VEHICLE_1 114.1 88.9 1.5 19.6 530.0 3.93E-7 0.041 R 1 1.0
LINK SUBURBN_VA VEHICLE_1 162.6 88.9 1.5 382.2 760.0 3.93E-7 0.041 S 1 1.0
LINK URBAN_VA VEHICLE_1 23.5 88.9 1.5 2355.2 2400.0 3.93E-7 0.041 U 1 1.0

STOP STOP_1 VEHICLE_1 30000.0 1.0 10.0 1.0 1.5
```

```
STOP STOP_2 VEHICLE_1 340.0 10.0 800.0 0.2 1.5

HANDLING HANDLE_1 VEHICLE_1 5.0 1.0 0.5

EOF
```

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Calc. 2009-06944: Radwaste: PSEG ESP to Barnwell SC: Fatalities

NON-RADIOLOGICAL DATA (ACCIDENTS and FATALITIES)
****

HIGHWAY

	ACCIDENT RATE	ACCIDENTS	FATALITIES
RURAL_DE	5.18E-07	3.06E-06	3.30E-08
SUBURBN_DE	5.18E-07	8.75E-06	9.45E-08
URBAN_DE	5.18E-07	1.71E-06	1.85E-08
RURAL_MD	5.40E-07	2.52E-05	3.03E-07
SUBURBN_MD	5.40E-07	5.00E-05	5.99E-07
URBAN_MD	5.40E-07	2.38E-05	2.86E-07
RURAL_NJ	5.65E-07	1.16E-05	2.49E-07
SUBURBN_NJ	5.65E-07	7.06E-06	1.51E-07
URBAN_NJ	5.65E-07	6.22E-07	1.33E-08
RURAL_NC	3.46E-07	6.06E-05	2.57E-06
SUBURBN_NC	3.46E-07	4.02E-05	1.71E-06
URBAN_NC	3.46E-07	6.23E-07	2.65E-08
RURAL_SC	3.15E-07	5.59E-05	1.56E-06
SUBURBN_SC	3.15E-07	2.89E-05	8.08E-07
URBAN_SC	3.15E-07	6.62E-07	1.85E-08
RURAL_VA	3.93E-07	4.48E-05	1.84E-06
SUBURBN_VA	3.93E-07	6.39E-05	2.62E-06
URBAN_VA	3.93E-07	9.24E-06	3.79E-07
TOTALS:	8.03E-06	4.37E-04	1.33E-05

Calc. 2009-06944: Radwaste: PSEG ESP to Barnwell SC: Fatalities

REGULATORY CHECKS

```
FOR VEHICLE_1  THE DOSE RATE AT 2 METERS COULD EXCEED 0.1 MSV/HR
THE VEHICLE DOSE RATE HAS BEEN RESET TO EQUAL   0.13 MSV/HR
```

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Calc. 2009-06944: Radwaste: PSEG ESP to Barnwell SC: Fatalities

CALCULATIONAL INFORMATION

FOR VEHICLE_1 AREAS WITH TOTAL CONTAMINATION RATIO GREATER THAN 40.000
(THE AREAS MARKED WITH AN 'X' ARE INTERDICTED AND HAVE
NO 50 YEAR GROUNDSHINE DOSE AND NO INGESTION DOSE.)

AREA/SEVERITY	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-
2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-
3	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-
4	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-
5	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-
6	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-
7	X	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-
8	-	-	-	X	-	-	X	X	-	-	-	-	-	X	X	-	-	-	-
9	-	-	-	-	-	-	-	X	-	-	-	-	-	X	X	-	-	-	-
10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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Calc. 2009-06944: Radwaste: PSEG ESP to Barnwell SC: Fatalities

INCIDENT-FREE SUMMARY
******** **** *******

IN-TRANSIT POPULATION EXPOSURE IN PERSON-SV
*INPUT DATA WERE ALTERED WITH REGULATORY CHECKS

	PASSENGER	CREW	OFF LINK	ON LINK	TOTALS
RURAL_DE	0.00E+00	2.62E-06	4.12E-08	4.12E-06	6.77E-06
SUBURBN_DE	0.00E+00	7.49E-06	2.04E-06	1.69E-06	1.12E-05
URBAN_DE	0.00E+00	1.46E-06	4.64E-08	1.04E-06	2.55E-06
RURAL_MD	0.00E+00	2.07E-05	3.77E-07	3.26E-06	2.43E-05
SUBURBN_MD	0.00E+00	4.10E-05	1.32E-05	9.25E-06	6.34E-05
URBAN_MD	0.00E+00	1.95E-05	6.79E-07	1.39E-05	3.42E-05
RURAL_NJ	0.00E+00	9.13E-06	8.24E-08	1.44E-06	1.07E-05
SUBURBN_NJ	0.00E+00	5.54E-06	1.30E-06	1.25E-06	8.09E-06
URBAN_NJ	0.00E+00	4.88E-07	1.36E-08	3.47E-07	8.49E-07
RURAL_NC	0.00E+00	7.76E-05	1.07E-06	1.22E-05	9.09E-05
SUBURBN_NC	0.00E+00	5.15E-05	9.47E-06	1.16E-05	7.26E-05
URBAN_NC	0.00E+00	7.98E-07	2.01E-08	5.68E-07	1.39E-06
RURAL_SC	0.00E+00	7.87E-05	7.16E-07	1.24E-05	9.18E-05
SUBURBN_SC	0.00E+00	4.07E-05	8.10E-06	9.19E-06	5.80E-05
URBAN_SC	0.00E+00	9.31E-07	2.50E-08	6.63E-07	1.62E-06
RURAL_VA	0.00E+00	5.06E-05	7.58E-07	7.96E-06	5.93E-05
SUBURBN_VA	0.00E+00	7.21E-05	1.83E-05	1.63E-05	1.07E-04
URBAN_VA	0.00E+00	1.04E-05	3.38E-07	7.42E-06	1.82E-05
RURAL	0.00E+00	2.39E-04	3.05E-06	4.14E-05	2.84E-04
SUBURB	0.00E+00	2.18E-04	5.24E-05	4.93E-05	3.20E-04
URBAN	0.00E+00	3.36E-05	1.12E-06	2.40E-05	5.87E-05
TOTALS:	0.00E+00	4.91E-04	5.66E-05	1.15E-04	6.62E-04

MAXIMUM INDIVIDUAL IN-TRANSIT DOSE

VEHICLE_1 5.92E-09 SV

STOP EXPOSURE IN PERSON-SV

ANNULAR AREA	STOP_1	9.43E-04
ANNULAR AREA	STOP_2	4.07E-06
	TOTAL:	9.47E-04

HANDLING EXPOSURE IN PERSON-SV

HANDLING	VEHICLE	MATERIAL	METHOD	DOSE
HANDLE_1	VEHICLE_1	PACKAGE_1	LINE-SOURCE	1.17E-03
			TOTAL:	1.17E-03

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Calc. 2009-06944: Radwaste: PSEG ESP to Barnwell SC: Fatalities

ACCIDENT SUMMARY
******** *******

EXPECTED VALUES OF POPULATION RISK IN PERSON-SV

	GROUND	INHALED	RESUSPD	CLOUDSH	TOTAL
RURAL_DE	2.73E-11	1.73E-13	8.90E-18	6.91E-15	2.75E-11
SUBURBN_DE	1.56E-09	9.88E-12	5.07E-16	3.94E-13	1.57E-09
URBAN_DE	4.96E-09	3.15E-11	1.62E-15	1.26E-12	5.00E-09
RURAL_MD	2.60E-10	1.65E-12	8.48E-17	6.58E-14	2.62E-10
SUBURBN_MD	1.05E-08	6.64E-11	3.41E-15	2.64E-12	1.05E-08
URBAN_MD	7.58E-08	4.81E-10	2.47E-14	1.92E-11	7.63E-08
RURAL_NJ	5.96E-11	3.78E-13	1.94E-17	1.51E-14	6.00E-11
SUBURBN_NJ	1.08E-09	6.88E-12	3.53E-16	2.74E-13	1.09E-09
URBAN_NJ	1.59E-09	1.01E-11	5.17E-16	4.01E-13	1.60E-09
RURAL_NC	4.76E-10	3.02E-12	1.55E-16	1.20E-13	4.79E-10
SUBURBN_NC	4.82E-09	3.06E-11	1.57E-15	1.22E-12	4.86E-09
URBAN_NC	1.44E-09	9.14E-12	4.69E-16	3.64E-13	1.45E-09
RURAL_SC	2.89E-10	1.83E-12	9.41E-17	7.30E-14	2.91E-10
SUBURBN_SC	3.76E-09	2.38E-11	1.22E-15	9.50E-13	3.78E-09
URBAN_SC	1.63E-09	1.03E-11	5.31E-16	4.12E-13	1.64E-09
RURAL_VA	3.81E-10	2.42E-12	1.24E-16	9.64E-14	3.84E-10
SUBURBN_VA	1.06E-08	6.72E-11	3.45E-15	2.68E-12	1.07E-08
URBAN_VA	2.74E-08	1.74E-10	8.93E-15	6.93E-12	2.76E-08
RURAL	1.49E-09	9.47E-12	4.86E-16	3.78E-13	1.50E-09
SUBURB	3.23E-08	2.05E-10	1.05E-14	8.16E-12	3.25E-08
URBAN	1.13E-07	7.16E-10	3.67E-14	2.85E-11	1.14E-07
TOTALS:	1.47E-07	9.30E-10	4.77E-14	3.71E-11	1.48E-07

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Calc. 2009-06944: Radwaste: PSEG ESP to Barnwell SC: Fatalities

SOCIETAL INGESTION RISK - PERSON-SV

LINK	GONADS	EFFECTIVE
RURAL_DE	2.13E-11	2.09E-11
RURAL_MD	1.76E-10	1.73E-10
RURAL_NJ	8.12E-11	7.97E-11
RURAL_NC	4.23E-10	4.15E-10
RURAL_SC	3.90E-10	3.83E-10
RURAL_VA	3.13E-10	3.07E-10
TOTAL	1.40E-09	1.38E-09

SOCIETAL INGESTION RISK BY ORGAN - PERSON-SV

LINK	BREAST	LUNGS	RED MARR	BONE SUR	THYROID	REMAINDER
RURAL_DE	1.71E-11	1.71E-11	1.95E-11	1.84E-11	1.89E-11	2.51E-11
RURAL_MD	1.41E-10	1.41E-10	1.61E-10	1.52E-10	1.56E-10	2.07E-10
RURAL_NJ	6.53E-11	6.52E-11	7.41E-11	7.00E-11	7.21E-11	9.56E-11
RURAL_NC	3.40E-10	3.39E-10	3.85E-10	3.64E-10	3.75E-10	4.97E-10
RURAL_SC	3.14E-10	3.13E-10	3.56E-10	3.36E-10	3.47E-10	4.59E-10
RURAL_VA	2.52E-10	2.51E-10	2.85E-10	2.70E-10	2.78E-10	3.68E-10
TOTAL	1.13E-09	1.13E-09	1.28E-09	1.21E-09	1.25E-09	1.65E-09

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Calc. 2009-06944: Radwaste: PSEG ESP to Barnwell SC: Fatalities

EXPECTED RISK VALUES - OTHER

LINK	EARLY FATALITY	EARLY MORBIDITY
RURAL_DE	0.00E+00	0.00E+00
SUBURBN_DE	0.00E+00	0.00E+00
URBAN_DE	0.00E+00	0.00E+00
RURAL_MD	0.00E+00	0.00E+00
SUBURBN_MD	0.00E+00	0.00E+00
URBAN_MD	0.00E+00	0.00E+00
RURAL_NJ	0.00E+00	0.00E+00
SUBURBN_NJ	0.00E+00	0.00E+00
URBAN_NJ	0.00E+00	0.00E+00
RURAL_NC	0.00E+00	0.00E+00
SUBURBN_NC	0.00E+00	0.00E+00
URBAN_NC	0.00E+00	0.00E+00
RURAL_SC	0.00E+00	0.00E+00
SUBURBN_SC	0.00E+00	0.00E+00
URBAN_SC	0.00E+00	0.00E+00
RURAL_VA	0.00E+00	0.00E+00
SUBURBN_VA	0.00E+00	0.00E+00
URBAN_VA	0.00E+00	0.00E+00
TOTAL	0.00E+00	0.00E+00

EOI
END OF RUN
SUCCESSFUL COMPLETION

6 RADTRAN INJURIES CASE OUTPUT

```
                                                        RUN DATE: [ 29-JUL-09 AT
20:52:08 ]           PAGE    1


  RRRR    AAA   DDDD   TTTTT  RRRR    AAA   N   N  55555        6
  R   R  A   A  D   D    T    R   R  A   A  NN  N  5            6
  R   R  A   A  D   D    T    R   R  A   A  N N N  5            6
  RRRR   A   A  D   D    T    RRRR   A   A  N  NN  5555         6666
  R R    AAAAA  D   D    T    R R    AAAAA  N   N      5        6   6
  R  R   A   A  D   D    T    R  R   A   A  N   N  5   5        6   6
  R   R  A   A  DDDD     T    R   R  A   A  N   N  5555      *   666

                            RADTRAN 5.6   February 20, 2006

                                    INPUT ECHO
                                    ----------


 TITLE Calc. 2009-06944: Radwaste: PSEG ESP to Barnwell SC: Injuries
 INPUT STANDARD
STD: 0 10 18                              && DIMEN=NSEV NRAD NAREAS
STD: 1 3 3 0                              && PARM=IRNKC IANA ISEN IPSQSB
STD: .TRUE. .FALSE.                       && FORM = UNIT, SI-UNITS?
STD: 2.3E12                               && NEVAL FOR CF252
STD: 9.25E5 5.77E6 1.27E6                 && RPCTHY FOR I125, I129, I131
STD: 0.0 0.0 0.0 0.0 0.0                  && TRANSFER GAMMA
STD: 7.42E-3 2.02E-2 6.17E-5 3.17E-8 0.0  && TRANSFER NEUTRON
STD: 30  24                               && MITDDIST  MITDVEL
STD: 1  2   .0018                         && ITRAIN FMINCL DDRWEF
STD:    33    68    105   244   369               && CENTER LINE
STD:   561  1018   1628  2308  4269               && DISTANCES
STD:  5468 11136  13097 21334 40502               && FOR AVERAGE
STD: 69986 89860 120878 0 0 0 0 0 0 0 0 0 0 0 0   && US CLOUD
STD: 4.59E+02 1.53E+03 3.94E+03 1.25E+04 3.04E+04 6.85E+04 1.76E+05 4.45E+05
STD: 8.59E+05 2.55E+06 4.45E+06 1.03E+07 2.16E+07 5.52E+07 1.77E+08 4.89E+08
STD: 8.12E+08 1.35E+09 0 0 0 0 0 0 0 0 0 0 0 0 0    && AREADA
STD: 3.42E-03 1.72E-03 8.58E-04 3.42E-04 1.72E-04 8.58E-05 3.42E-05 1.72E-05
STD:  8.58E-06 3.42E-06 1.72E-06 8.58E-07 3.42E-07 1.72E-07 8.58E-08 5.42E-08
STD:  4.30E-08 3.42E-08 0 0 0 0 0 0 0 0 0 0 0 0 0     && DFLEV
STD: 3 6 9 12 15 30 61 91 152 305 0 0 0 0 0
STD: 3 6 9 12 15 30 61 91 152 305 0 0 0 0 0
STD: 3 6 9 12 15 30 61 91 152 305 0 0 0 0 0 && RADIST
STD: 0.5                              && SMLPKG
STD: 1.0  0.87  0.018                 && SHIELDING FACTORS RR  RS  RU
STD:  30  30  800                     && OFFLINK {FREEWAY}
STD:  27  30  800                     && OFFLINK {NON-FREEWAY}
STD:   5   8  800                     && OFFLINK {CITY STREETS}
STD:  30  30  800                     && OFFLINK {RAILWAY}
STD: 200 200 1000                     && OFFLINK {WATERWAY}
STD: 15  3  3  3  4                   && ONLINK {FWAY NONFWY STREET RAIL ADJ}
STD: 6.0  4  40.0                     && RPD FNOATT INTERDICT
STD: 0.05   0.2   3.3E-4              && BDF CULVL BRATE
STD: 0.9   0.1                        && UBF USWF
STD: 1.0  10.0 1.0                    && EVACUATION SURVEY CAMPAIGN
```

```
                 RUN DATE: [ 29-JUL-09 AT 20:52:08 ]            PAGE    2

        Calc. 2009-06944: Radwaste: PSEG ESP to Barnwell SC: Injuries

STD: 0.0  0.0     1.5E-8  5.3E-8      && HIGHWAY - RURAL - NONRAD
STD: 0.0  0.0     3.7E-9  1.3E-8      && HIGHWAY - SUBURBAN - NONRAD
STD: 0.0  0.0     2.1E-9  7.5E-9      && HIGHWAY - URBAN - NONRAD
STD: 0.0  0.0    1.81E-9  2.64E-8     && GENERAL FREIGHT - R - NONRAD
STD: 0.0  0.0    1.81E-9  2.64E-8     && GENERAL FREIGHT - S - NONRAD
STD: 0.0  0.0    1.81E-9  2.64E-8     && GENERAL FREIGHT - U - NONRAD
STD: 0.0  0.0    1.27E-7  1.85E-6     && DEDICATED RAIL - R - NONRAD
STD: 0.0  0.0    1.27E-7  1.85E-6     && DEDICATED RAIL - S - NONRAD
STD: 0.0  0.0    1.27E-7  1.85E-6     && DEDICATED RAIL - U - NONRAD
STD: 0.0 0.0 0.0 0.0 0.0 0.0          && PSPROB
STD: 0.67  0.67  0.42                 && TIMENDE NON-DISPERSAL EVAC TIME
(LCF&EARLY)
STD: 2 2 1                            && FLAGS=IUOPT IACC REGCHECK
STD: 5E-4, 4E-4, 1.0E-4               && LCFCON(1), LCFCON(2), GECON
STD: R5INGEST.BIN                     && INGESTION FILE
 OUTPUT BQ_SV
 FORM UNIT
 DIMEN 19 10 18
 PARM 1 3 1 0
 SEVERITY
    NPOP=1
       NMODE=1
        1.53E-8
  5.88E-5 1.81E-6 7.49E-8 4.65E-7 3.31E-9
  0.0 1.13E-8 8.03E-11 0.0 1.44E-10
  1.02E-12 0.0 7.49E-11 0.0 0.0
  0.0 5.86E-6 0.99993
    NPOP=2
       NMODE=1
        1.53E-8
  5.88E-5 1.81E-6 7.49E-8 4.65E-7 3.31E-9
  0.0 1.13E-8 8.03E-11 0.0 1.44E-10
  1.02E-12 0.0 7.49E-11 0.0 0.0
  0.0 5.86E-6 0.99993
    NPOP=3
       NMODE=1
        1.53E-8
  5.88E-5 1.81E-6 7.49E-8 4.65E-7 3.31E-9
  0.0 1.13E-8 8.03E-11 0.0 1.44E-10
  1.02E-12 0.0 7.49E-11 0.0 0.0
  0.0 5.86E-6 0.99993
 RELEASE
    GROUP=Cor
       RFRAC
          0.0020
  0.0014 0.0018 0.0032 0.0018 0.0021
  0.0031 0.02 0.0022 0.0025 0.0020
  0.0022 0.0025 0.0064 0.0059 0.0033
  0.0033 0.0025 0.0
       AERSOL
          1.0
```

```
RUN DATE: [ 29-JUL-09 AT 20:52:08 ]           PAGE    3

Calc. 2009-06944: Radwaste: PSEG ESP to Barnwell SC: Injuries

1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0
     RESP
        1.0
1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0
     LOS
        0.0
0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0
     DEPVEL 0.01
  GROUP=gas
     RFRAC
        0.8
0.14 0.18 0.84 0.43 0.49
0.85 0.82 0.89 0.91 0.82
0.89 0.91 0.84 0.85 0.91
0.91 0.84 0.0
     AERSOL
        1.0
1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0
     RESP
        1.0
1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0
     LOS
        0.0
0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0
     DEPVEL 0.0
  GROUP=part
     RFRAC
        6.0E-7
1.0E-7 1.3E-7 3.8E-6 3.2E-7 3.7E-7
2.1E-6 6.1E-7 6.7E-7 6.8E-7 6.1E-7
6.7E-7 6.8E-7 1.8E-5 9.0E-6 6.8E-7
6.8E-7 6.7E-8 0.0
     AERSOL
        1.0
1.0 1.0 1.0 1.0 1.0
```

```
      Calc. 2009-06944: Radwaste: PSEG ESP to Barnwell SC: Injuries

1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0
     RESP
        1.0
1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0
     LOS
        0.0
0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0
     DEPVEL 0.01
  GROUP=Cs
     RFRAC
        2.4E-8
4.1E-9 5.4E-9 3.6E-5 1.3E-8 1.5E-8
2.7E-5 2.4E-8 2.7E-8 5.9E-6 2.4E-8
2.7E-8 5.9E-6 9.6E-5 5.5E-5 5.9E-6
5.9E-6 1.7E-5 0.0
     AERSOL
        1.0
1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0
     RESP
        1.0
1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0
     LOS
        0.0
0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0 0.0 0.0
0.0 0.0 0.0
     DEPVEL 0.01
  GROUP=Ru
     RFRAC
        6.0E-7
1.0E-7 1.3E-7 3.8E-6 3.2E-7 3.7E-7
2.1E-6 6.1E-7 6.7E-7 6.8E-7 6.1E-7
6.7E-7 6.8E-7 1.8E-5 9.0E-6 6.8E-7
6.8E-7 6.7E-8 0.0
     AERSOL
        1.0
1.0 1.0 1.0 1.0 1.0
1.0 1.0 1.0 1.0 1.0
```

Calc. 2009-06944: Radwaste: PSEG ESP to Barnwell SC: Injuries

```
 1.0 1.0 1.0 1.0 1.0
 1.0 1.0 1.0
      RESP
         1.0
 1.0 1.0 1.0 1.0 1.0
 1.0 1.0 1.0 1.0 1.0
 1.0 1.0 1.0 1.0 1.0
 1.0 1.0 1.0
      LOS
         0.0
 0.0 0.0 0.0 0.0 0.0
 0.0 0.0 0.0 0.0 0.0
 0.0 0.0 0.0 0.0 0.0
 0.0 0.0 0.0
      DEPVEL 0.01
PACKAGE PACKAGE_1 13.9 0.5 0.5 5.2
   CO60 1040.0 Cor
   CO58 1140.0 Cor
   NI63 1090.0 Cor
   CR51 5240.0 Cor
   FE55 2600.0 Cor
   FE59 0.533 Cor
   MN54 1690.0 Cor
   NB95 94.9 Cor
   ZR95 62.4 Cor
   MO99 3250.0 Cor
   ZN65 416.0 Cor
   H3WTR 1.61 gas
   C14ORG 0.285 gas
   BA140 340.0 part
   PU241 0.339 part
   CE141 31.2 part
   CE144 169.0 part
   EU154 3.51 part
   PM147 31.2 part
   SR89 260.0 part
   SR90 156.0 part
   Y90 156.0 part
   Y91 48.1 part
   TE125M 66.3 part
   TE127M 494.0 part
   TE129M 520.0 part
   TE132 1430.0 part
   CS134 416000.0 Cs
   CS137 312000.0 Cs
   I131 33800.0 Cs
   RB86 221.0 Cs
   RU103 31.2 Ru
   RU106 78.0 Ru
END
VEHICLE -1 VEHICLE_1 1.39E01 1.0 0.0 5.2 1.0 2.0 4.0 1.0 1.0
      PACKAGE_1 1.0
FLAGS
```

Calc. 2009-06944: Radwaste: PSEG ESP to Barnwell SC: Injuries

```
   IACC 2
   IUOPT 2
   REGCHECK 1
MODSTD
   DISTOFF FREEWAY 3.00E01 3.00E01 8.00E02
   DISTOFF SECONDARY 2.70E01 3.00E01 8.00E02
   DISTOFF STREET 5.00E00 8.00E00 8.00E02
   DISTON
     FREEWAY 1.50E01
     SECONDARY 3.00E00
     STREET 3.00E00
     ADJACENT 4.00E00
   BDF 5.00E-02
   BRATE 3.30E-04
   CULVL 2.00E-01
   EVACUATION 1.00E00
   GECON 1.00E-04
   INTERDICT 4.00E01
   LCFCON 5.00E-04 4.00E-04
   SURVEY 1.00E01
   UBF 5.20E-01
   USWF 4.80E-01
   CAMPAIGN 8.33E-02
   MITDDIST 3.00E01
   MITDVEL 2.40E01
   RPD 6.00E00
   RR 1.00E00
   RU 1.80E-02
   RS 8.70E-01
   SMALLPKG 5.00E-01
   RPCTHYROID
     I131  1.27E06
EOF
LINK RURAL_DE VEHICLE_1 5.9 88.9 1.5 20.6 5301.5 5.18E-7 0.66 R 1 1.0
LINK SUBURBN_DE VEHICLE_1 16.9 88.9 1.5 409.8 760.0 5.18E-7 0.66 S 1 1.0
LINK URBAN_DE VEHICLE_1 3.3 88.9 1.5 2303.2 2400.0 5.18E-7 0.66 U 1 1.0
LINK RURAL_MD VEHICLE_1 46.7 88.9 1.5 23.8 530.0 5.4E-7 0.85 R 1 1.0
LINK SUBURBN_MD VEHICLE_1 92.5 88.9 1.5 482.5 760.0 5.4E-7 0.85 S 1 1.0
LINK URBAN_MD VEHICLE_1 44.1 88.9 1.5 2524.1 2400.0 5.4E-7 0.85 U 1 1.0
LINK RURAL_NJ VEHICLE_1 20.6 88.9 1.5 11.8 530.0 5.65E-7 0.692 R 1 1.0
LINK SUBURBN_NJ VEHICLE_1 12.5 88.9 1.5 353.9 760.0 5.65E-7 0.692 S 1 1.0
LINK URBAN_NJ VEHICLE_1 1.1 88.9 1.5 2025.9 2400.0 5.65E-7 0.692 U 1 1.0
LINK RURAL_NC VEHICLE_1 175.0 88.9 1.5 18.1 530.0 3.46E-7 0.916 R 1 1.0
LINK SUBURBN_NC VEHICLE_1 116.2 88.9 1.5 276.5 760.0 3.46E-7 0.916 S 1 1.0
LINK URBAN_NC VEHICLE_1 1.8 88.9 1.5 1834.3 2400.0 3.46E-7 0.916 U 1 1.0
LINK RURAL_SC VEHICLE_1 177.6 88.9 1.5 11.9 530.0 3.15E-7 0.721 R 1 1.0
LINK SUBURBN_SC VEHICLE_1 91.9 88.9 1.5 299.0 760.0 3.15E-7 0.721 S 1 1.0
LINK URBAN_SC VEHICLE_1 2.1 88.9 1.5 1953.4 2400.0 3.15E-7 0.721 U 1 1.0
LINK RURAL_VA VEHICLE_1 114.1 88.9 1.5 19.6 530.0 3.93E-7 0.789 R 1 1.0
LINK SUBURBN_VA VEHICLE_1 162.6 88.9 1.5 382.2 760.0 3.93E-7 0.789 S 1 1.0
LINK URBAN_VA VEHICLE_1 23.5 88.9 1.5 2355.2 2400.0 3.93E-7 0.789 U 1 1.0

STOP STOP_1 VEHICLE_1 30000.0 1.0 10.0 1.0 1.5
```

```
STOP STOP_2 VEHICLE_1 340.0 10.0 800.0 0.2 1.5

HANDLING HANDLE_1 VEHICLE_1 5.0 1.0 0.5

EOF
```

RUN DATE: [29-JUL-09 AT 20:52:08] PAGE 7

Calc. 2009-06944: Radwaste: PSEG ESP to Barnwell SC: Injuries

NON-RADIOLOGICAL DATA (ACCIDENTS and FATALITIES)
****

HIGHWAY

	ACCIDENT RATE	ACCIDENTS	FATALITIES
RURAL_DE	5.18E-07	3.06E-06	2.02E-06
SUBURBN_DE	5.18E-07	8.75E-06	5.78E-06
URBAN_DE	5.18E-07	1.71E-06	1.13E-06
RURAL_MD	5.40E-07	2.52E-05	2.14E-05
SUBURBN_MD	5.40E-07	5.00E-05	4.25E-05
URBAN_MD	5.40E-07	2.38E-05	2.02E-05
RURAL_NJ	5.65E-07	1.16E-05	8.05E-06
SUBURBN_NJ	5.65E-07	7.06E-06	4.89E-06
URBAN_NJ	5.65E-07	6.22E-07	4.30E-07
RURAL_NC	3.46E-07	6.06E-05	5.55E-05
SUBURBN_NC	3.46E-07	4.02E-05	3.68E-05
URBAN_NC	3.46E-07	6.23E-07	5.70E-07
RURAL_SC	3.15E-07	5.59E-05	4.03E-05
SUBURBN_SC	3.15E-07	2.89E-05	2.09E-05
URBAN_SC	3.15E-07	6.62E-07	4.77E-07
RURAL_VA	3.93E-07	4.48E-05	3.54E-05
SUBURBN_VA	3.93E-07	6.39E-05	5.04E-05
URBAN_VA	3.93E-07	9.24E-06	7.29E-06
TOTALS:	8.03E-06	4.37E-04	3.54E-04

RUN DATE: [29-JUL-09 AT 20:52:08]   PAGE   8

Calc. 2009-06944: Radwaste: PSEG ESP to Barnwell SC: Injuries

REGULATORY CHECKS

```
FOR VEHICLE_1  THE DOSE RATE AT 2 METERS COULD EXCEED 0.1 MSV/HR
THE VEHICLE DOSE RATE HAS BEEN RESET TO EQUAL   0.13 MSV/HR
```

RUN DATE: [29-JUL-09 AT 20:52:08] PAGE 9

Calc. 2009-06944: Radwaste: PSEG ESP to Barnwell SC: Injuries

CALCULATIONAL INFORMATION

FOR VEHICLE_1 AREAS WITH TOTAL CONTAMINATION RATIO GREATER THAN 40.000
(THE AREAS MARKED WITH AN 'X' ARE INTERDICTED AND HAVE
NO 50 YEAR GROUNDSHINE DOSE AND NO INGESTION DOSE.)

AREA/SEVERITY	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-
2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-
3	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-
4	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-
5	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-
6	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-
7	X	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-
8	-	-	-	X	-	-	X	X	-	-	-	-	-	X	X	-	-	-	-
9	-	-	-	-	-	-	-	X	-	-	-	-	-	X	X	-	-	-	-
10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

RUN DATE: [29-JUL-09 AT 20:52:08]   PAGE   10

Calc. 2009-06944: Radwaste: PSEG ESP to Barnwell SC: Injuries

INCIDENT-FREE SUMMARY
******** **** *******

IN-TRANSIT POPULATION EXPOSURE IN PERSON-SV
*INPUT DATA WERE ALTERED WITH REGULATORY CHECKS

	PASSENGER	CREW	OFF LINK	ON LINK	TOTALS
RURAL_DE	0.00E+00	2.62E-06	4.12E-08	4.12E-06	6.77E-06
SUBURBN_DE	0.00E+00	7.49E-06	2.04E-06	1.69E-06	1.12E-05
URBAN_DE	0.00E+00	1.46E-06	4.64E-08	1.04E-06	2.55E-06
RURAL_MD	0.00E+00	2.07E-05	3.77E-07	3.26E-06	2.43E-05
SUBURBN_MD	0.00E+00	4.10E-05	1.32E-05	9.25E-06	6.34E-05
URBAN_MD	0.00E+00	1.95E-05	6.79E-07	1.39E-05	3.42E-05
RURAL_NJ	0.00E+00	9.13E-06	8.24E-08	1.44E-06	1.07E-05
SUBURBN_NJ	0.00E+00	5.54E-06	1.30E-06	1.25E-06	8.09E-06
URBAN_NJ	0.00E+00	4.88E-07	1.36E-08	3.47E-07	8.49E-07
RURAL_NC	0.00E+00	7.76E-05	1.07E-06	1.22E-05	9.09E-05
SUBURBN_NC	0.00E+00	5.15E-05	9.47E-06	1.16E-05	7.26E-05
URBAN_NC	0.00E+00	7.98E-07	2.01E-08	5.68E-07	1.39E-06
RURAL_SC	0.00E+00	7.87E-05	7.16E-07	1.24E-05	9.18E-05
SUBURBN_SC	0.00E+00	4.07E-05	8.10E-06	9.19E-06	5.80E-05
URBAN_SC	0.00E+00	9.31E-07	2.50E-08	6.63E-07	1.62E-06
RURAL_VA	0.00E+00	5.06E-05	7.58E-07	7.96E-06	5.93E-05
SUBURBN_VA	0.00E+00	7.21E-05	1.83E-05	1.63E-05	1.07E-04
URBAN_VA	0.00E+00	1.04E-05	3.38E-07	7.42E-06	1.82E-05
RURAL	0.00E+00	2.39E-04	3.05E-06	4.14E-05	2.84E-04
SUBURB	0.00E+00	2.18E-04	5.24E-05	4.93E-05	3.20E-04
URBAN	0.00E+00	3.36E-05	1.12E-06	2.40E-05	5.87E-05
TOTALS:	0.00E+00	4.91E-04	5.66E-05	1.15E-04	6.62E-04

MAXIMUM INDIVIDUAL IN-TRANSIT DOSE

VEHICLE_1   5.92E-09 SV

STOP EXPOSURE IN PERSON-SV

ANNULAR AREA	STOP_1	9.43E-04
ANNULAR AREA	STOP_2	4.07E-06
	TOTAL:	9.47E-04

HANDLING EXPOSURE IN PERSON-SV

HANDLING	VEHICLE	MATERIAL	METHOD	DOSE
HANDLE_1	VEHICLE_1	PACKAGE_1	LINE-SOURCE	1.17E-03
			TOTAL:	1.17E-03

RUN DATE: [29-JUL-09 AT 20:52:08] PAGE 11

Calc. 2009-06944: Radwaste: PSEG ESP to Barnwell SC: Injuries

ACCIDENT SUMMARY
******** *******
EXPECTED VALUES OF POPULATION RISK IN PERSON-SV

	GROUND	INHALED	RESUSPD	CLOUDSH	TOTAL
RURAL_DE	2.73E-11	1.73E-13	8.90E-18	6.91E-15	2.75E-11
SUBURBN_DE	1.56E-09	9.88E-12	5.07E-16	3.94E-13	1.57E-09
URBAN_DE	4.96E-09	3.15E-11	1.62E-15	1.26E-12	5.00E-09
RURAL_MD	2.60E-10	1.65E-12	8.48E-17	6.58E-14	2.62E-10
SUBURBN_MD	1.05E-08	6.64E-11	3.41E-15	2.64E-12	1.05E-08
URBAN_MD	7.58E-08	4.81E-10	2.47E-14	1.92E-11	7.63E-08
RURAL_NJ	5.96E-11	3.78E-13	1.94E-17	1.51E-14	6.00E-11
SUBURBN_NJ	1.08E-09	6.88E-12	3.53E-16	2.74E-13	1.09E-09
URBAN_NJ	1.59E-09	1.01E-11	5.17E-16	4.01E-13	1.60E-09
RURAL_NC	4.76E-10	3.02E-12	1.55E-16	1.20E-13	4.79E-10
SUBURBN_NC	4.82E-09	3.06E-11	1.57E-15	1.22E-12	4.86E-09
URBAN_NC	1.44E-09	9.14E-12	4.69E-16	3.64E-13	1.45E-09
RURAL_SC	2.89E-10	1.83E-12	9.41E-17	7.30E-14	2.91E-10
SUBURBN_SC	3.76E-09	2.38E-11	1.22E-15	9.50E-13	3.78E-09
URBAN_SC	1.63E-09	1.03E-11	5.31E-16	4.12E-13	1.64E-09
RURAL_VA	3.81E-10	2.42E-12	1.24E-16	9.64E-14	3.84E-10
SUBURBN_VA	1.06E-08	6.72E-11	3.45E-15	2.68E-12	1.07E-08
URBAN_VA	2.74E-08	1.74E-10	8.93E-15	6.93E-12	2.76E-08
RURAL	1.49E-09	9.47E-12	4.86E-16	3.78E-13	1.50E-09
SUBURB	3.23E-08	2.05E-10	1.05E-14	8.16E-12	3.25E-08
URBAN	1.13E-07	7.16E-10	3.67E-14	2.85E-11	1.14E-07
TOTALS:	1.47E-07	9.30E-10	4.77E-14	3.71E-11	1.48E-07

RUN DATE: [29-JUL-09 AT 20:52:08] PAGE 12

Calc. 2009-06944: Radwaste: PSEG ESP to Barnwell SC: Injuries

SOCIETAL INGESTION RISK - PERSON-SV

LINK	GONADS	EFFECTIVE
RURAL_DE	2.13E-11	2.09E-11
RURAL_MD	1.76E-10	1.73E-10
RURAL_NJ	8.12E-11	7.97E-11
RURAL_NC	4.23E-10	4.15E-10
RURAL_SC	3.90E-10	3.83E-10
RURAL_VA	3.13E-10	3.07E-10
TOTAL	1.40E-09	1.38E-09

SOCIETAL INGESTION RISK BY ORGAN - PERSON-SV

LINK	BREAST	LUNGS	RED MARR	BONE SUR	THYROID	REMAINDER
RURAL_DE	1.71E-11	1.71E-11	1.95E-11	1.84E-11	1.89E-11	2.51E-11
RURAL_MD	1.41E-10	1.41E-10	1.61E-10	1.52E-10	1.56E-10	2.07E-10
RURAL_NJ	6.53E-11	6.52E-11	7.41E-11	7.00E-11	7.21E-11	9.56E-11
RURAL_NC	3.40E-10	3.39E-10	3.85E-10	3.64E-10	3.75E-10	4.97E-10
RURAL_SC	3.14E-10	3.13E-10	3.56E-10	3.36E-10	3.47E-10	4.59E-10
RURAL_VA	2.52E-10	2.51E-10	2.85E-10	2.70E-10	2.78E-10	3.68E-10
TOTAL	1.13E-09	1.13E-09	1.28E-09	1.21E-09	1.25E-09	1.65E-09

RUN DATE: [29-JUL-09 AT 20:52:08] PAGE 13

Calc. 2009-06944: Radwaste: PSEG ESP to Barnwell SC: Injuries

EXPECTED RISK VALUES - OTHER

LINK	EARLY FATALITY	EARLY MORBIDITY
RURAL_DE	0.00E+00	0.00E+00
SUBURBN_DE	0.00E+00	0.00E+00
URBAN_DE	0.00E+00	0.00E+00
RURAL_MD	0.00E+00	0.00E+00
SUBURBN_MD	0.00E+00	0.00E+00
URBAN_MD	0.00E+00	0.00E+00
RURAL_NJ	0.00E+00	0.00E+00
SUBURBN_NJ	0.00E+00	0.00E+00
URBAN_NJ	0.00E+00	0.00E+00
RURAL_NC	0.00E+00	0.00E+00
SUBURBN_NC	0.00E+00	0.00E+00
URBAN_NC	0.00E+00	0.00E+00
RURAL_SC	0.00E+00	0.00E+00
SUBURBN_SC	0.00E+00	0.00E+00
URBAN_SC	0.00E+00	0.00E+00
RURAL_VA	0.00E+00	0.00E+00
SUBURBN_VA	0.00E+00	0.00E+00
URBAN_VA	0.00E+00	0.00E+00
TOTAL	0.00E+00	0.00E+00

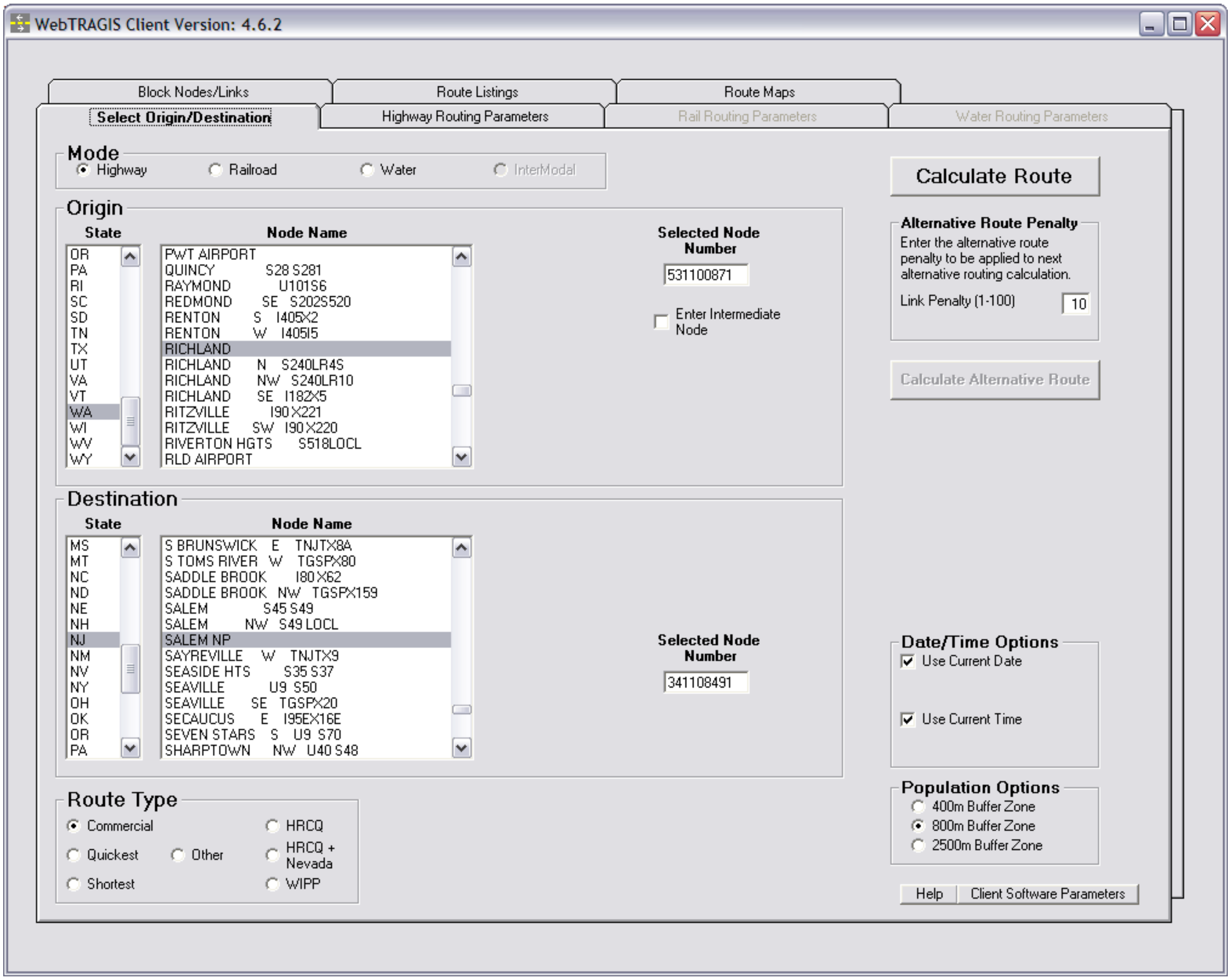
EOI
END OF RUN
SUCCESSFUL COMPLETION

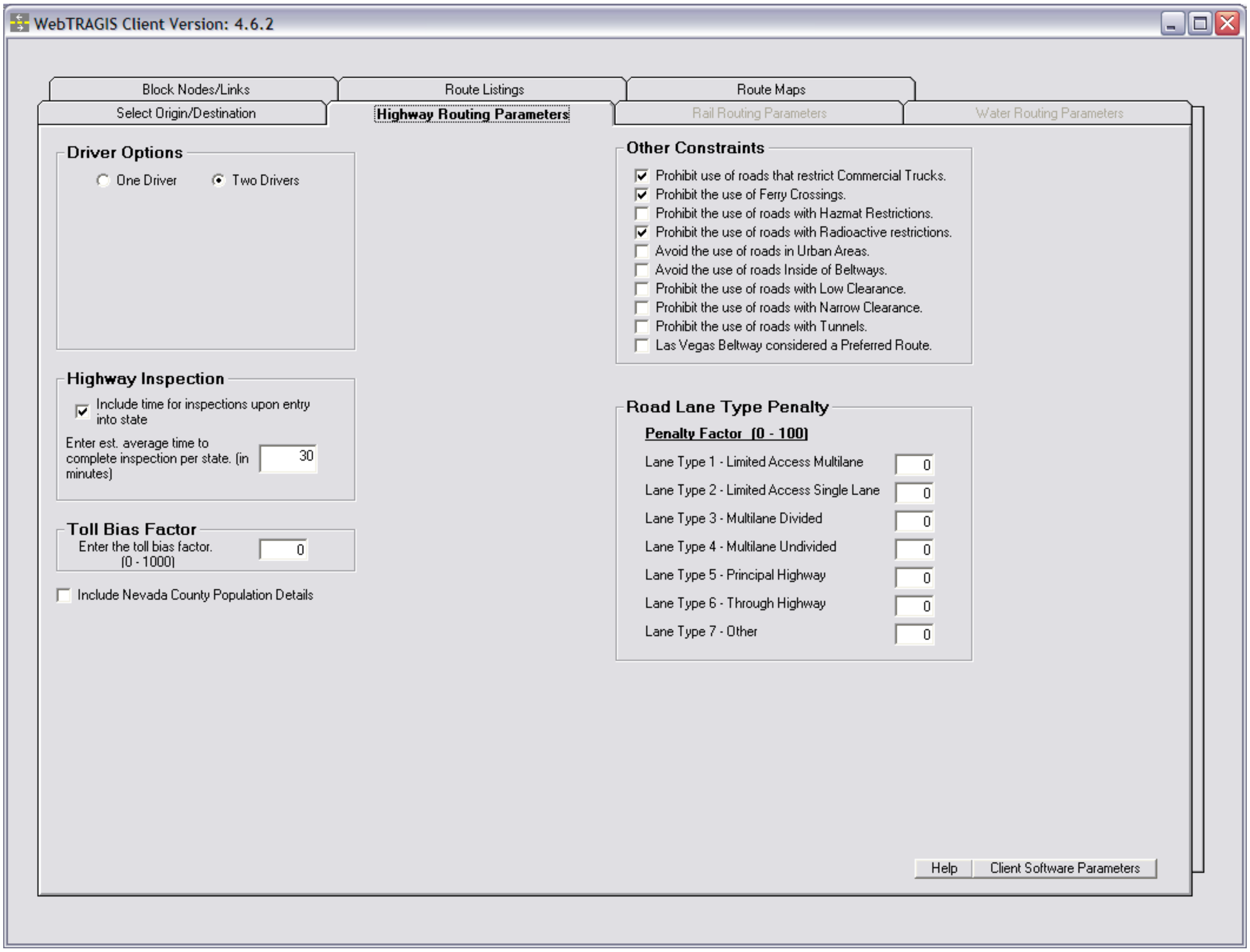
7A.3 NEW FUEL ANALYSIS

This attachment contains the TRAGIS and RADCAT/RADTRAN input and output for one new fuel shipment from Richland, WA to the PSEG Site.

1 TRAGIS INPUT

The TRAGIS input screens are reproduced below.




WebTRAGIS Client Version: 4.6.2
Block Nodes/Links
Route Listings
Route Maps
Select Origin/Destination
Highway Routing Parameters
Rail Routing Parameters
Water Routing Parameters
Driver Options
One Driver
Two Drivers
Highway Inspection
Include time for inspections upon entry into state
Enter est. average time to complete inspection per state. (in minutes)
30
Toll Bias Factor
Enter the toll bias factor. (0 - 1000)
0
Include Nevada County Population Details
Other Constraints
Prohibit use of roads that restrict Commercial Trucks.
Prohibit the use of Ferry Crossings.
Prohibit the use of roads with Hazmat Restrictions.
Prohibit the use of roads with Radioactive restrictions.
Avoid the use of roads in Urban Areas.
Avoid the use of roads Inside of Beltways.
Prohibit the use of roads with Low Clearance.
Prohibit the use of roads with Narrow Clearance.
Prohibit the use of roads with Tunnels.
Las Vegas Beltway considered a Preferred Route.
Road Lane Type Penalty
Penalty Factor (0 - 100)
Lane Type 1 - Limited Access Multilane 0
Lane Type 2 - Limited Access Single Lane 0
Lane Type 3 - Multilane Divided 0
Lane Type 4 - Multilane Undivided 0
Lane Type 5 - Principal Highway 0
Lane Type 6 - Through Highway 0
Lane Type 7 - Other 0
Help
Client Software Parameters

2 TRAGIS OUTPUT

TRAGIS Routing Engine Version 1.5.4 -- Highway Data Network 4.0

```
FROM:    RICHLAND                     WA         Leaving  : 06/26/09 15:33
TO  :    SALEM NP                     NJ              Arriving : 06/29/09 01:54
```

Routing parameters used to calculate the route-

Routing type: Commercial with 2 driver(s)
Time bias: 0.70 Mile bias: 0.30, Toll bias: 1.00

Constraints used on route:
Prohibit use of links prohibiting truck use
Prohibit use of ferry crossing
Prohibit use of roads with Radioactive materials prohibition

Miles	Hwy Sign		City	Dir	Junction	State	Dist	Time	Date	Hour
0.0			RICHLAND			WA	0.0	0:00	06/26/09	15:33
10.1	S240		KENNEWICK	NW	U395S240	WA	10.1	0:13	06/26/09	15:46
5.8	U395		KENNEWICK	SW	I82 X113	WA	15.9	0:21	06/26/09	15:54
19.1	I82		PLYMOUTH		I82 X131	WA	35.0	0:40	06/26/09	16:13
0.7	I82		crossing state border OR/WA			BD	35.6	1:11	06/26/09	16:44
			State Inspection took 30 minutes							
10.6	I82		HERMISTON	SW	I82 I84	OR	46.2	1:22	06/26/09	16:55
			Rest 30 minutes							
196.6	I84		ONTARIO	E	I84 X376	OR	242.8	5:27	06/26/09	22:00
1.3	I84		crossing state border ID/OR			BD	244.1	5:58	06/26/09	22:31
			State Inspection took 30 minutes							
			Rest 30 minutes							
221.6	I84		RAFT RIVER	W	I84 I86	ID	465.7	9:53	06/27/09	02:26
54.0	I84		crossing state border ID/UT			BD	519.7	11:13	06/27/09	03:46
			State Inspection took 30 minutes							
41.8	I84		TREMONTON	W	I15 I84	UT	561.5	11:48	06/27/09	04:21
			Rest 30 minutes							
39.4	I15	I84	OGDEN	S	I15 I84	UT	600.9	12:52	06/27/09	05:25
38.5	I84		ECHO		I80 I84	UT	639.5	13:23	06/27/09	05:56
29.4	I80		crossing state border UT/WY			BD	668.9	14:17	06/27/09	06:50
			State Inspection took 30 minutes							
			Rest 30 minutes							
360.1	I80		CHEYENNE	S	I80 X362	WY	1028.9	19:35	06/27/09	12:08
40.5	I80		crossing state border NE/WY			BD	1069.4	20:37	06/27/09	13:10
			Rest 30 minutes							
			State Inspection took 30 minutes							
			Rest 30 minutes							
450.5	I80		OMAHA	S	I80 X453	NE	1520.0	27:41	06/27/09	21:14
2.2	I80		crossing state border IA/NE			BD	1522.1	28:13	06/27/09	21:46
			State Inspection took 30 minutes							
0.9	I80		COUNCIL BLUFFS	SW	I29 I80	IA	1523.0	28:14	06/27/09	21:47
2.8	I29	I80	COUNCIL BLUFFS	SE	I29 I80	IA	1525.8	28:17	06/27/09	21:50
			Rest 30 minutes							
119.5	I80		DES MOINES	W	I235I35	IA	1645.3	30:38	06/28/09	00:11
14.2	I35	I80	DES MOINES	N	I235I35	IA	1659.5	30:52	06/28/09	00:25
			Rest 30 minutes							
167.6	I80		LE CLAIRE	SW	I80 X306	IA	1827.1	33:27	06/28/09	03:00
0.4	I80		crossing state border IA/IL			BD	1827.4	34:28	06/28/09	04:01
			State Inspection took 30 minutes							
154.7	I80		HOMEWOOD	NW	I294I80	IL	1982.1	37:16	06/28/09	06:49
4.9	I294$	I80 $	LANSING	W	I294I94	IL	1987.1	37:22	06/28/09	06:55
3.0	I80	I94	crossing state border IL/IN			BD	1990.0	37:55	06/28/09	07:28

			Rest 30 minutes							
			State Inspection took 30 minutes							
15.4	I80	I94	LAKE STATION	NE	I80 I94	IN	2005.4	38:41	06/28/09	08:14
0.5	I80		PORTAGE	W	I80 I90	IN	2005.9	38:42	06/28/09	08:15
122.2	I80 $	I90 $	JAMESTOWN	SE	I69 I80	IN	2128.1	40:44	06/28/09	10:17
13.2	I80 $	I90 $	crossing state border IN/OH			BD	2141.3	41:27	06/28/09	11:00
			State Inspection took 30 minutes							
			Rest 30 minutes							
141.8	I80 $	I90 $	ELYRIA	NW	I80 I90	OH	2283.0	44:32	06/28/09	15:05
76.0	I80 $		NORTH JACKSON	NE	I76 I80	OH	2359.0	45:55	06/28/09	16:28
15.2	I80		HUBBARD	N	I80 X234	OH	2374.2	46:12	06/28/09	16:45
2.7	I80		crossing state border OH/PA			BD	2376.9	46:44	06/28/09	17:17
			Rest 30 minutes							
			State Inspection took 30 minutes							
121.8	I80		NEEDFUL	S	I80 X123	PA	2498.7	49:08	06/28/09	19:41
1.6	S970		WOODLAND	E	U322S970	PA	2500.3	49:10	06/28/09	19:43
22.9	U322		PORT MATILDA		U220U322	PA	2523.2	49:38	06/28/09	20:11
2.9	U220	U322	MARTHA FURNACE		U220U322	PA	2526.1	49:41	06/28/09	20:14
38.6	U322		LEWISTOWN	NE	U322U522	PA	2564.7	50:27	06/28/09	21:00
0.5	U322	U522	LEWISTOWN	E	U322U522	PA	2565.2	50:27	06/28/09	21:00
1.9	U322		LEWISTOWN	SE	U22 U322	PA	2567.1	50:29	06/28/09	21:02
			Rest 30 minutes							
52.1	U22	U322	ROCKVILLE	S	I81 X67	PA	2619.1	51:23	06/28/09	21:56
2.6	I81		PENBROOK	NE	I81 I83	PA	2621.7	51:55	06/28/09	22:28
4.1	I83		HARRISBURG	SE	I283I83	PA	2625.8	51:59	06/28/09	22:32
2.8	I283		HIGHSPIRE	N	I283X1	PA	2628.6	52:02	06/28/09	22:35
28.4	S283		LANCASTER	NW	U30 S283	PA	2656.9	52:30	06/28/09	23:03
1.0	U30		LANCASTER	N	U222U30	PA	2657.9	52:31	06/28/09	23:04
1.0	U222	U30	LANCASTER	NE	U222U30	PA	2658.9	52:32	06/28/09	23:05
15.5	U30		GAP	NW	U30 S41	PA	2674.4	52:51	06/28/09	23:24
21.6	S41		KAOLIN		S41 S7	PA	2696.1	53:23	06/28/09	23:56
0.7	S41		crossing state border DE/PA			BD	2696.7	53:54	06/29/09	00:27
			State Inspection took 30 minutes							
7.4	S41		NEWPORT		S141S41	DE	2704.2	54:06	06/29/09	00:39
1.7	S141		NEWPORT	S	I95 X5	DE	2705.9	54:07	06/29/09	00:40
0.7	I95		NEWPORT	SE	I295I95	DE	2706.6	54:08	06/29/09	00:41
2.1	I295		NEW CASTLE	N	I295S9	DE	2708.7	54:10	06/29/09	00:43
2.5	I295#		crossing state border DE/NJ			BD	2711.2	54:43	06/29/09	01:16
			State Inspection took 30 minutes							
0.9	I295#		DEEPWATER	S	I295X1	NJ	2712.2	54:44	06/29/09	01:17
0.4	I295$	TNJT$	DEEPWATER	SE	TNJTI295	NJ	2712.6	54:44	06/29/09	01:17
4.7	C551		PENNSVILLE	S	S49 C551	NJ	2717.2	54:51	06/29/09	01:24
3.0	S49		SALEM	NW	S49 LOCL	NJ	2720.2	54:56	06/29/09	01:29
12.3	LOCAL		SALEM NP			NJ	2732.5	55:21	06/29/09	01:54

Total elapsed time: 55:21 Total trip mileage: 2732.5 Impedance: 2640.8

Mileage by State :

DE: 14.5	IA: 305.3	ID: 275.6	IL: 162.6	IN: 151.2	NE: 452.7
NJ: 21.3	OH: 235.7	OR: 208.5	PA: 319.8	UT: 149.1	WA: 35.6
WY: 400.5					

Mileage by Sign Type:
1-INTERSTATE: 2498.9 2-US: 142.2 3-STATE: 74.4 5-COUNTY: 4.7
6-LOCAL: 12.3

Mileage by Lane Type:
1-Multi-Lane Controlled Access: 2596.1 3-Multi-Lane Divided Highway: 13.5
5-Principle Road: 104.4 7-Other: 18.5

Mileage by Tribal Lands:
Total Outside Tribal Lands : 2705.6
Total Inside Tribal Lands : 26.9

3 TRAGIS GENERATED INPUT FOR RADTRAN

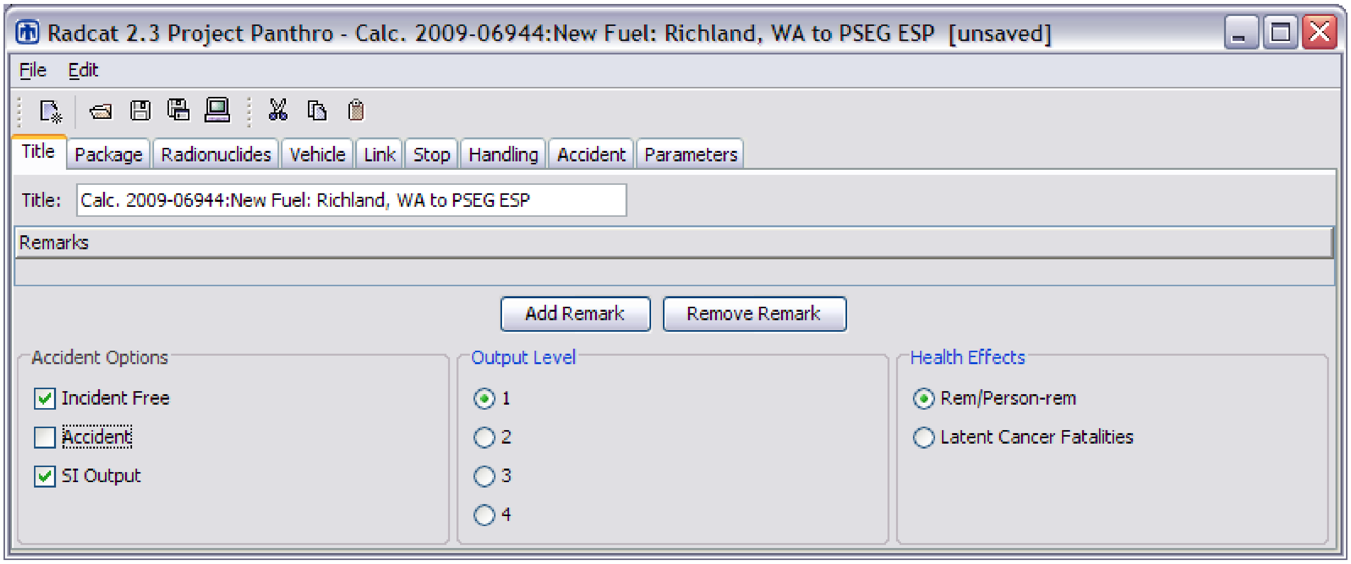
```
[TRAGIS]
TRAGIS Version=1.5.4
Mode=H
Network Version=4.0
Census Data=2000
Buffer Zone=800
[ROUTEINFO]
From CITY=RICHLAND
From STATE=WA
From SUBNET=
To CITY=SALEM NP
To STATE=NJ
To SUBNET=
[DE]
Rural - KM=   3.3
Suburban - KM=  14.0
Urban - KM=   6.0
Total - KM=  23.3
Rural Pop Density=  18.8
Suburban Pop Density= 549.2
Urban Pop Density=2168.9
[ID]
Rural - KM= 357.0
Suburban - KM=  79.3
Urban - KM=   7.3
Total - KM= 443.5
Rural Pop Density=  11.3
Suburban Pop Density= 278.7
Urban Pop Density=2219.6
[IL]
Rural - KM= 178.4
Suburban - KM=  73.0
Urban - KM=  10.2
Total - KM= 261.7
Rural Pop Density=  14.4
Suburban Pop Density= 323.6
Urban Pop Density=2379.1
[IN]
Rural - KM= 136.7
Suburban - KM=  97.3
Urban - KM=   9.4
Total - KM= 243.4
Rural Pop Density=  19.9
Suburban Pop Density= 276.3
Urban Pop Density=2354.7
[IA]
Rural - KM= 377.8
Suburban - KM= 107.7
Urban - KM=   5.8
Total - KM= 491.3
Rural Pop Density=  16.4
Suburban Pop Density= 272.7
Urban Pop Density=2191.1
[NE]
Rural - KM= 649.1
Suburban - KM=  71.5
Urban - KM=   8.0
Total - KM= 728.5
Rural Pop Density=   9.9
Suburban Pop Density= 270.2
Urban Pop Density=2410.2
```

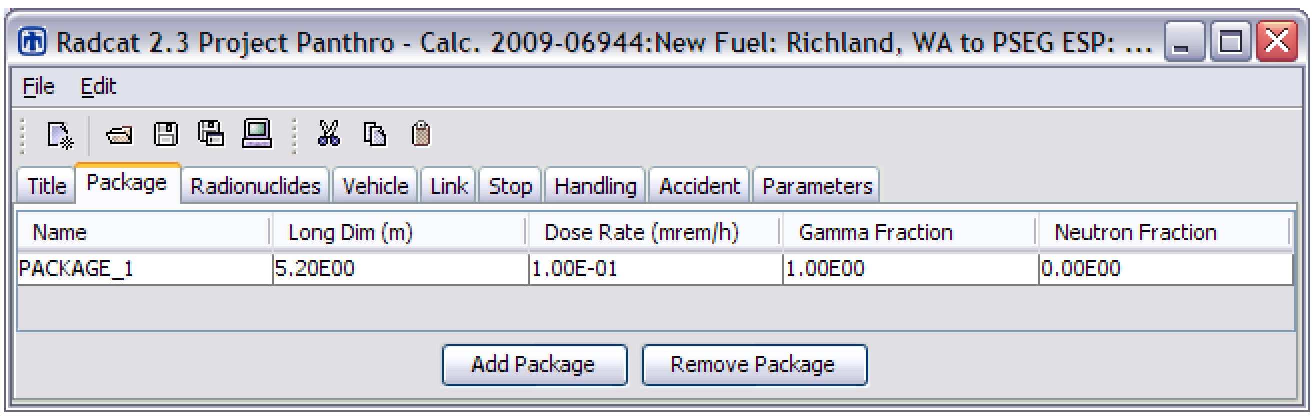
```
[NJ]
Rural - KM=  20.6
Suburban - KM=  12.5
Urban - KM=   1.1
Total - KM=  34.3
Rural Pop Density=  11.8
Suburban Pop Density= 353.9
Urban Pop Density=2025.9
[OH]
Rural - KM= 213.1
Suburban - KM= 151.3
Urban - KM=  14.8
Total - KM= 379.3
Rural Pop Density=  19.7
Suburban Pop Density= 309.6
Urban Pop Density=2211.7
[OR]
Rural - KM= 301.0
Suburban - KM=  32.2
Urban - KM=   2.3
Total - KM= 335.5
Rural Pop Density=   8.2
Suburban Pop Density= 313.2
Urban Pop Density=1976.3
[PA]
Rural - KM= 321.7
Suburban - KM= 172.2
Urban - KM=  20.7
Total - KM= 514.7
Rural Pop Density=  18.4
Suburban Pop Density= 313.8
Urban Pop Density=2452.8
[UT]
Rural - KM= 186.8
Suburban - KM=  51.6
Urban - KM=   1.5
Total - KM= 240.0
Rural Pop Density=   9.7
Suburban Pop Density= 257.8
Urban Pop Density=2112.2
[WA]
Rural - KM=  44.1
Suburban - KM=   8.6
Urban - KM=   4.7
Total - KM=  57.4
Rural Pop Density=   1.5
Suburban Pop Density= 604.4
Urban Pop Density=2293.2
[WY]
Rural - KM= 607.2
Suburban - KM=  33.9
Urban - KM=   3.4
Total - KM= 644.6
Rural Pop Density=   4.9
Suburban Pop Density= 399.4
Urban Pop Density=1966.6
```

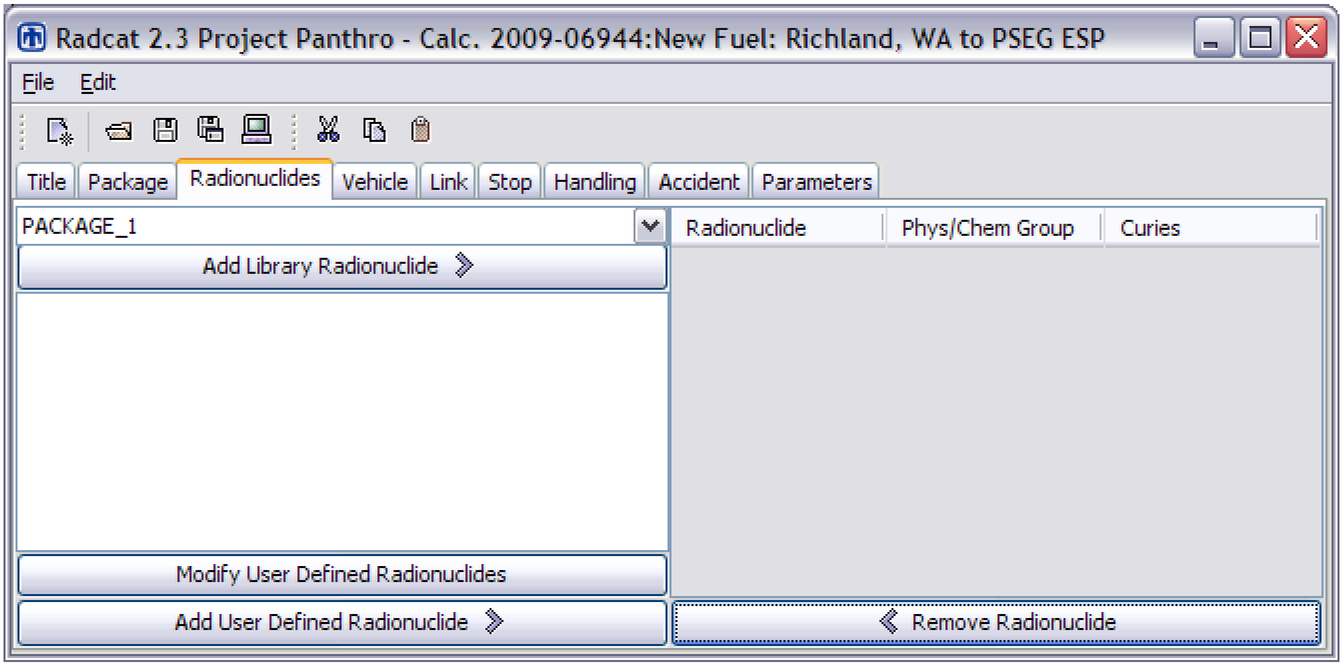
```
[Total]
Rural - KM=3396.8
Suburban - KM= 905.4
Urban - KM=  95.3
Total - KM=4397.4
Rural Pop Density=  11.7
Suburban Pop Density= 305.4
Urban Pop Density=2294.9
```

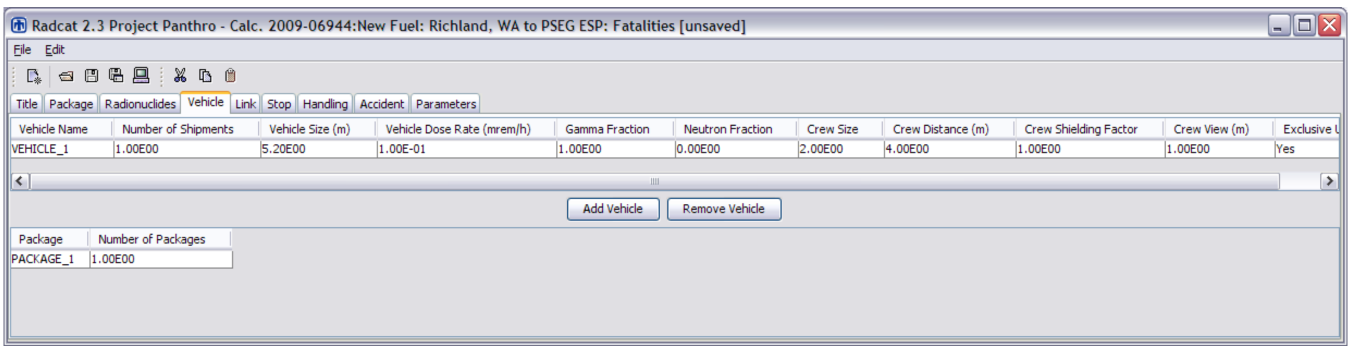
4 RADTRAN INPUT

The RADTRAN/RADCAT input screens are reproduced below.

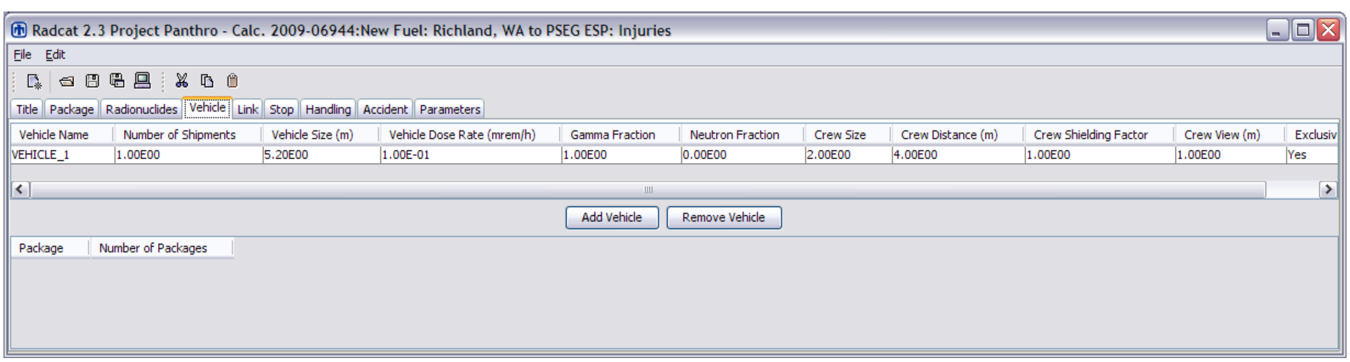








Note: This screen is the same for both the “fatalities” case and the “injuries” case.



Radcat 2.3 Project Panthro - Calc. 2009-06944:New Fuel: Richland, WA to PSEG ESP: Fatalities

File Edit

Title | Package | Radionuclides | Vehicle | Link | Stop | Handling | Accident | Parameters

Link Name	Vehicle	Length (km)	Speed (km/h)	Population Density (persons/km²)	Vehicle Density (vehicles/hr)	Persons per Vehicle	Accident Rate (accidents/veh-km)	Fatalities per Accident	Zone	
RURAL_DE	VEHICLE_1	3.30E00	8.89E01	1.88E01	5.30E02	1.50E00	5.18E-07	1.08E-02	Rural	Primary Hi
SUBURBN_DE	VEHICLE_1	1.40E01	8.89E01	5.49E02	7.60E02	1.50E00	5.18E-07	1.08E-02	Suburban	Primary Hi
URBAN_DE	VEHICLE_1	6.00E00	8.89E01	2.17E03	2.40E03	1.50E00	5.18E-07	1.08E-02	Urban	Primary Hi
RURAL_ID	VEHICLE_1	3.57E02	8.89E01	1.13E01	5.30E02	1.50E00	2.95E-07	1.29E-02	Rural	Primary Hi
SUBURBN_ID	VEHICLE_1	7.93E01	8.89E01	2.79E02	7.60E02	1.50E00	2.95E-07	1.29E-02	Suburban	Primary Hi
URBAN_ID	VEHICLE_1	7.30E00	8.89E01	2.22E03	2.40E03	1.50E00	2.95E-07	1.29E-02	Urban	Primary Hi
RURAL_IL	VEHICLE_1	1.78E02	8.89E01	1.44E01	5.30E02	1.50E00	2.22E-07	3.74E-02	Rural	Primary Hi
SUBURBN_IL	VEHICLE_1	7.30E01	8.89E01	3.24E02	7.60E02	1.50E00	2.22E-07	3.74E-02	Suburban	Primary Hi
URBAN_IL	VEHICLE_1	1.02E01	8.89E01	2.38E03	2.40E03	1.50E00	2.22E-07	3.74E-02	Urban	Primary Hi
RURAL_IN	VEHICLE_1	1.37E02	8.89E01	1.99E01	5.30E02	1.50E00	2.25E-07	2.98E-02	Rural	Primary Hi
SUBURBN_IN	VEHICLE_1	9.73E01	8.89E01	2.76E02	7.60E02	1.50E00	2.25E-07	2.98E-02	Suburban	Primary Hi
URBAN_IN	VEHICLE_1	9.40E00	8.89E01	2.35E03	2.40E03	1.50E00	2.25E-07	2.98E-02	Urban	Primary Hi
RURAL_IA	VEHICLE_1	3.78E02	8.89E01	1.64E01	5.30E02	1.50E00	1.12E-07	8.39E-02	Rural	Primary Hi
SUBURBN_IA	VEHICLE_1	1.08E02	8.89E01	2.73E02	7.60E02	1.50E00	1.12E-07	8.39E-02	Suburban	Primary Hi
URBAN_IA	VEHICLE_1	5.80E00	8.89E01	2.19E03	2.40E03	1.50E00	1.12E-07	8.39E-02	Urban	Primary Hi
RURAL_NE	VEHICLE_1	6.49E02	8.89E01	9.90E00	5.30E02	1.50E00	3.19E-07	4.29E-02	Rural	Primary Hi
SUBURBN_NE	VEHICLE_1	7.15E01	8.89E01	2.70E02	7.60E02	1.50E00	3.19E-07	4.29E-02	Suburban	Primary Hi
URBAN_NE	VEHICLE_1	8.00E00	8.89E01	2.41E03	2.40E03	1.50E00	3.19E-07	4.29E-02	Urban	Primary Hi
RURAL_NJ	VEHICLE_1	2.06E01	8.89E01	1.18E01	5.30E02	1.50E00	5.65E-07	2.14E-02	Rural	Primary Hi
SUBURBN_NJ	VEHICLE_1	1.25E01	8.90E00	3.54E02	7.60E02	1.50E00	5.65E-07	2.14E-02	Suburban	Primary Hi
URBAN_NJ	VEHICLE_1	1.10E00	8.89E01	2.03E03	2.40E03	1.50E00	5.65E-07	2.14E-02	Urban	Primary Hi
RURAL_OH	VEHICLE_1	2.13E02	8.89E01	1.97E01	5.30E02	1.50E00	1.64E-07	2.38E-02	Rural	Primary Hi
SUBURBN_OH	VEHICLE_1	1.51E02	8.89E01	3.10E02	7.60E02	1.50E00	1.64E-07	2.38E-02	Suburban	Primary Hi
URBAN_OH	VEHICLE_1	1.48E01	8.89E01	2.21E03	2.40E03	1.50E00	1.64E-07	2.38E-02	Urban	Primary Hi
RURAL_OR	VEHICLE_1	3.01E02	8.89E01	8.20E00	5.30E02	1.50E00	3.15E-07	6.48E-02	Rural	Primary Hi
SUBURBN_OR	VEHICLE_1	3.22E01	8.89E01	3.13E02	7.60E02	1.50E00	3.15E-07	6.48E-02	Suburban	Primary Hi
URBAN_OR	VEHICLE_1	2.30E00	8.89E01	1.98E03	2.40E03	1.50E00	3.15E-07	6.48E-02	Urban	Primary Hi
RURAL_PA	VEHICLE_1	3.22E02	8.89E01	1.84E01	5.30E02	1.50E00	5.14E-07	2.63E-02	Rural	Primary Hi
SUBURBN_PA	VEHICLE_1	1.72E02	8.89E01	3.14E02	7.60E02	1.50E00	5.14E-07	2.63E-02	Suburban	Primary Hi
URBAN_PA	VEHICLE_1	2.07E01	8.89E01	2.45E03	2.40E03	1.50E00	5.14E-07	2.63E-02	Urban	Primary Hi
RURAL_UT	VEHICLE_1	1.87E02	8.89E01	9.70E00	5.30E02	1.50E00	2.90E-07	4.10E-02	Rural	Primary Hi
SUBURBN_UT	VEHICLE_1	5.16E01	8.89E01	2.58E02	7.60E02	1.50E00	2.90E-07	4.10E-02	Suburban	Primary Hi
URBAN_UT	VEHICLE_1	1.50E00	8.89E01	2.11E03	2.40E03	1.50E00	2.90E-07	4.10E-02	Urban	Primary Hi
RURAL_WA	VEHICLE_1	4.41E01	8.89E01	1.50E00	5.30E02	1.50E00	2.65E-07	6.34E-02	Rural	Primary Hi
SUBURBN_WA	VEHICLE_1	8.60E00	8.89E01	6.04E02	7.60E02	1.50E00	2.65E-07	6.34E-02	Suburban	Primary Hi
URBAN_WA	VEHICLE_1	4.70E00	8.89E01	2.29E03	2.40E03	1.50E00	2.65E-07	6.34E-02	Urban	Primary Hi
RURAL_WY	VEHICLE_1	6.07E02	8.89E01	4.90E00	5.30E02	1.50E00	6.74E-07	1.60E-02	Rural	Primary Hi
SUBURBN_WY	VEHICLE_1	3.39E01	8.89E01	3.99E02	7.60E02	1.50E00	6.74E-07	1.60E-02	Suburban	Primary Hi
URBAN_WY	VEHICLE_1	3.40E00	8.89E01	1.97E03	2.40E03	1.50E00	6.74E-07	1.60E-02	Urban	Primary Hi

Add Link | Remove Link | Import Web Tragis

Injuries per Accident in Column Labeled “Fatalities per Accident”

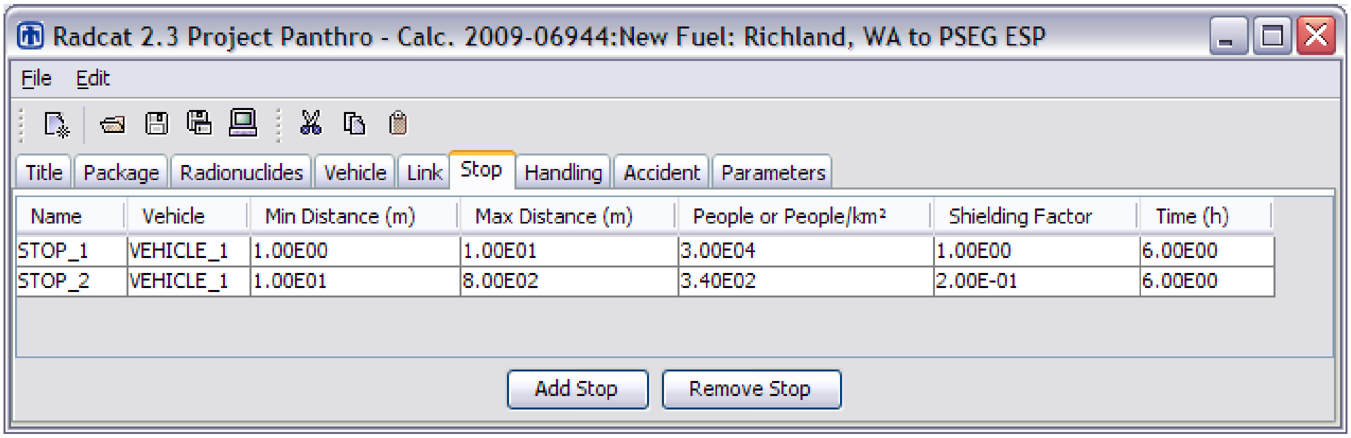
Radcat 2.3 Project Panthro - Calc. 2009-06944:New Fuel: Richland, WA to PSEG ESP: Injuries

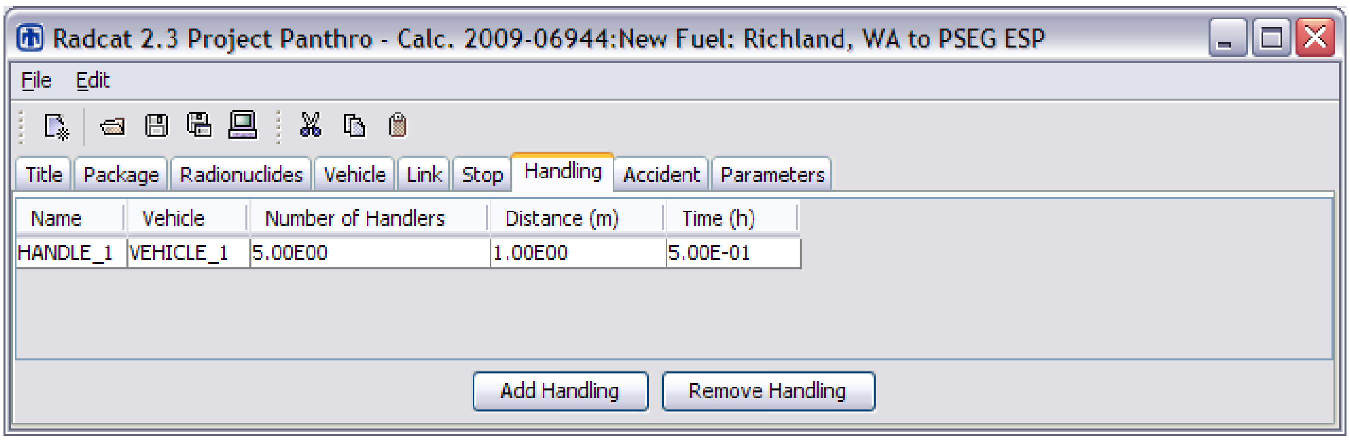
File Edit

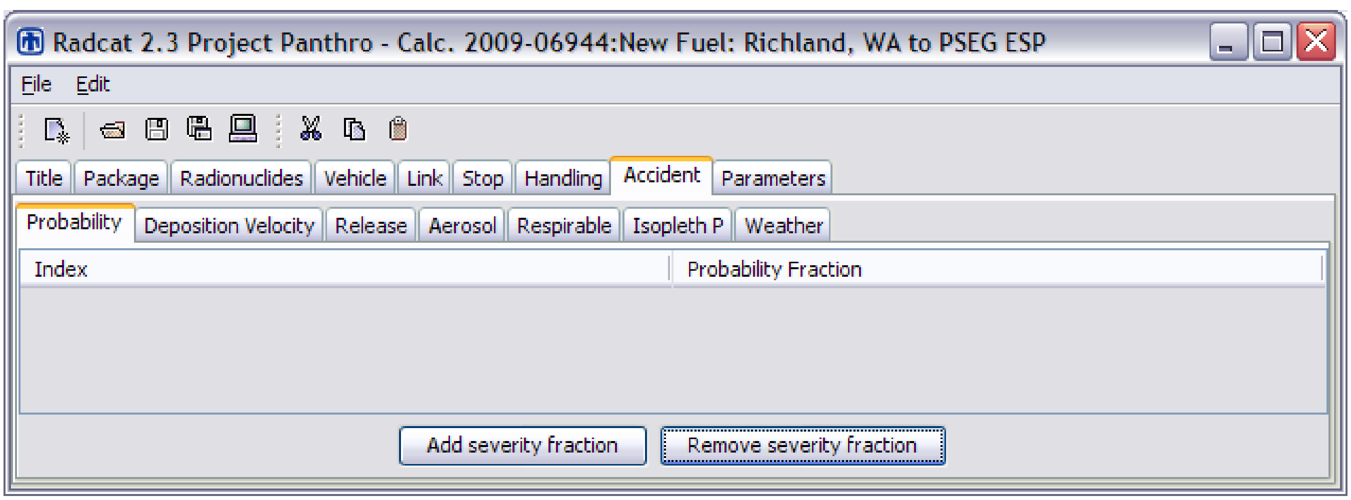
Title | Package | Radionuclides | Vehicle | Link | Stop | Handling | Accident | Parameters

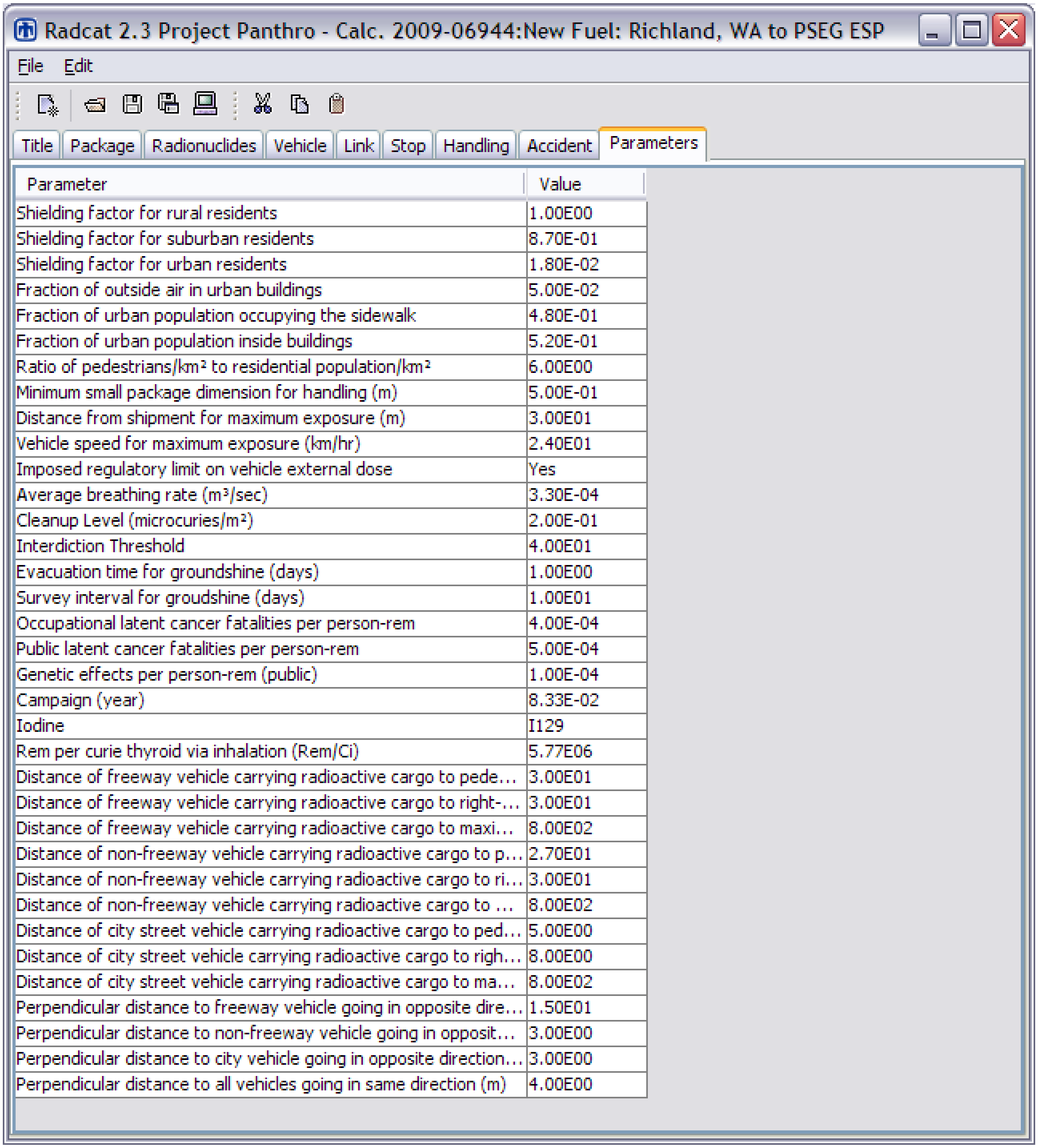
Link Name	Vehicle	Length (km)	Speed (km/h)	Population Density (persons/km²)	Vehicle Density (vehicles/hr)	Persons per Vehicle	Accident Rate (accidents/veh-km)	Fatalities per Accident	Zone
RURAL_DE	VEHICLE_1	3.30E00	8.89E01	1.88E01	5.30E02	1.50E00	5.18E-07	6.60E-01	Rural
SUBURBN_DE	VEHICLE_1	1.40E01	8.89E01	5.49E02	7.60E02	1.50E00	5.18E-07	6.60E-01	Suburb
URBAN_DE	VEHICLE_1	6.00E00	8.89E01	2.17E03	2.40E03	1.50E00	5.18E-07	6.60E-01	Urban
RURAL_ID	VEHICLE_1	3.57E02	8.89E01	1.13E01	5.30E02	1.50E00	2.95E-07	1.04E00	Rural
SUBURBN_ID	VEHICLE_1	7.93E01	8.89E01	2.79E02	7.60E02	1.50E00	2.95E-07	1.04E00	Suburb
URBAN_ID	VEHICLE_1	7.30E00	8.89E01	2.22E03	2.40E03	1.50E00	2.95E-07	1.04E00	Urban
RURAL_IL	VEHICLE_1	1.78E02	8.89E01	1.44E01	5.30E02	1.50E00	2.22E-07	6.76E-01	Rural
SUBURBN_IL	VEHICLE_1	7.30E01	8.89E01	3.24E02	7.60E02	1.50E00	2.22E-07	6.76E-01	Suburb
URBAN_IL	VEHICLE_1	1.02E01	8.89E01	2.38E03	2.40E03	1.50E00	2.22E-07	6.76E-01	Urban
RURAL_IN	VEHICLE_1	1.37E02	8.89E01	1.99E01	5.30E02	1.50E00	2.25E-07	6.22E-01	Rural
SUBURBN_IN	VEHICLE_1	9.73E01	8.89E01	2.76E02	7.60E02	1.50E00	2.25E-07	6.22E-01	Suburb
URBAN_IN	VEHICLE_1	9.40E00	8.89E01	2.35E03	2.40E03	1.50E00	2.25E-07	6.22E-01	Urban
RURAL_IA	VEHICLE_1	3.78E02	8.89E01	1.64E01	5.30E02	1.50E00	1.12E-07	7.68E-01	Rural
SUBURBN_IA	VEHICLE_1	1.08E02	8.89E01	2.73E02	7.60E02	1.50E00	1.12E-07	7.68E-01	Suburb
URBAN_IA	VEHICLE_1	5.80E00	8.89E01	2.19E03	2.40E03	1.50E00	1.12E-07	7.68E-01	Urban
RURAL_NE	VEHICLE_1	6.49E02	8.89E01	9.90E00	5.30E02	1.50E00	3.19E-07	6.18E-01	Rural
SUBURBN_NE	VEHICLE_1	7.15E01	8.89E01	2.70E02	7.60E02	1.50E00	3.19E-07	6.18E-01	Suburb
URBAN_NE	VEHICLE_1	8.00E00	8.89E01	2.41E03	2.40E03	1.50E00	3.19E-07	6.18E-01	Urban
RURAL_NJ	VEHICLE_1	2.06E01	8.89E01	1.18E01	5.30E02	1.50E00	5.65E-07	6.92E-01	Rural
SUBURBN_NJ	VEHICLE_1	1.25E01	8.90E00	3.54E02	7.60E02	1.50E00	5.65E-07	6.92E-01	Suburb
URBAN_NJ	VEHICLE_1	1.10E00	8.89E01	2.03E03	2.40E03	1.50E00	5.65E-07	6.92E-01	Urban
RURAL_OH	VEHICLE_1	2.13E02	8.89E01	1.97E01	5.30E02	1.50E00	1.64E-07	8.54E-01	Rural
SUBURBN_OH	VEHICLE_1	1.51E02	8.89E01	3.10E02	7.60E02	1.50E00	1.64E-07	8.54E-01	Suburb
URBAN_OH	VEHICLE_1	1.48E01	8.89E01	2.21E03	2.40E03	1.50E00	1.64E-07	8.54E-01	Urban
RURAL_OR	VEHICLE_1	3.01E02	8.89E01	8.20E00	5.30E02	1.50E00	3.15E-07	7.21E-01	Rural
SUBURBN_OR	VEHICLE_1	3.22E01	8.89E01	3.13E02	7.60E02	1.50E00	3.15E-07	7.21E-01	Suburb
URBAN_OR	VEHICLE_1	2.30E00	8.89E01	1.98E03	2.40E03	1.50E00	3.15E-07	7.21E-01	Urban
RURAL_PA	VEHICLE_1	3.22E02	8.89E01	1.84E01	5.30E02	1.50E00	5.14E-07	7.45E-01	Rural
SUBURBN_PA	VEHICLE_1	1.72E02	8.89E01	3.14E02	7.60E02	1.50E00	5.14E-07	7.45E-01	Suburb
URBAN_PA	VEHICLE_1	2.07E01	8.89E01	2.45E03	2.40E03	1.50E00	5.14E-07	7.45E-01	Urban
RURAL_UT	VEHICLE_1	1.87E02	8.89E01	9.70E00	5.30E02	1.50E00	2.90E-07	8.72E-01	Rural
SUBURBN_UT	VEHICLE_1	5.16E01	8.89E01	2.58E02	7.60E02	1.50E00	2.90E-07	8.72E-01	Suburb
URBAN_UT	VEHICLE_1	1.50E00	8.89E01	2.11E03	2.40E03	1.50E00	2.90E-07	8.72E-01	Urban
RURAL_WA	VEHICLE_1	4.41E01	8.89E01	1.50E00	5.30E02	1.50E00	2.65E-07	6.79E-01	Rural
SUBURBN_WA	VEHICLE_1	8.60E00	8.89E01	6.04E02	7.60E02	1.50E00	2.65E-07	6.79E-01	Suburb
URBAN_WA	VEHICLE_1	4.70E00	8.89E01	2.29E03	2.40E03	1.50E00	2.65E-07	6.79E-01	Urban
RURAL_WY	VEHICLE_1	6.07E02	8.89E01	4.90E00	5.30E02	1.50E00	6.74E-07	4.79E-01	Rural
SUBURBN_WY	VEHICLE_1	3.39E01	8.89E01	3.99E02	7.60E02	1.50E00	6.74E-07	4.79E-01	Suburb
URBAN_WY	VEHICLE_1	3.40E00	8.89E01	1.97E03	2.40E03	1.50E00	6.74E-07	4.79E-01	Urban

Add Link | Remove Link | Import Web Tragis


Radcat 2.3 Project Panthro - Calc. 2009-06944:New Fuel: Richland, WA to PSEG ESP
File Edit
Title Package Radionuclides Vehicle Link Stop Handling Accident Parameters
Name | Vehicle | Min Distance (m) | Max Distance (m) | People or People/km² | Shielding Factor | Time (h)
STOP_1 | VEHICLE_1 | 1.00E00 | 1.00E01 | 3.00E04 | 1.00E00 | 6.00E00
STOP_2 | VEHICLE_1 | 1.00E01 | 8.00E02 | 3.40E02 | 2.00E-01 | 6.00E00
Add Stop
Remove Stop


Radcat 2.3 Project Panthro - Calc. 2009-06944:New Fuel: Richland, WA to PSEG ESP
File Edit
Title Package Radionuclides Vehicle Link Stop Handling Accident Parameters
Name | Vehicle | Number of Handlers | Distance (m) | Time (h)
HANDLE_1 | VEHICLE_1 | 5.00E00 | 1.00E00 | 5.00E-01
Add Handling
Remove Handling


Radcat 2.3 Project Panthro - Calc. 2009-06944:New Fuel: Richland, WA to PSEG ESP
File Edit
Title Package Radionuclides Vehicle Link Stop Handling Accident Parameters
Probability Deposition Velocity Release Aerosol Respirable Isopleth P Weather
Index
Probability Fraction
Add severity fraction
Remove severity fraction



Parameter	Value
Shielding factor for rural residents	1.00E00
Shielding factor for suburban residents	8.70E-01
Shielding factor for urban residents	1.80E-02
Fraction of outside air in urban buildings	5.00E-02
Fraction of urban population occupying the sidewalk	4.80E-01
Fraction of urban population inside buildings	5.20E-01
Ratio of pedestrians/km² to residential population/km²	6.00E00
Minimum small package dimension for handling (m)	5.00E-01
Distance from shipment for maximum exposure (m)	3.00E01
Vehicle speed for maximum exposure (km/hr)	2.40E01
Imposed regulatory limit on vehicle external dose	Yes
Average breathing rate (m³/sec)	3.30E-04
Cleanup Level (microcuries/m²)	2.00E-01
Interdiction Threshold	4.00E01
Evacuation time for groundshine (days)	1.00E00
Survey interval for groudshine (days)	1.00E01
Occupational latent cancer fatalities per person-rem	4.00E-04
Public latent cancer fatalities per person-rem	5.00E-04
Genetic effects per person-rem (public)	1.00E-04
Campaign (year)	8.33E-02
Iodine	I129
Rem per curie thyroid via inhalation (Rem/Ci)	5.77E06
Distance of freeway vehicle carrying radioactive cargo to pede...	3.00E01
Distance of freeway vehicle carrying radioactive cargo to right-...	3.00E01
Distance of freeway vehicle carrying radioactive cargo to maxi...	8.00E02
Distance of non-freeway vehicle carrying radioactive cargo to p...	2.70E01
Distance of non-freeway vehicle carrying radioactive cargo to ri...	3.00E01
Distance of non-freeway vehicle carrying radioactive cargo to ...	8.00E02
Distance of city street vehicle carrying radioactive cargo to ped...	5.00E00
Distance of city street vehicle carrying radioactive cargo to righ...	8.00E00
Distance of city street vehicle carrying radioactive cargo to ma...	8.00E02
Perpendicular distance to freeway vehicle going in opposite dire...	1.50E01
Perpendicular distance to non-freeway vehicle going in opposit...	3.00E00
Perpendicular distance to city vehicle going in opposite direction...	3.00E00
Perpendicular distance to all vehicles going in same direction (m)	4.00E00

5 RADTRAN FATALITIES CASE OUTPUT

```
                                                RUN DATE: [ 01-JUL-09 AT 13:38:08 ]
PAGE    1


  RRRR    AAA   DDDD   TTTTT  RRRR    AAA   N   N  55555         6
  R   R  A   A  D   D    T    R   R  A   A  NN  N  5             6
  R   R  A   A  D   D    T    R   R  A   A  N N N  5             6
  RRRR   A   A  D   D    T    RRRR   A   A  N  NN  5555          6666
  R R    AAAAA  D   D    T    R R    AAAAA  N   N      5         6   6
  R  R   A   A  D   D    T    R  R   A   A  N   N  5   5         6   6
  R   R  A   A  DDDD     T    R   R  A   A  N   N  5555      *    666

                                   RADTRAN 5.6   February 20, 2006

                                           INPUT ECHO
                                           ----------


 TITLE Calc. 2009-06944:New Fuel: Richland, WA to PSEG ESP: Fatalities
 INPUT STANDARD
STD: 0 10 18                              && DIMEN=NSEV NRAD NAREAS
STD: 1 3 3 0                              && PARM=IRNKC IANA ISEN IPSQSB
STD: .TRUE. .FALSE.                       && FORM = UNIT, SI-UNITS?
STD: 2.3E12                               && NEVAL FOR CF252
STD: 9.25E5 5.77E6 1.27E6                 && RPCTHY FOR I125, I129, I131
STD: 0.0 0.0 0.0 0.0 0.0                  && TRANSFER GAMMA
STD: 7.42E-3 2.02E-2 6.17E-5 3.17E-8 0.0  && TRANSFER NEUTRON
STD: 30  24                               && MITDDIST  MITDVEL
STD: 1  2   .0018                         && ITRAIN FMINCL DDRWEF
STD:    33    68    105   244   369               && CENTER LINE
STD:   561  1018   1628  2308  4269               && DISTANCES
STD:  5468 11136  13097 21334 40502               && FOR AVERAGE
STD: 69986 89860 120878 0 0 0 0 0 0 0 0 0 0 0 0   && US CLOUD
STD: 4.59E+02 1.53E+03 3.94E+03 1.25E+04 3.04E+04 6.85E+04 1.76E+05 4.45E+05
STD: 8.59E+05 2.55E+06 4.45E+06 1.03E+07 2.16E+07 5.52E+07 1.77E+08 4.89E+08
STD: 8.12E+08 1.35E+09 0 0 0 0 0 0 0 0 0 0 0 0 0     && AREADA
STD: 3.42E-03 1.72E-03 8.58E-04 3.42E-04 1.72E-04 8.58E-05 3.42E-05 1.72E-05
STD:  8.58E-06 3.42E-06 1.72E-06 8.58E-07 3.42E-07 1.72E-07 8.58E-08 5.42E-08
STD:  4.30E-08 3.42E-08 0 0 0 0 0 0 0 0 0 0 0 0 0     && DFLEV
STD: 3 6 9 12 15 30 61 91 152 305 0 0 0 0 0
STD: 3 6 9 12 15 30 61 91 152 305 0 0 0 0 0
STD: 3 6 9 12 15 30 61 91 152 305 0 0 0 0 0 && RADIST
STD: 0.5                              && SMLPKG
STD: 1.0  0.87  0.018                 && SHIELDING FACTORS RR  RS  RU
STD:  30  30  800                     && OFFLINK {FREEWAY}
STD:  27  30  800                     && OFFLINK {NON-FREEWAY}
STD:   5   8  800                     && OFFLINK {CITY STREETS}
STD:  30  30  800                     && OFFLINK {RAILWAY}
STD: 200 200 1000                     && OFFLINK {WATERWAY}
STD: 15  3  3  3  4                   && ONLINK {FWAY NONFWY STREET RAIL ADJ}
STD: 6.0  4  40.0                     && RPD FNOATT INTERDICT
STD: 0.05   0.2   3.3E-4              && BDF CULVL BRATE
STD: 0.9   0.1                        && UBF USWF
STD: 1.0  10.0 1.0                    && EVACUATION SURVEY CAMPAIGN
```

```
                    RUN DATE: [ 01-JUL-09 AT 13:38:08 ]            PAGE    2

      Calc. 2009-06944:New Fuel: Richland, WA to PSEG ESP: Fatalities

STD: 0.0  0.0     1.5E-8  5.3E-8      && HIGHWAY - RURAL - NONRAD
STD: 0.0  0.0     3.7E-9  1.3E-8      && HIGHWAY - SUBURBAN - NONRAD
STD: 0.0  0.0     2.1E-9  7.5E-9      && HIGHWAY - URBAN - NONRAD
STD: 0.0  0.0    1.81E-9  2.64E-8     && GENERAL FREIGHT - R - NONRAD
STD: 0.0  0.0    1.81E-9  2.64E-8     && GENERAL FREIGHT - S - NONRAD
STD: 0.0  0.0    1.81E-9  2.64E-8     && GENERAL FREIGHT - U - NONRAD
STD: 0.0  0.0    1.27E-7  1.85E-6     && DEDICATED RAIL - R - NONRAD
STD: 0.0  0.0    1.27E-7  1.85E-6     && DEDICATED RAIL - S - NONRAD
STD: 0.0  0.0    1.27E-7  1.85E-6     && DEDICATED RAIL - U - NONRAD
STD: 0.0 0.0 0.0 0.0 0.0 0.0          && PSPROB
STD: 0.67  0.67  0.42                 && TIMENDE NON-DISPERSAL EVAC TIME
(LCF&EARLY)
STD: 2 2 1                            && FLAGS=IUOPT IACC REGCHECK
STD: 5E-4, 4E-4, 1.0E-4               && LCFCON(1), LCFCON(2), GECON
STD: R5INGEST.BIN                     && INGESTION FILE
 OUTPUT BQ_SV
 FORM UNIT
 DIMEN 0 10 18
 PARM 1 1 1 0
 SEVERITY
    NPOP=1
       NMODE=1

    NPOP=2
       NMODE=1

    NPOP=3
       NMODE=1

 RELEASE
 PACKAGE PACKAGE_1 0.1 1.0 0.0 5.2
 END
 VEHICLE -1 VEHICLE_1 1.00E-01 1.0 0.0 5.2 1.0 2.0 4.0 1.0 1.0
       PACKAGE_1 1.0
 FLAGS
    IACC 2
    IUOPT 2
    REGCHECK 1
 MODSTD
    DISTOFF FREEWAY 3.00E01 3.00E01 8.00E02
    DISTOFF SECONDARY 2.70E01 3.00E01 8.00E02
    DISTOFF STREET 5.00E00 8.00E00 8.00E02
    DISTON
      FREEWAY 1.50E01
      SECONDARY 3.00E00
      STREET 3.00E00
      ADJACENT 4.00E00
    BDF 5.00E-02
    BRATE 3.30E-04
    CULVL 2.00E-01
    EVACUATION 1.00E00
```

```
RUN DATE: [ 01-JUL-09 AT 13:38:08 ]          PAGE    3

Calc. 2009-06944:New Fuel: Richland, WA to PSEG ESP: Fatalities

GECON 1.00E-04
INTERDICT 4.00E01
LCFCON 5.00E-04 4.00E-04
SURVEY 1.00E01
UBF 5.20E-01
USWF 4.80E-01
CAMPAIGN 8.33E-02
MITDDIST 3.00E01
MITDVEL 2.40E01
RPD 6.00E00
RR 1.00E00
RU 1.80E-02
RS 8.70E-01
SMALLPKG 5.00E-01
RPCTHYROID
  I129  5.77E06
EOF
LINK RURAL_DE VEHICLE_1 3.3 88.9 1.5 18.8 530.0 5.18E-7 0.0108 R 1 1.0
LINK SUBURBN_DE VEHICLE_1 14.0 88.9 1.5 549.2 760.0 5.18E-7 0.0108 S 1 1.0
LINK URBAN_DE VEHICLE_1 6.0 88.9 1.5 2168.9 2400.0 5.18E-7 0.0108 U 1 1.0
LINK RURAL_ID VEHICLE_1 357.0 88.9 1.5 11.3 530.0 2.95E-7 0.0129 R 1 1.0
LINK SUBURBN_ID VEHICLE_1 79.3 88.9 1.5 278.7 760.0 2.95E-7 0.0129 S 1 1.0
LINK URBAN_ID VEHICLE_1 7.3 88.9 1.5 2219.6 2400.0 2.95E-7 0.0129 U 1 1.0
LINK RURAL_IL VEHICLE_1 178.4 88.9 1.5 14.4 530.0 2.22E-7 0.0374 R 1 1.0
LINK SUBURBN_IL VEHICLE_1 73.0 88.9 1.5 323.6 760.0 2.22E-7 0.0374 S 1 1.0
LINK URBAN_IL VEHICLE_1 10.2 88.9 1.5 2379.1 2400.0 2.22E-7 0.0374 U 1 1.0
LINK RURAL_IN VEHICLE_1 136.7 88.9 1.5 19.9 530.0 2.25E-7 0.0298 R 1 1.0
LINK SUBURBN_IN VEHICLE_1 97.3 88.9 1.5 276.3 760.0 2.25E-7 0.0298 S 1 1.0
LINK URBAN_IN VEHICLE_1 9.4 88.9 1.5 2354.7 2400.0 2.25E-7 0.0298 U 1 1.0
LINK RURAL_IA VEHICLE_1 377.8 88.9 1.5 16.4 530.0 1.12E-7 0.0839 R 1 1.0
LINK SUBURBN_IA VEHICLE_1 107.7 88.9 1.5 272.7 760.0 1.12E-7 0.0839 S 1 1.0
LINK URBAN_IA VEHICLE_1 5.8 88.9 1.5 2191.1 2400.0 1.12E-7 0.0839 U 1 1.0
LINK RURAL_NE VEHICLE_1 649.1 88.9 1.5 9.9 530.0 3.19E-7 0.0429 R 1 1.0
LINK SUBURBN_NE VEHICLE_1 71.5 88.9 1.5 270.2 760.0 3.19E-7 0.0429 S 1 1.0
LINK URBAN_NE VEHICLE_1 8.0 88.9 1.5 2410.2 2400.0 3.19E-7 0.0429 U 1 1.0
LINK RURAL_NJ VEHICLE_1 20.6 88.9 1.5 11.8 530.0 5.65E-7 0.0214 R 1 1.0
LINK SUBURBN_NJ VEHICLE_1 12.5 8.9 1.5 353.9 760.0 5.65E-7 0.0214 S 1 1.0
LINK URBAN_NJ VEHICLE_1 1.1 88.9 1.5 2025.9 2400.0 5.65E-7 0.0214 U 1 1.0
LINK RURAL_OH VEHICLE_1 213.1 88.9 1.5 19.7 530.0 1.64E-7 0.0238 R 1 1.0
LINK SUBURBN_OH VEHICLE_1 151.3 88.9 1.5 309.6 760.0 1.64E-7 0.0238 S 1 1.0
LINK URBAN_OH VEHICLE_1 14.8 88.9 1.5 2211.7 2400.0 1.64E-7 0.0238 U 1 1.0
LINK RURAL_OR VEHICLE_1 301.0 88.9 1.5 8.2 530.0 3.15E-7 0.0648 R 1 1.0
LINK SUBURBN_OR VEHICLE_1 32.2 88.9 1.5 313.2 760.0 3.15E-7 0.0648 S 1 1.0
LINK URBAN_OR VEHICLE_1 2.3 88.9 1.5 1976.3 2400.0 3.15E-7 0.0648 U 1 1.0
LINK RURAL_PA VEHICLE_1 321.7 88.9 1.5 18.4 530.0 5.14E-7 0.0263 R 1 1.0
LINK SUBURBN_PA VEHICLE_1 172.2 88.9 1.5 313.8 760.0 5.14E-7 0.0263 S 1 1.0
LINK URBAN_PA VEHICLE_1 20.7 88.9 1.5 2452.8 2400.0 5.14E-7 0.0263 U 1 1.0
LINK RURAL_UT VEHICLE_1 186.8 88.9 1.5 9.7 530.0 2.9E-7 0.041 R 1 1.0
LINK SUBURBN_UT VEHICLE_1 51.6 88.9 1.5 257.8 760.0 2.9E-7 0.041 S 1 1.0
LINK URBAN_UT VEHICLE_1 1.5 88.9 1.5 2112.2 2400.0 2.9E-7 0.041 U 1 1.0
LINK RURAL_WA VEHICLE_1 44.1 88.9 1.5 1.5 530.0 2.65E-7 0.0634 R 1 1.0
LINK SUBURBN_WA VEHICLE_1 8.6 88.9 1.5 604.4 760.0 2.65E-7 0.0634 S 1 1.0
LINK URBAN_WA VEHICLE_1 4.7 88.9 1.5 2293.2 2400.0 2.65E-7 0.0634 U 1 1.0
```

```
LINK RURAL_WY VEHICLE_1 607.2 88.9 1.5 4.9 530.0 6.74E-7 0.016 R 1 1.0
LINK SUBURBN_WY VEHICLE_1 33.9 88.9 1.5 399.4 760.0 6.74E-7 0.016 S 1 1.0
LINK URBAN_WY VEHICLE_1 3.4 88.9 1.5 1966.6 2400.0 6.74E-7 0.016 U 1 1.0

STOP STOP_1 VEHICLE_1 30000.0 1.0 10.0 1.0 6.0
STOP STOP_2 VEHICLE_1 340.0 10.0 800.0 0.2 6.0

HANDLING HANDLE_1 VEHICLE_1 5.0 1.0 0.5

EOF
```

RUN DATE: [01-JUL-09 AT 13:38:08] PAGE 4

Calc. 2009-06944:New Fuel: Richland, WA to PSEG ESP: Fatalities

NON-RADIOLOGICAL DATA (ACCIDENTS and FATALITIES)
****

HIGHWAY

	ACCIDENT RATE	ACCIDENTS	FATALITIES
RURAL_DE	5.18E-07	1.71E-06	1.85E-08
SUBURBN_DE	5.18E-07	7.25E-06	7.83E-08
URBAN_DE	5.18E-07	3.11E-06	3.36E-08
RURAL_ID	2.95E-07	1.05E-04	1.36E-06
SUBURBN_ID	2.95E-07	2.34E-05	3.02E-07
URBAN_ID	2.95E-07	2.15E-06	2.78E-08
RURAL_IL	2.22E-07	3.96E-05	1.48E-06
SUBURBN_IL	2.22E-07	1.62E-05	6.06E-07
URBAN_IL	2.22E-07	2.26E-06	8.47E-08
RURAL_IN	2.25E-07	3.08E-05	9.17E-07
SUBURBN_IN	2.25E-07	2.19E-05	6.52E-07
URBAN_IN	2.25E-07	2.12E-06	6.30E-08
RURAL_IA	1.12E-07	4.23E-05	3.55E-06
SUBURBN_IA	1.12E-07	1.21E-05	1.01E-06
URBAN_IA	1.12E-07	6.50E-07	5.45E-08
RURAL_NE	3.19E-07	2.07E-04	8.88E-06
SUBURBN_NE	3.19E-07	2.28E-05	9.78E-07
URBAN_NE	3.19E-07	2.55E-06	1.09E-07
RURAL_NJ	5.65E-07	1.16E-05	2.49E-07
SUBURBN_NJ	5.65E-07	7.06E-06	1.51E-07
URBAN_NJ	5.65E-07	6.22E-07	1.33E-08
RURAL_OH	1.64E-07	3.49E-05	8.32E-07
SUBURBN_OH	1.64E-07	2.48E-05	5.91E-07
URBAN_OH	1.64E-07	2.43E-06	5.78E-08
RURAL_OR	3.15E-07	9.48E-05	6.14E-06
SUBURBN_OR	3.15E-07	1.01E-05	6.57E-07
URBAN_OR	3.15E-07	7.25E-07	4.69E-08
RURAL_PA	5.14E-07	1.65E-04	4.35E-06
SUBURBN_PA	5.14E-07	8.85E-05	2.33E-06
URBAN_PA	5.14E-07	1.06E-05	2.80E-07
RURAL_UT	2.90E-07	5.42E-05	2.22E-06
SUBURBN_UT	2.90E-07	1.50E-05	6.14E-07
URBAN_UT	2.90E-07	4.35E-07	1.78E-08
RURAL_WA	2.65E-07	1.17E-05	7.41E-07
SUBURBN_WA	2.65E-07	2.28E-06	1.44E-07
URBAN_WA	2.65E-07	1.25E-06	7.90E-08
RURAL_WY	6.74E-07	4.09E-04	6.55E-06
SUBURBN_WY	6.74E-07	2.28E-05	3.66E-07
URBAN_WY	6.74E-07	2.29E-06	3.67E-08
TOTALS:	1.34E-05	1.51E-03	4.67E-05

```
RUN DATE: [ 01-JUL-09 AT 13:38:08 ]           PAGE    5

Calc. 2009-06944:New Fuel: Richland, WA to PSEG ESP: Fatalities

REGULATORY CHECKS


THE SHIPMENT BY VEHICLE_1  IS DESIGNATED AS EXCLUSIVE USE
BUT IS NOT REQUIRED TO BE SO DESIGNATED BY REGULATIONS
```

RUN DATE: [01-JUL-09 AT 13:38:08] PAGE 6

Calc. 2009-06944:New Fuel: Richland, WA to PSEG ESP: Fatalities

INCIDENT-FREE SUMMARY
******** **** *******

IN-TRANSIT POPULATION EXPOSURE IN PERSON-SV

	PASSENGER	CREW	OFF LINK	ON LINK	TOTALS
RURAL_DE	0.00E+00	1.05E-08	1.62E-10	1.77E-09	1.25E-08
SUBURBN_DE	0.00E+00	4.46E-08	1.74E-08	1.08E-08	7.29E-08
URBAN_DE	0.00E+00	1.91E-08	6.11E-10	1.46E-08	3.43E-08
RURAL_ID	0.00E+00	1.14E-06	1.05E-08	1.92E-07	1.34E-06
SUBURBN_ID	0.00E+00	2.53E-07	5.01E-08	6.10E-08	3.64E-07
URBAN_ID	0.00E+00	2.33E-08	7.60E-10	1.77E-08	4.18E-08
RURAL_IL	0.00E+00	5.69E-07	6.70E-09	9.57E-08	6.71E-07
SUBURBN_IL	0.00E+00	2.33E-07	5.36E-08	5.62E-08	3.43E-07
URBAN_IL	0.00E+00	3.25E-08	1.14E-09	2.48E-08	5.85E-08
RURAL_IN	0.00E+00	4.36E-07	7.09E-09	7.34E-08	5.16E-07
SUBURBN_IN	0.00E+00	3.10E-07	6.10E-08	7.49E-08	4.46E-07
URBAN_IN	0.00E+00	3.00E-08	1.04E-09	2.28E-08	5.39E-08
RURAL_IA	0.00E+00	1.20E-06	1.62E-08	2.03E-07	1.42E-06
SUBURBN_IA	0.00E+00	3.43E-07	6.66E-08	8.29E-08	4.93E-07
URBAN_IA	0.00E+00	1.85E-08	5.96E-10	1.41E-08	3.32E-08
RURAL_NE	0.00E+00	2.07E-06	1.68E-08	3.48E-07	2.44E-06
SUBURBN_NE	0.00E+00	2.28E-07	4.38E-08	5.50E-08	3.27E-07
URBAN_NE	0.00E+00	2.55E-08	9.05E-10	1.94E-08	4.59E-08
RURAL_NJ	0.00E+00	6.57E-08	6.34E-10	1.11E-08	7.74E-08
SUBURBN_NJ	0.00E+00	3.98E-07	1.00E-07	1.32E-06	1.82E-06
URBAN_NJ	0.00E+00	3.51E-09	1.05E-10	2.67E-09	6.29E-09
RURAL_OH	0.00E+00	6.80E-07	1.09E-08	1.14E-07	8.05E-07
SUBURBN_OH	0.00E+00	4.82E-07	1.06E-07	1.16E-07	7.05E-07
URBAN_OH	0.00E+00	4.72E-08	1.54E-09	3.60E-08	8.47E-08
RURAL_OR	0.00E+00	9.60E-07	6.44E-09	1.62E-07	1.13E-06
SUBURBN_OR	0.00E+00	1.03E-07	2.29E-08	2.48E-08	1.50E-07
URBAN_OR	0.00E+00	7.33E-09	2.13E-10	5.59E-09	1.31E-08
RURAL_PA	0.00E+00	1.03E-06	1.54E-08	1.73E-07	1.21E-06
SUBURBN_PA	0.00E+00	5.49E-07	1.23E-07	1.33E-07	8.04E-07
URBAN_PA	0.00E+00	6.60E-08	2.38E-09	5.03E-08	1.19E-07
RURAL_UT	0.00E+00	5.96E-07	4.72E-09	1.00E-07	7.01E-07
SUBURBN_UT	0.00E+00	1.65E-07	3.02E-08	3.97E-08	2.34E-07
URBAN_UT	0.00E+00	4.78E-09	1.49E-10	3.65E-09	8.58E-09
RURAL_WA	0.00E+00	1.41E-07	1.72E-10	2.37E-08	1.64E-07
SUBURBN_WA	0.00E+00	2.74E-08	1.18E-08	6.62E-09	4.58E-08
URBAN_WA	0.00E+00	1.50E-08	5.06E-10	1.14E-08	2.69E-08
RURAL_WY	0.00E+00	1.94E-06	7.76E-09	3.26E-07	2.27E-06
SUBURBN_WY	0.00E+00	1.08E-07	3.07E-08	2.61E-08	1.65E-07
URBAN_WY	0.00E+00	1.08E-08	3.14E-10	8.26E-09	1.94E-08

RURAL	0.00E+00	1.08E-05	1.03E-07	1.82E-06	1.28E-05
SUBURB	0.00E+00	3.24E-06	7.17E-07	2.01E-06	5.97E-06
URBAN	0.00E+00	3.04E-07	1.03E-08	2.31E-07	5.45E-07

```
TOTALS:  0.00E+00  1.44E-05  8.31E-07  4.07E-06  1.93E-05


          MAXIMUM INDIVIDUAL IN-TRANSIT DOSE


               VEHICLE_1   4.26E-11 SV

          STOP EXPOSURE IN PERSON-SV

     ANNULAR AREA        STOP_1   2.90E-05
     ANNULAR AREA        STOP_2   1.25E-07

                         TOTAL:   2.92E-05


        HANDLING EXPOSURE IN PERSON-SV

HANDLING    VEHICLE     MATERIAL     METHOD         DOSE
HANDLE_1  VEHICLE_1    PACKAGE_1   LINE-SOURCE     8.35E-06

                                       TOTAL:   8.35E-06
EOI
END OF RUN
SUCCESSFUL COMPLETION
```

6 RADTRAN INJURIES CASE OUTPUT

```
                                               RUN DATE: [ 01-JUL-09 AT 14:08:12 ]
PAGE    1


  RRRR    AAA   DDDD   TTTTT  RRRR    AAA   N   N  55555         6
  R   R  A   A  D   D    T    R   R  A   A  NN  N  5             6
  R   R  A   A  D   D    T    R   R  A   A  N N N  5             6
  RRRR   A   A  D   D    T    RRRR   A   A  N  NN  5555          6666
  R R    AAAAA  D   D    T    R R    AAAAA  N   N      5         6   6
  R  R   A   A  D   D    T    R  R   A   A  N   N  5   5         6   6
  R   R  A   A  DDDD     T    R   R  A   A  N   N  5555      *    666

                           RADTRAN 5.6   February 20, 2006

                                   INPUT ECHO
                                   ----------


 TITLE Calc. 2009-06944:New Fuel: Richland, WA to PSEG ESP: Injuries
 INPUT STANDARD
STD: 0 10 18                              && DIMEN=NSEV NRAD NAREAS
STD: 1 3 3 0                              && PARM=IRNKC IANA ISEN IPSQSB
STD: .TRUE. .FALSE.                       && FORM = UNIT, SI-UNITS?
STD: 2.3E12                               && NEVAL FOR CF252
STD: 9.25E5 5.77E6 1.27E6                 && RPCTHY FOR I125, I129, I131
STD: 0.0 0.0 0.0 0.0 0.0                  && TRANSFER GAMMA
STD: 7.42E-3 2.02E-2 6.17E-5 3.17E-8 0.0  && TRANSFER NEUTRON
STD: 30  24                               && MITDDIST  MITDVEL
STD: 1  2   .0018                         && ITRAIN FMINCL DDRWEF
STD:    33    68    105   244   369               && CENTER LINE
STD:   561  1018   1628  2308  4269               && DISTANCES
STD:  5468 11136  13097 21334 40502               && FOR AVERAGE
STD: 69986 89860 120878 0 0 0 0 0 0 0 0 0 0 0 0   && US CLOUD
STD: 4.59E+02 1.53E+03 3.94E+03 1.25E+04 3.04E+04 6.85E+04 1.76E+05 4.45E+05
STD: 8.59E+05 2.55E+06 4.45E+06 1.03E+07 2.16E+07 5.52E+07 1.77E+08 4.89E+08
STD: 8.12E+08 1.35E+09 0 0 0 0 0 0 0 0 0 0 0 0     && AREADA
STD: 3.42E-03 1.72E-03 8.58E-04 3.42E-04 1.72E-04 8.58E-05 3.42E-05 1.72E-05
STD:  8.58E-06 3.42E-06 1.72E-06 8.58E-07 3.42E-07 1.72E-07 8.58E-08 5.42E-08
STD:  4.30E-08 3.42E-08 0 0 0 0 0 0 0 0 0 0 0 0     && DFLEV
STD: 3 6 9 12 15 30 61 91 152 305 0 0 0 0 0
STD: 3 6 9 12 15 30 61 91 152 305 0 0 0 0 0
STD: 3 6 9 12 15 30 61 91 152 305 0 0 0 0 0 && RADIST
STD: 0.5                              && SMLPKG
STD: 1.0  0.87  0.018                 && SHIELDING FACTORS RR  RS  RU
STD:  30  30  800                     && OFFLINK {FREEWAY}
STD:  27  30  800                     && OFFLINK {NON-FREEWAY}
STD:   5   8  800                     && OFFLINK {CITY STREETS}
STD:  30  30  800                     && OFFLINK {RAILWAY}
STD: 200 200 1000                     && OFFLINK {WATERWAY}
STD: 15  3  3  3  4                   && ONLINK {FWAY NONFWY STREET RAIL ADJ}
STD: 6.0  4  40.0                     && RPD FNOATT INTERDICT
STD: 0.05   0.2   3.3E-4              && BDF CULVL BRATE
STD: 0.9   0.1                        && UBF USWF
STD: 1.0  10.0 1.0                    && EVACUATION SURVEY CAMPAIGN
```

```
                    RUN DATE: [ 01-JUL-09 AT 14:08:12 ]            PAGE    2

        Calc. 2009-06944:New Fuel: Richland, WA to PSEG ESP: Injuries

STD: 0.0  0.0     1.5E-8  5.3E-8      && HIGHWAY - RURAL - NONRAD
STD: 0.0  0.0     3.7E-9  1.3E-8      && HIGHWAY - SUBURBAN - NONRAD
STD: 0.0  0.0     2.1E-9  7.5E-9      && HIGHWAY - URBAN - NONRAD
STD: 0.0  0.0    1.81E-9  2.64E-8     && GENERAL FREIGHT - R - NONRAD
STD: 0.0  0.0    1.81E-9  2.64E-8     && GENERAL FREIGHT - S - NONRAD
STD: 0.0  0.0    1.81E-9  2.64E-8     && GENERAL FREIGHT - U - NONRAD
STD: 0.0  0.0    1.27E-7  1.85E-6     && DEDICATED RAIL - R - NONRAD
STD: 0.0  0.0    1.27E-7  1.85E-6     && DEDICATED RAIL - S - NONRAD
STD: 0.0  0.0    1.27E-7  1.85E-6     && DEDICATED RAIL - U - NONRAD
STD: 0.0 0.0 0.0 0.0 0.0 0.0          && PSPROB
STD: 0.67  0.67  0.42                 && TIMENDE NON-DISPERSAL EVAC TIME
(LCF&EARLY)
STD: 2 2 1                            && FLAGS=IUOPT IACC REGCHECK
STD: 5E-4, 4E-4, 1.0E-4               && LCFCON(1), LCFCON(2), GECON
STD: R5INGEST.BIN                     && INGESTION FILE
 OUTPUT BQ_SV
 FORM UNIT
 DIMEN 0 10 18
 PARM 1 1 1 0
 SEVERITY
    NPOP=1
       NMODE=1

    NPOP=2
       NMODE=1

    NPOP=3
       NMODE=1

 RELEASE
 PACKAGE PACKAGE_1 0.1 1.0 0.0 5.2
 END
 VEHICLE -1 VEHICLE_1 1.00E-01 1.0 0.0 5.2 1.0 2.0 4.0 1.0 1.0
       PACKAGE_1 1.0
 FLAGS
    IACC 2
    IUOPT 2
    REGCHECK 1
 MODSTD
    DISTOFF FREEWAY 3.00E01 3.00E01 8.00E02
    DISTOFF SECONDARY 2.70E01 3.00E01 8.00E02
    DISTOFF STREET 5.00E00 8.00E00 8.00E02
    DISTON
      FREEWAY 1.50E01
      SECONDARY 3.00E00
      STREET 3.00E00
      ADJACENT 4.00E00
    BDF 5.00E-02
    BRATE 3.30E-04
    CULVL 2.00E-01
    EVACUATION 1.00E00
```

```
                RUN DATE: [ 01-JUL-09 AT 14:08:12 ]            PAGE    3

        Calc. 2009-06944:New Fuel: Richland, WA to PSEG ESP: Injuries

   GECON 1.00E-04
   INTERDICT 4.00E01
   LCFCON 5.00E-04 4.00E-04
   SURVEY 1.00E01
   UBF 5.20E-01
   USWF 4.80E-01
   CAMPAIGN 8.33E-02
   MITDDIST 3.00E01
   MITDVEL 2.40E01
   RPD 6.00E00
   RR 1.00E00
   RU 1.80E-02
   RS 8.70E-01
   SMALLPKG 5.00E-01
   RPCTHYROID
     I129  5.77E06
EOF
LINK RURAL_DE VEHICLE_1 3.3 88.9 1.5 18.8 530.0 5.18E-7 0.66 R 1 1.0
LINK SUBURBN_DE VEHICLE_1 14.0 88.9 1.5 549.2 760.0 5.18E-7 0.66 S 1 1.0
LINK URBAN_DE VEHICLE_1 6.0 88.9 1.5 2168.9 2400.0 5.18E-7 0.66 U 1 1.0
LINK RURAL_ID VEHICLE_1 357.0 88.9 1.5 11.3 530.0 2.95E-7 1.04 R 1 1.0
LINK SUBURBN_ID VEHICLE_1 79.3 88.9 1.5 278.7 760.0 2.95E-7 1.04 S 1 1.0
LINK URBAN_ID VEHICLE_1 7.3 88.9 1.5 2219.6 2400.0 2.95E-7 1.04 U 1 1.0
LINK RURAL_IL VEHICLE_1 178.4 88.9 1.5 14.4 530.0 2.22E-7 0.676 R 1 1.0
LINK SUBURBN_IL VEHICLE_1 73.0 88.9 1.5 323.6 760.0 2.22E-7 0.676 S 1 1.0
LINK URBAN_IL VEHICLE_1 10.2 88.9 1.5 2379.1 2400.0 2.22E-7 0.676 U 1 1.0
LINK RURAL_IN VEHICLE_1 136.7 88.9 1.5 19.9 530.0 2.25E-7 0.622 R 1 1.0
LINK SUBURBN_IN VEHICLE_1 97.3 88.9 1.5 276.3 760.0 2.25E-7 0.622 S 1 1.0
LINK URBAN_IN VEHICLE_1 9.4 88.9 1.5 2354.7 2400.0 2.25E-7 0.622 U 1 1.0
LINK RURAL_IA VEHICLE_1 377.8 88.9 1.5 16.4 530.0 1.12E-7 0.768 R 1 1.0
LINK SUBURBN_IA VEHICLE_1 107.7 88.9 1.5 272.7 760.0 1.12E-7 0.768 S 1 1.0
LINK URBAN_IA VEHICLE_1 5.8 88.9 1.5 2191.1 2400.0 1.12E-7 0.768 U 1 1.0
LINK RURAL_NE VEHICLE_1 649.1 88.9 1.5 9.9 530.0 3.19E-7 0.618 R 1 1.0
LINK SUBURBN_NE VEHICLE_1 71.5 88.9 1.5 270.2 760.0 3.19E-7 0.618 S 1 1.0
LINK URBAN_NE VEHICLE_1 8.0 88.9 1.5 2410.2 2400.0 3.19E-7 0.618 U 1 1.0
LINK RURAL_NJ VEHICLE_1 20.6 88.9 1.5 11.8 530.0 5.65E-7 0.692 R 1 1.0
LINK SUBURBN_NJ VEHICLE_1 12.5 8.9 1.5 353.9 760.0 5.65E-7 0.692 S 1 1.0
LINK URBAN_NJ VEHICLE_1 1.1 88.9 1.5 2025.9 2400.0 5.65E-7 0.692 U 1 1.0
LINK RURAL_OH VEHICLE_1 213.1 88.9 1.5 19.7 530.0 1.64E-7 0.854 R 1 1.0
LINK SUBURBN_OH VEHICLE_1 151.3 88.9 1.5 309.6 760.0 1.64E-7 0.854 S 1 1.0
LINK URBAN_OH VEHICLE_1 14.8 88.9 1.5 2211.7 2400.0 1.64E-7 0.854 U 1 1.0
LINK RURAL_OR VEHICLE_1 301.0 88.9 1.5 8.2 530.0 3.15E-7 0.721 R 1 1.0
LINK SUBURBN_OR VEHICLE_1 32.2 88.9 1.5 313.2 760.0 3.15E-7 0.721 S 1 1.0
LINK URBAN_OR VEHICLE_1 2.3 88.9 1.5 1976.3 2400.0 3.15E-7 0.721 U 1 1.0
LINK RURAL_PA VEHICLE_1 321.7 88.9 1.5 18.4 530.0 5.14E-7 0.745 R 1 1.0
LINK SUBURBN_PA VEHICLE_1 172.2 88.9 1.5 313.8 760.0 5.14E-7 0.745 S 1 1.0
LINK URBAN_PA VEHICLE_1 20.7 88.9 1.5 2452.8 2400.0 5.14E-7 0.745 U 1 1.0
LINK RURAL_UT VEHICLE_1 186.8 88.9 1.5 9.7 530.0 2.9E-7 0.872 R 1 1.0
LINK SUBURBN_UT VEHICLE_1 51.6 88.9 1.5 257.8 760.0 2.9E-7 0.872 S 1 1.0
LINK URBAN_UT VEHICLE_1 1.5 88.9 1.5 2112.2 2400.0 2.9E-7 0.872 U 1 1.0
LINK RURAL_WA VEHICLE_1 44.1 88.9 1.5 1.5 530.0 2.65E-7 0.679 R 1 1.0
LINK SUBURBN_WA VEHICLE_1 8.6 88.9 1.5 604.4 760.0 2.65E-7 0.679 S 1 1.0
LINK URBAN_WA VEHICLE_1 4.7 88.9 1.5 2293.2 2400.0 2.65E-7 0.679 U 1 1.0
```

```
LINK RURAL_WY VEHICLE_1 607.2 88.9 1.5 4.9 530.0 6.74E-7 0.479 R 1 1.0
LINK SUBURBN_WY VEHICLE_1 33.9 88.9 1.5 399.4 760.0 6.74E-7 0.479 S 1 1.0
LINK URBAN_WY VEHICLE_1 3.4 88.9 1.5 1966.6 2400.0 6.74E-7 0.479 U 1 1.0

STOP STOP_1 VEHICLE_1 30000.0 1.0 10.0 1.0 6.0
STOP STOP_2 VEHICLE_1 340.0 10.0 800.0 0.2 6.0

HANDLING HANDLE_1 VEHICLE_1 5.0 1.0 0.5

EOF
```

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Calc. 2009-06944:New Fuel: Richland, WA to PSEG ESP: Injuries

NON-RADIOLOGICAL DATA (ACCIDENTS and FATALITIES)
****

HIGHWAY

	ACCIDENT RATE	ACCIDENTS	FATALITIES
RURAL_DE	5.18E-07	1.71E-06	1.13E-06
SUBURBN_DE	5.18E-07	7.25E-06	4.79E-06
URBAN_DE	5.18E-07	3.11E-06	2.05E-06
RURAL_ID	2.95E-07	1.05E-04	1.10E-04
SUBURBN_ID	2.95E-07	2.34E-05	2.43E-05
URBAN_ID	2.95E-07	2.15E-06	2.24E-06
RURAL_IL	2.22E-07	3.96E-05	2.68E-05
SUBURBN_IL	2.22E-07	1.62E-05	1.10E-05
URBAN_IL	2.22E-07	2.26E-06	1.53E-06
RURAL_IN	2.25E-07	3.08E-05	1.91E-05
SUBURBN_IN	2.25E-07	2.19E-05	1.36E-05
URBAN_IN	2.25E-07	2.12E-06	1.32E-06
RURAL_IA	1.12E-07	4.23E-05	3.25E-05
SUBURBN_IA	1.12E-07	1.21E-05	9.26E-06
URBAN_IA	1.12E-07	6.50E-07	4.99E-07
RURAL_NE	3.19E-07	2.07E-04	1.28E-04
SUBURBN_NE	3.19E-07	2.28E-05	1.41E-05
URBAN_NE	3.19E-07	2.55E-06	1.58E-06
RURAL_NJ	5.65E-07	1.16E-05	8.05E-06
SUBURBN_NJ	5.65E-07	7.06E-06	4.89E-06
URBAN_NJ	5.65E-07	6.22E-07	4.30E-07
RURAL_OH	1.64E-07	3.49E-05	2.98E-05
SUBURBN_OH	1.64E-07	2.48E-05	2.12E-05
URBAN_OH	1.64E-07	2.43E-06	2.07E-06
RURAL_OR	3.15E-07	9.48E-05	6.84E-05
SUBURBN_OR	3.15E-07	1.01E-05	7.31E-06
URBAN_OR	3.15E-07	7.25E-07	5.22E-07
RURAL_PA	5.14E-07	1.65E-04	1.23E-04
SUBURBN_PA	5.14E-07	8.85E-05	6.59E-05
URBAN_PA	5.14E-07	1.06E-05	7.93E-06
RURAL_UT	2.90E-07	5.42E-05	4.72E-05
SUBURBN_UT	2.90E-07	1.50E-05	1.30E-05
URBAN_UT	2.90E-07	4.35E-07	3.79E-07
RURAL_WA	2.65E-07	1.17E-05	7.94E-06
SUBURBN_WA	2.65E-07	2.28E-06	1.55E-06
URBAN_WA	2.65E-07	1.25E-06	8.46E-07
RURAL_WY	6.74E-07	4.09E-04	1.96E-04
SUBURBN_WY	6.74E-07	2.28E-05	1.09E-05
URBAN_WY	6.74E-07	2.29E-06	1.10E-06
TOTALS:	1.34E-05	1.51E-03	1.02E-03

```
              RUN DATE: [ 01-JUL-09 AT 14:08:12 ]            PAGE    5

   Calc. 2009-06944:New Fuel: Richland, WA to PSEG ESP: Injuries

                            REGULATORY CHECKS


THE SHIPMENT BY VEHICLE_1  IS DESIGNATED AS EXCLUSIVE USE
BUT IS NOT REQUIRED TO BE SO DESIGNATED BY REGULATIONS
```

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Calc. 2009-06944:New Fuel: Richland, WA to PSEG ESP: Injuries

INCIDENT-FREE SUMMARY
******** **** *******

IN-TRANSIT POPULATION EXPOSURE IN PERSON-SV

	PASSENGER	CREW	OFF LINK	ON LINK	TOTALS
RURAL_DE	0.00E+00	1.05E-08	1.62E-10	1.77E-09	1.25E-08
SUBURBN_DE	0.00E+00	4.46E-08	1.74E-08	1.08E-08	7.29E-08
URBAN_DE	0.00E+00	1.91E-08	6.11E-10	1.46E-08	3.43E-08
RURAL_ID	0.00E+00	1.14E-06	1.05E-08	1.92E-07	1.34E-06
SUBURBN_ID	0.00E+00	2.53E-07	5.01E-08	6.10E-08	3.64E-07
URBAN_ID	0.00E+00	2.33E-08	7.60E-10	1.77E-08	4.18E-08
RURAL_IL	0.00E+00	5.69E-07	6.70E-09	9.57E-08	6.71E-07
SUBURBN_IL	0.00E+00	2.33E-07	5.36E-08	5.62E-08	3.43E-07
URBAN_IL	0.00E+00	3.25E-08	1.14E-09	2.48E-08	5.85E-08
RURAL_IN	0.00E+00	4.36E-07	7.09E-09	7.34E-08	5.16E-07
SUBURBN_IN	0.00E+00	3.10E-07	6.10E-08	7.49E-08	4.46E-07
URBAN_IN	0.00E+00	3.00E-08	1.04E-09	2.28E-08	5.39E-08
RURAL_IA	0.00E+00	1.20E-06	1.62E-08	2.03E-07	1.42E-06
SUBURBN_IA	0.00E+00	3.43E-07	6.66E-08	8.29E-08	4.93E-07
URBAN_IA	0.00E+00	1.85E-08	5.96E-10	1.41E-08	3.32E-08
RURAL_NE	0.00E+00	2.07E-06	1.68E-08	3.48E-07	2.44E-06
SUBURBN_NE	0.00E+00	2.28E-07	4.38E-08	5.50E-08	3.27E-07
URBAN_NE	0.00E+00	2.55E-08	9.05E-10	1.94E-08	4.59E-08
RURAL_NJ	0.00E+00	6.57E-08	6.34E-10	1.11E-08	7.74E-08
SUBURBN_NJ	0.00E+00	3.98E-07	1.00E-07	1.32E-06	1.82E-06
URBAN_NJ	0.00E+00	3.51E-09	1.05E-10	2.67E-09	6.29E-09
RURAL_OH	0.00E+00	6.80E-07	1.09E-08	1.14E-07	8.05E-07
SUBURBN_OH	0.00E+00	4.82E-07	1.06E-07	1.16E-07	7.05E-07
URBAN_OH	0.00E+00	4.72E-08	1.54E-09	3.60E-08	8.47E-08
RURAL_OR	0.00E+00	9.60E-07	6.44E-09	1.62E-07	1.13E-06
SUBURBN_OR	0.00E+00	1.03E-07	2.29E-08	2.48E-08	1.50E-07
URBAN_OR	0.00E+00	7.33E-09	2.13E-10	5.59E-09	1.31E-08
RURAL_PA	0.00E+00	1.03E-06	1.54E-08	1.73E-07	1.21E-06
SUBURBN_PA	0.00E+00	5.49E-07	1.23E-07	1.33E-07	8.04E-07
URBAN_PA	0.00E+00	6.60E-08	2.38E-09	5.03E-08	1.19E-07
RURAL_UT	0.00E+00	5.96E-07	4.72E-09	1.00E-07	7.01E-07
SUBURBN_UT	0.00E+00	1.65E-07	3.02E-08	3.97E-08	2.34E-07
URBAN_UT	0.00E+00	4.78E-09	1.49E-10	3.65E-09	8.58E-09
RURAL_WA	0.00E+00	1.41E-07	1.72E-10	2.37E-08	1.64E-07
SUBURBN_WA	0.00E+00	2.74E-08	1.18E-08	6.62E-09	4.58E-08
URBAN_WA	0.00E+00	1.50E-08	5.06E-10	1.14E-08	2.69E-08
RURAL_WY	0.00E+00	1.94E-06	7.76E-09	3.26E-07	2.27E-06
SUBURBN_WY	0.00E+00	1.08E-07	3.07E-08	2.61E-08	1.65E-07
URBAN_WY	0.00E+00	1.08E-08	3.14E-10	8.26E-09	1.94E-08

RURAL	0.00E+00	1.08E-05	1.03E-07	1.82E-06	1.28E-05
SUBURB	0.00E+00	3.24E-06	7.17E-07	2.01E-06	5.97E-06
URBAN	0.00E+00	3.04E-07	1.03E-08	2.31E-07	5.45E-07

```
          TOTALS:  0.00E+00  1.44E-05  8.31E-07  4.07E-06  1.93E-05



                    MAXIMUM INDIVIDUAL IN-TRANSIT DOSE


                         VEHICLE_1   4.26E-11 SV

                    STOP EXPOSURE IN PERSON-SV

               ANNULAR AREA        STOP_1   2.90E-05
               ANNULAR AREA        STOP_2   1.25E-07

                                   TOTAL:   2.92E-05


                  HANDLING EXPOSURE IN PERSON-SV

      HANDLING    VEHICLE     MATERIAL     METHOD         DOSE
      HANDLE_1  VEHICLE_1    PACKAGE_1   LINE-SOURCE     8.35E-06

                                                TOTAL:   8.35E-06
EOI
END OF RUN
SUCCESSFUL COMPLETION
```

CHAPTER 8

NEED FOR POWER

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Acronym	Definition
AE	Atlantic City Electric Power Company
ARR	auction revenue rights
Btu	British thermal unit
CAES	compressed air energy storage
CO_2	carbon dioxide
COLA	combined license application
COL	combined license
CP	coincident peak
DFO	diesel fuel oil
DOE	U. S. Department of Energy
DPL	Delmarva Power & Light
DR	demand response, demand resources
DSM	demand side management
EMAAC	Eastern Mid-Atlantic Area Council
EPACT	Energy Policy Act of 2005
EA	environmental assessment
EE	energy efficiency
EFORd	equivalent demand forced outage rate
EIA	Energy Information Administration
ER	environmental report
ESP	early site permit
FERC	Federal Energy Regulatory Commission
FPR	forecast pool requirement

Acronym	Definition
GADS	Generator Availability Data System
GDP	gross domestic product
GMP	gross metropolitan product
GWh	gigawatt hour(s)
ILR	Interruptible Load for Reliability
IRM	Installed Reserve Margin
JCP&L	Jersey Central Power & Light
kV	kilovolt(s)
LCAPP	Long-Term Capacity Agreement Pilot Program
LDC	local distribution companies
LFG	landfill gas
LMP	locational marginal prices
LOLE	Loss of Load Expectation
MAAC	Middle Atlantic Area Council
MSB	municipal solid waste biogenic
MSW	municipal solid waste
MWe	megawatt electric
NCP	non-coincident peak
NEPT	Neptune Regional Transmission System
NERC	North America Electric Reliability Corporation
NJBPU	New Jersey Board of Public Utilities
NJDEP	New Jersey Department of Environmental Protection
NJEMP	New Jersey Energy Master Plan

Acronym	Definition
NJPDES	New Jersey Pollutant Discharge Elimination System
NRC	U.S. Nuclear Regulatory Commission
NYISO	New York Independent System Operator
PECO	PECO Energy Co.
PJM	PJM Interconnection, LLC
PRSG	Planned Reserve Sharing Groups
PSEG	PSEG Power, LLC and PSEG Nuclear, LLC
PSE&G	Public Service Electric & Gas
PV	photovoltaic
RECO	Rockland Electric Company
RFC	Reliability*First* Corporation
RFO	residual fuel oil
RG	Regulatory Guide
RGGI	Regional Greenhouse Gas Initiative
RPM	Reliability Pricing Model
RRS	reserve requirement study
RSA	relevant service area
RTEP	Regional Transmission Expansion Plan
RTO	Regional Transmission Organization
SREC	Solar Renewable Energy Credit

CHAPTER 8

NEED FOR POWER

8.0 NEED FOR POWER

This chapter assesses the need for baseload electric power in support of the early site permit (ESP) application for the new nuclear power plant at the PSEG Site. The new power plant will serve as a merchant generator to provide baseload power for sale on the wholesale market. The need for power analysis establishes a framework for evaluating project benefits for the region where a majority of the benefits are distributed. The analysis is organized into the following four sections:

- Description of Power System (Section 8.1)

  Section 8.1 describes the Relevant Service Area (RSA) and the overall power market for the new plant, addressing such characteristics as the geographic scope, population, major load centers, electric distribution companies, independent system operator requirements, status of deregulation, and competitive wholesale markets.

- Power Demand (Section 8.2)

  Section 8.2 describes the historical and forecasted demand for electricity in the market area served by the new plant.

- Power Supply (Section 8.3)

  Section 8.3 describes the existing and planned power supply available to meet the demand for power in the market area served by the new plant.

- Assessment of Need for Power (Section 8.4)

  Section 8.4 assesses the need for the power to be generated by the new plant by comparing the forecasted demand for electricity to the planned power supply. Other considerations are also assessed, such as the impact the new plant's generation will have on imports, transmission congestion, regional emissions including greenhouse gases, and cost of power.

Per NUREG-1555, *Standard Review Plans for Environmental Reviews for Nuclear Power Plants: Environmental Standard Review Plan*, guidance, the need for power analysis time frame extends three years past the planned commercial operation date. Accordingly, forecasts for demand, supply and the need for power are provided through 2024, three years after the planned new plant commercial operation date of 2021.

The forecasts for electricity demand, supply and need for power in this chapter were prepared in early 2010 using data and information available at that time. The impact of key changes in the economy and electric power markets that have occurred since that time have been analyzed based on data and information available in the summer of 2012. The original conclusion that there is a significant need for new baseload capacity in New Jersey (NJ) is unchanged. The

chapter has been updated accordingly to describe the key changes since 2010 and their impact on the need for power analysis.

Summary of Chapter 8 Findings and Conclusions

The following is a summary of the results of the need for power analysis, which is presented in detail in the remaining sections of this chapter.

The RSA for the new plant is the State of New Jersey (NJ), which is part of PJM Interconnection LLC (PJM), the Regional Transmission Organization (RTO) for the area. Electricity in the RSA is bought and sold in competitive wholesale markets administered by PJM and into which the new plant's baseload capacity is expected to be bid.

Within the RSA, the cost of electric power is impacted by the following factors:

- The mix of baseload, intermediate and peaking power generation used to meet the demand for electric power[a];
- The difference between the amount of electric power generation capacity in the RSA as compared to the demand for electric power in the RSA; and
- The cost of importing power generated from outside the RSA required to fill the gap between the supply and demand for electricity. This cost is impacted by transmission system congestion and reliability issues.

Electric rates in NJ are relatively high due to the lack of baseload generation in the RSA. In many situations, intermediate and peaking units within NJ are operated to provide baseload power to assure grid reliability or because they are less expensive than the combined cost of imported baseload power plus transmission costs, especially when the transmission system is congested. In addition to being more expensive, using intermediate or peaking units to provide baseload power also contributes to higher emissions because they are fossil-fueled.

Electricity demand in NJ is approximately 40 percent higher than indigenous generation capacity creating the need to import both baseload and peaking electric power into the State. NJ relies on the PJM transmission system to import power as needed from the western region of PJM to meet its peak load and energy needs, as well as to supply power to New York City[b]. PJM has authorized projects to assure that resulting power flows on the transmission system do not exceed design or operational limits and degrade reliability in NJ. However, wholesale power prices in NJ are higher than most other areas of PJM due to a higher demand for power and a higher cost of electric power generated in the RSA available to serve load.

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[a] Baseload resources are those that are operated with a capacity factor greater than 75 percent. Intermediate resources are those that operated with a capacity factor greater than 15 percent and less than 75 percent. Peaking resources are those that operated with a capacity factor of less than 15 percent.

[b] Three transmission projects which provide power from northern New Jersey to New York City are planned or are already in operation

Choosing NJ as the RSA is also aligned with two of the five overarching goals of the 2011 New Jersey Energy Master Plan (NJEMP): 1) to drive down the cost of energy for all customers; and 2) to promote a diverse portfolio of new, clean, in-State generation. The marginal cost of PSEG's proposed nuclear plant (fuel and variable O&M expenses) is low and will contribute to lower locational marginal prices (LMP) in NJ. The proposed plant is new, clean with respect to pollutant and carbon dioxide emissions when compared to the fossil-fueled generation it will displace, and located in-State.

As part of an overall effort to reduce electric rates by reducing demand for electricity, the NJEMP also has set aggressive targets for reducing peak load and energy needs. Forecasted power needs within the RSA are based on the PJM peak load and energy forecast. The 2008-2009 recession resulted in a reduction in PJM forecasted power needs. The projected peak load in NJ is expected to grow modestly at a rate of 1.1 percent annually. The projected annual energy use in NJ is expected to grow at an annual rate of 1.6 percent. The increase in forecasted NJ power needs is driven by economic and population growth and takes into account the long term effects of current energy efficiency and demand side management programs. Demand response and energy efficiency projects are also bid into competitive markets in the same manner as generation and transmission resources and have been incorporated in the need for power analysis as supply resources.

Contributing to the complexity of the NJ power supply situation is the changing composition of electric generating resources in NJ. Almost 3,000 MWe of existing NJ generating capacity is projected to be retired by 2019. The 637 MWe Oyster Creek Generating Station (OCGS) will be decommissioned starting in 2019. PJM anticipates another 2,300 MWe of NJ generation deactivations through 2015, composed of natural gas, oil, kerosene, coal and landfill gas resources. Older fossil-fueled plants in NJ, as well as in other areas of PJM, are becoming increasingly less competitive due to inefficiencies caused by aging, lower prices for natural gas relative to petroleum liquids and coal, and the impact of stricter EPA regulations on emissions. Fossil fueled power plants, such as coal, oil and kerosene fueled units, typically must add both flue gas desulphurization (FGD) and selective catalytic reduction (SCRs) equipment to reduce emissions to meet new regulatory limits. This will require millions of dollars of pollution control modifications to the plants. Generating companies will in many cases choose to shutdown these units rather than incur the added expense.

Offsetting these retirements are a number of new capacity additions planned in NJ. NJ's Long-Term Capacity Agreement Pilot Program (LCAPP) has resulted in three projected new natural gas fired combined cycle generation projects totaling 1,949 MWe. Due to NJ's support for renewable energy development, about 1,780 MWe of solar projects are in the analytical or under-construction phase and 1,440 MWe of offshore wind projects are in the analytical phase within PJM's generation interconnection queues. Other capacity additions include a natural gas repowering of the B. L. England coal and oil fired plant, increases in energy efficiency and demand response resources that have cleared recent PJM capacity auctions and a capacity allocation correction of 50 MWe for PSEG's Hope Creek Generating Station. [c]

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[c] PSEG Nuclear has requested a 50 MWe increase in PJM capacity rights to recognize the final net increase in capacity resulting from the Hope Creek extended power uprate completed in 2008.

Despite the reduction in forecasted load due to the recession and the net positive capacity additions, the projected peak capacity in NJ is forecast to be about 2600 MWe less than the expected peak load in 2021; the projected date of new plant commercial operation. In addition, the forecast shows that the shortfall in the capacity that NJ needs to supply the PJM targeted reserve margin of 15.4% is greater than 5800 MWe.

Similarly, the projected baseload capacity in NJ is forecast to be about 7,300 MWe less than the 11,000 MWe of baseload capacity projected to be needed in NJ in 2021. The greater deficit in baseload resources reflects NJ's dependence on higher cost intermediate and peaking resources, which contribute to higher power costs. The new plant at the PSEG Site operates as a merchant baseload plant producing between 1350 and 2200 MWe. It provides 18 to 30 percent of the 7,300 MWe projected baseload capacity need in the relevant service area served by the new plant in 2021.

As discussed in Subsection 9.2.1.3, the alternative of purchasing power to provide baseload capacity in NJ is neither feasible nor desirable. Importing additional baseload power into New Jersey instead of generating it with new nuclear units at the PSEG Site is not a feasible option because there is not expected to be any surplus baseload capacity available in PJM or New York Independent System Operator (NYISO) near the PSEG region of interest in the 2021 time period. In addition, there is insufficient transfer capability in the PJM operated transmission system to provide for additional imports into New Jersey from western areas of PJM projected for the 2021 time period. Furthermore, PJM does not plan upgrades to the bulk electric system (BES) to provide for imports beyond what is required to resolve the North America Electric Reliability Corporation (NERC) reliability criteria violations.

Imports of baseload capacity from western PJM to NJ also is not desirable because imports cannot be increased without causing increased congestion, higher power prices, and potential reliability issues. The only potential baseload capacity additions in regions near NJ which could be available for importation to address the baseload capacity need in NJ are 650 MWe of nuclear uprate projects and the proposed 1,600 MWe Bell Bend nuclear plant in Eastern Pennsylvania. The completion of the Susquehanna-Roseland (SR) 500 kV Transmission Line, currently scheduled for 2015, will resolve numerous overloads on critical 230 kV circuits in Eastern Pennsylvania and Northern NJ, and will facilitate limited imports of baseload capacity from Eastern Pennsylvania. Even considering the congestion relief projected by the approved SR transmission project, the types of generating units that supply imported power from the western portion of PJM are often fossil-fueled and typically coal-fired. Due to lower load growth, the installation of new intermediate and peaking gas fired power plants, and the increase in demand response programs, PJM cancelled the Middle Atlantic Power Pathway (MAPP) and Potomac-Appalachian Transmission Highline (PATH) projects, which in combination, were designed to increase the capability to transfer power from western PJM into the Eastern Mid-Atlantic Area Council (EMAAC), of which NJ is a part. While nuclear baseload capacity additions planned in areas near NJ will displace imports from fossil fueled resources, any substantial increase in the levels of imports is not considered feasible as discussed in Subsection 9.2.1.3.

Due to its location and operating characteristics, the new plant provides several ancillary benefits that supplement the overall need for baseload capacity. As a baseload nuclear plant, the new plant generates electricity while operating at a high capacity factor and producing negligible greenhouse gas or other air emissions, which is consistent with the NJEMP goal of

promoting a diverse portfolio of new, clean, in-State generation. Operating the new plant will result in the following net benefits within the RSA:

- Reduces the amount of CO_2 generating imports needed to meet baseload demand in NJ
- Supports Global Warming Response Act, P.L. 2007, goals for the reduction of greenhouse gas emissions in NJ to 80 percent below 2006 levels by 2050.
- Reduces other emissions from fossil fueled generation in NJ and from imports
- Lowers LMP due to reduced generation from fossil fueled resources in NJ. Fossil fueled resources are projected to have increased generation costs due to pending costs associated with increased air emissions regulations, including those pending for carbon dioxide.
- Supports the NJEMP goal of fulfilling 70 percent of the State's electric needs from "clean" energy sources by 2050
- Reduces potential for transmission congestion
- Reduces reliance on imported petroleum to the extent that generation from oil-fired resources is reduced
- Increases the diversity of the NJ generation portfolio, which is currently comprised of 73 percent fossil fuel fired plants (Figure 8.3-1)
- Increases NJ's reserve margins to improve the capability of generating resources within NJ to meet the summer peak load with less dependence on imports and their associated challenge to transmission congestion

8.1 DESCRIPTION OF POWER SYSTEM

The new plant's RSA, which consists of the State of NJ, defines the region where the majority of electricity is expected to be delivered and where the greatest benefit from the new plant will be received. The structure of the power markets, reliability requirements, and subsequent rationale for selecting NJ as the RSA is discussed below. Subsection 8.4.1 contains a discussion of the marketability of the new plant's power output together with any significant market competition and risks.

Structure of Power Markets Serving NJ

New Jersey is part of PJM, the RTO for the area. PJM serves to maintain the bulk electricity power supply system reliability for 13 states and the District of Columbia. PJM serves 51 million people and includes the major U.S. load centers from the western border of Illinois to the Atlantic coast including the metropolitan areas in and around Baltimore, Chicago, Columbus, Dayton, Newark, and northern NJ, Norfolk, Philadelphia, Pittsburgh, Richmond and Washington, D.C. (Figure 8.1-1). (Reference 8.1-2)

The service territories of the electric delivery companies (EDCs) serving NJ are identified and depicted in Figure 8.1-2. These companies are Public Service Electric & Gas (PSE&G), Rockland Electric Company (RECO), Jersey Central Power & Light Company (JCP&L), and Atlantic City Electric (AE).

> PSE&G is one of the largest combined electric and gas companies in the United States, and is also New Jersey's oldest and largest publicly owned utility. PSE&G currently serves nearly three quarters of the state's population in a service area consisting of a 2600 square-mile diagonal corridor across the state from Bergen County in the Northeast portion of the state to Gloucester County in the Southwest. PSE&G is the largest provider of electric and gas service in NJ, with over 1.7 million gas and 2.1 million electric customers in more than 300 urban, suburban and rural communities, including New Jersey's six largest cities (Newark, Jersey City, Paterson, Elizabeth, Edison, and Woodbridge Township)(Reference 8.1-1).
>
> JCP&L is headquartered in Morristown, NJ and provides electric service to one million residential and business customers within 3200 square miles of northern and central NJ. JCP&L is a member of the FirstEnergy family of companies (Reference 8.1-1).
>
> Atlantic City Electric, a subsidiary of Pepco Holdings, Inc., is a regulated utility that provides electric service to more than 500,000 customers in southern NJ.
>
> Rockland Electric Company, a wholly owned subsidiary of Orange and Rockland Utilities, Inc. (Orange and Rockland), an electric and gas utility headquartered in Pearl River, New York (NY), is a public utility authorized by the Board of Public Utilities to provide electric service within the northern parts of Bergen and Passaic Counties and small areas in the northeastern and northwestern parts of Sussex County, NJ. RECO, along with Orange and Rockland, and Orange and Rockland's PA subsidiary, Pike County Light & Power Company, operate a fully integrated electric system serving parts of NJ, New York (NY), and PA (Reference 8.1-1).

Electricity in the region is bought and sold in competitive wholesale markets into which the new plant is expected to be bid. The majority of electricity from the new plant is expected to be delivered to NJ, which is where the greatest benefit from the new plant is received. The region encompasses commercial and industrial load centers and major cities such as Newark, Passaic, Jersey City, Hoboken, New Brunswick, Trenton, Camden, and Atlantic City. The estimated population of the region in 2008 is 8.7 million people (Reference 8.1-8).

New Jersey has restructured the manner in which utilities are regulated and utilities no longer engage in traditional integrated resource planning. In 1999, NJ electricity customers were granted the option to choose the company that supplies them with electric power. This choice is available due to the enactment of the Electric Discount and Energy Competition Act, which, among other things, allows competition in the power generation portion of the electric industry (Reference 8.1-4). As a result of this Act, the different utility responsibilities were unbundled and the power industry was separated into four divisions: generation, transmission, distribution, and energy services. Utilities were essentially required to divest generating plants and, as a result, utilities are no longer the sole producers of electricity. New Jersey, in turn, no longer issues certificates of convenience and necessity for deregulated merchant power vendors. The transmission and distribution sectors remain subject to regulation by the federal government through the Federal Energy Regulatory Commission (FERC) and the New Jersey Board of Public Utilities (NJBPU). The NJBPU has adopted an auction mechanism for procurement of electric supply covering the power needs for the state.

Electricity customers can elect to participate in the Basic Generation Service (BGS) where power is supplied by the regulated utilities within NJ (e.g., PSE&G) or select a Third Party Supplier (TPS) who is independent of the utilities. The BGS offered by the four NJ utilities is the default supply service for those customers who do not choose a TPS. Retail electric rates generally consist of three components: generation services (either under BGS or provided by a TPS); distribution charges that cover the local distribution system and regional transmission system and customer service; and other charges associated with state and federal programs. The generation services charge includes all of the components required to reliably supply electricity including: the cost of wholesale energy; capacity cost, which is the cost resulting from having adequate generation resources available to call upon as needed to meet peak demand for energy; and costs for ancillary services which ensure proper power delivery throughout the grid. These ancillary costs are procured through the PJM markets. There are also supplier’s cost to hedge and manage both price and quantity risks associated with electrical generation. These cost components are discussed in more detail below. Distribution and customer service costs are regulated by the NJBPU, which also supervises the process by which BGS is procured.

Each year since 2002, the four NJ EDCs have procured several billion dollars of electric supply to serve their BGS customers through a statewide auction process held in February. Starting in 2003, the needs of residential and smaller commercial customers, who are on a fixed-price service, are met through a statewide auction called the BGS-FP Auction, while the needs of larger commercial and industrial customers, who are on a mandatory hourly service, are met through a second and concurrent statewide auction called the BGS-CIEP Auction. Each auction uses a descending clock auction format and bids are submitted on-line.

Electricity provided to consumers in NJ through BGS or a TPS is bought and sold in the competitive wholesale electricity markets administered by PJM. PJM coordinates the continuous buying, selling and delivery of wholesale electricity through its security constrained dispatch system.[d] PJM balances the needs of suppliers, wholesale customers and other market participants and continuously monitors market behavior to ensure transparency and compliance with FERC regulations. PJM also coordinates reliability assessments with adjacent RTOs. Generators that sell electricity in PJM, including those in NJ, are contractually obligated to meet the reliability requirements in accordance with PJM rules and Reliability*First* Corporation (RFC) as described in more detail below. Working via market forces to encourage independent owners to build the needed generating facilities, PJM directly procures electric supply only when the market does not appear to be providing sufficient incentive to ensure adequate capacity to meet regional demand and ensure continuing system reliability (Reference 8.1-3).

Energy, measured in kilowatt-hours (kWh), is the bulk electricity generated by electric power generation resources. Wholesale energy prices, commonly referred to as LMPs, are established in two separate but inextricably linked markets – the Day-Ahead Market (DAM) and the Real-Time Market (RTM). Wholesale energy markets are cleared at specific locations on the grid on an hourly basis by PJM, thus accounting for power flow limitations caused by transmission congestion and setting energy prices on a locational basis within NJ and the remainder of the PJM market area. Auction clearing prices are the result of PJM's matching bids received by generators to supply energy for a given hour, to demand for energy (system load) in that hour. The DAM is conducted one day prior to the delivery. Bids for supply are received from generators on Thursday for delivery on Friday, for example. Prices are set based on the bids received and PJM's expectation of the following day's demand, which is based primarily on a one-day-ahead weather forecast. On the day of delivery, deviations in the amounts of supply and demand cleared in the DAM can occur. Weather may change unexpectedly, causing demand to increase or decrease. Suppliers may not be able to meet their obligations due to unscheduled outages. These and other factors mean that the system requires a reconciliation market to deal with variances between expected conditions and actual delivery day conditions. This is the role of the RTM.

Capacity, measured in megawatts (MW), is the ability to generate electricity when needed. Capacity prices pay for the costs resulting from having adequate generation resources available to call upon as needed to meet peak demand for energy. PJM administers the capacity market using the Reliability Pricing Model (RPM). Resources that are paid for capacity obligations commit to being available to PJM to generate or to reduce load when called on. Some resources, such as inefficient peaking units, will only be required to generate during the few hours a year when demand is highest. Under RPM, capacity prices are set for each Delivery Year by auctions held three years in advance. Prices are set by the intersection of bids received from generators and energy efficiency and demand response resources and an administratively-determined demand curve designed to procure enough capacity to maintain reliability, based on the then-prevailing PJM load forecast. Additional information on RPM is provided in Section 8.3.

[d] Security constrained economic dispatch is the operation of generation facilities to produce energy at the lowest cost to reliably serve consumers, recognizing any operational limits of generation and transmission facilities.

PJM operates the high voltage transmission system that gives EDCs and suppliers access to cost effective energy resources and assures them of adequate reliability. PJM is responsible for grid reliability and implements transmission upgrade projects when regions are forecast to have inadequate capacity supplies relative to their peak load requirements due to operational limitations of the transmission system.

Electric System Reliability in NJ

New Jersey is under the jurisdiction of RFC for electric system reliability. RFC was organized to develop regional standards for reliable planning and operation of the regional electric power system and to provide non-discriminatory compliance monitoring and enforcement of both the North America Electric Reliability Corporation (NERC) and RFC standards in its region (Reference 8.1-5). RFC was incorporated in mid-2005. NERC approved RFC as a regional reliability council in late 2005 and RFC officially assumed its regional responsibilities from predecessor organizations in 2006. PJM establishes reserve margin requirements in compliance with RFC standards, and coordinates a capacity market to assure that generation is available to meet these requirements. RFC standards affecting PJM reserve requirements are further discussed in Section 8.4.

New Jersey is part of a larger region of PJM known as the EMAAC. The EMAAC region of PJM includes all of NJ, Delaware (DE) and parts of Maryland (MD) and Pennsylvania (PA). This area includes the service territories of the electric delivery companies of PECO Energy (PECO) and Delmarva Power & Light (DPL) as well as the electric delivery companies in NJ. The EMAAC region also imports power from western PJM to serve its needs.

The new plant increases power grid reliability by adding 1350 to 2200 MWe of baseload generation within NJ. The agreements that PJM holds with adjacent NERC regions and sub-regions allow the new plant to support and potentially alleviate conditions that can create localized areas of congestion in the region. As shown in Figure 8.1-3 (Reference 8.1-7), the U.S. Department of Energy (DOE) has identified NJ and EMAAC as part of a larger region within PJM having congestion problems adversely effecting consumers and local economies, or, Critical Congestion Areas (Reference 8.1-6). PJM expects expanded power exports into NY, further challenging the situation. Limitations in the west-to-east transmission of energy across the Allegheny Mountains and the growing demand for baseload power at load centers in NJ and along the east coast are also contributing to localized areas of congestion. Section 8.3 discusses regional 500 kV transmission projects that have been approved within PJM to help address congestion issues.

Rationale for Choosing NJ as the RSA

The chosen RSA for the new plant is the State of NJ, which is part of PJM, the RTO for the area. The RSA for the new plant is based on the region where the majority of current generation and future expected new plant energy will be delivered and where the greatest benefit from the new plant will be received. The RSA geographic area contains a large population and major load centers, and a majority of its baseload power needs are imported. The new plant location is a favorable geographic area for serving the RSA because the new plant will reduce reliance on intermediate and peaking power generation sources in the RSA and will decrease the amount of baseload power currently imported into the RSA. In addition, a significant portion of the existing

transmission system directly servicing the PSEG Site extends directly into the regions of major load within NJ.

PJM expects that NJ will continue to rely on transmission capability to replace retired generation and to meet growth in peak power demand. On an annual basis, NJ imports more than half of its baseload power needs. Large amounts of power importation often lead to transmission congestion; a condition where increased power flows challenge the operational limits of critical portions of the transmission system. To assure the reliability of the power grid in congested areas of NJ, transmission congestion is relieved by dispatching higher cost intermediate and peaking units in NJ because insufficient baseload capacity with lower dispatch costs is available. This results in higher LMPs in NJ. In addition, the potential for more power exports to New York City and Long Island further increase the demand for in-state generating resources and/or transmission capability.

Construction of new transmission lines and upgrades to existing transmission lines is a long, costly and publicly contentious process that is required to allow increased importation of power into the RSA. The new SR 500 kV transmission line project creates a strong link from generation sources in northeastern and north-central PA, across northeastern PA and into NJ. This new link is required by PJM as part of its Regional Transmission Expansion Planning (RTEP) process, to meet system reliability requirements in the immediate future. However, due to lower regional load growth, the installation of new intermediate and peaking gas fired power plants, and the increase in demand response programs, the PJM Board cancelled the 500 kV circuit MAPP and the 765 kV PATH projects. These projects were designed to increase the capability to transfer power from western PJM into the EMAAC region of the system. Consequently, imports of baseload capacity from western PJM to NJ cannot be increased to accommodate increasing demand without causing increased congestion, higher power prices, and potential reliability issues.

The intermediate and peaking units in NJ that are dispatched due to the lack of baseload capacity are fossil-fueled. Even considering the congestion relief projected by the approved SR transmission project, the types of generating units that supply imported power from the western portion of PJM also are often fossil-fueled and typically coal-fired. While nuclear baseload capacity additions planned in areas near NJ will displace imports from fossil fueled resources, they will still cause increased congestion, higher power prices, and potential reliability issues. Therefore, choosing NJ as the RSA is aligned with two of the five overarching goals of the NJEMP: 1) to drive down the cost of energy for all customers; and 2) to promote a diverse portfolio of new, clean, in-state generation (Reference 8.1-9).

8.1.1 REFERENCES

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8.1-8 U. S. Census Bureau, website, http://www.census.gov/population/projections/SummaryTabA1.pdf, accessed November 9, 2009.

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8.2 POWER DEMAND

The PJM load forecast described in this section is compared to the available New Jersey (NJ) power supply (Section 8.3) to develop a basis for an overall baseload power need in Section 8.4. This comparison of forecast demand and supply identifies a need for the baseload capacity that is provided by the new plant.

The power demand presented in this section was developed in 2009 and is based on the load forecast published by PJM in January of 2009 (Reference 8.2-4). The 2012 PJM load forecast has been reviewed to assess any changes in the demand for both peak load and baseload energy over the three year period (Reference 8.2-24). As described below in Subsection 8.2.1.2, the forecasted growth in peak and energy demand within NJ is substantially lower than prior forecasts due to the impact of the 2008-2009 economic recession. However, despite this suppressed load growth, the need for power analysis, as described in this chapter, still identifies a substantial need for baseload generation in NJ for the year 2021; the expected service date for the new plant. Based on this observation, many of the discussions, bases and references regarding power demand from the original 2009 need for power analysis are still retained.

The increase in peak power and net energy needs forecasted by PJM is driven by economic and population growth and is offset by energy efficiency and demand side management programs and the promotion of distributed generation using renewable resources. These parameters are assessed in detail in the following sections.

8.2.1 POWER AND ENERGY REQUIREMENTS

8.2.1.1 Methodology

PJM produces and publishes an annual peak load and energy forecast report with sufficient detail to determine a 15-year load and energy forecast for NJ. As discussed below, the PJM projection is an acceptable basis for the need for power analysis because it is (1) systematic; (2) comprehensive; (3) subject to confirmation; and (4) responsive to forecasting uncertainty. The PJM load and energy forecasts are reviewed by both its Load Analysis Subcommittee and Planning Committee to ensure the accuracy of the forecast. Note that no other current load forecast for NJ is publicly available. Although the Energy Information Administration (EIA) performs a load forecast for the Middle Atlantic Area Council (MAAC[e]) region, it does not provide a breakdown at the state level.

The PJM Load Forecast Model employs econometric multiple regression processes to estimate and produce 15-year monthly peak demand forecasts assuming normal weather for each PJM zone and the RTO as a whole. The model incorporates three classes of variables: (1) calendar effects, such as day of the week, month, and holidays, (2) economic conditions, and (3) weather conditions across the RTO (Reference 8.2-4). The model is used to set the expected peak loads for capacity obligations, for reliability studies, and to support transmission planning. PJM uses gross metropolitan product (GMP)[f] in the econometric component of its forecast model to

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[e] The Middle Atlantic Area Council (MAAC) region as defined by EIA includes NJ, northeast PA, and NY.

[f] GMP is defined as the market value of all final goods and services produced within a metropolitan area in a given period of time.

account for localized treatment of economic effects within a zone. Ongoing economic forecasts for all areas within the PJM market area are also inputs into the analysis. Weather conditions across the region are considered by calculating a weighted average of temperature, humidity, and wind speed as the weather inputs. PJM has access to weather data from approximately 30 weather stations across the PJM area (Reference 8.2-4). All non-coincident peak (NCP)[g] models used GMP and coincident peak (CP) forecasts and were modeled as zonal shares of the PJM peak. PJM incorporates estimates of load management, energy efficiency and distributed generation to supplement the base forecast. This accounts for changes in energy use resulting from actions taken to achieve the 2011 NJEMP goal to reward energy efficiency and energy conservation and reduce peak demand. Forecasted power needs within the RSA are based on the PJM peak load and energy forecast. The PJM CP and zonal NCP forecasts are published in the annual PJM Load Forecast Report (Reference 8.2-2).

PJM develops 15-year monthly energy forecasts assuming normal weather for each PJM zone and the RTO. These forecasts are used to meet reporting requirements for NERC and the Federal Energy Regulatory Commission (FERC). The methodology used for these forecasts is the same as the load forecast model except that the dependent variable of the econometric model is daily energy consumption instead of daily peak load.

The analysis to determine power and energy requirements has been adapted to use the available data to determine the energy and capacity forecasts for NJ in Subsection 8.2.1.2. PJM does not forecast hourly loads or load duration curves. In addition, forecasts of residential, commercial and industrial loads are not prepared. Load and energy forecasts are not available from electric distribution companies operating within NJ, because load forecasts have been characterized by FERC as market information that may not be shared with merchant generators. To develop these projections, PSEG obtained historical energy forecasts from published PJM Load Forecast reports and compared them to historical annual energy consumption in NJ. Peak load forecasts and actual peak loads could not be compared because weather normalized peak load data are not available. Figure 8.2-1 compares the annual NJ energy for 1999 to 2008 (available on the PJM website, References 8.2-5 and 8.2-6) with forecasts for each year prepared from 1999 through 2008. Based on this comparison, the annual error for PJM energy forecasts is estimated to be 2.0 percent over the ten years from 1999 to 2008. Load forecasts were compiled by PJM from forecasts supplied by member companies from 1999 to 2005 and produced by PJM thereafter to maintain independence from market participants and to improve forecast accuracy (Reference 8.2-3). Energy forecasts were not included in the published Load Forecast reports for 2006 and 2007 and are not available from PJM.

The process conducted by PJM is responsive to forecasting uncertainty. Through its annual load forecast development, changes in economic inputs affecting the forecasted loads are made. For example, the 2009 Load Forecast showed a reduction in forecasted peak load and energy due to the effects of the recession beginning in 2008 (Reference 8.2-4). By incorporating recent load history into its econometric model, trends such as the potential load growth associated with plug-in electric vehicles is captured in the PJM load forecast methodology.

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[g] The non-coincident peak is the peak load of the zone. The coincident peak is the load of a zone, coincident with one of the five highest loads used in the weather normalization of the PJM seasonal peak.

PJM serves to maintain the bulk electricity power supply system reliability for 13 states and the District of Columbia and therefore is accountable for developing the peak load and energy forecast for NJ and the region. The annual peak load and energy report produced and published by PJM provides sufficient detail to accurately forecast load and energy requirements for NJ, and is the only publicly available forecast for NJ. The PJM forecast is the appropriate basis for the need for power analysis because it is:

(1) Systematic: The PJM forecast process is documented in PJM Manual 19, Load Forecasting and Analysis. The forecast is developed annually and is reviewed by market participants and stakeholders through the PJM committee system. PJM's forecast methodology is routinely assessed by stakeholders and independent parties to ensure its accuracy.

(2) Comprehensive: The PJM forecast covers the four local distribution companies (LDCs) in NJ and considers the relevant factors driving peak loads and energy, including calendar, weather, and economic input variables.

(3) Subject to confirmation: The PJM forecast is reviewed by both PJM's Load Analysis Subcommittee and Planning Committee to ensure the accuracy of the forecast. A third party review of the PJM forecast concluded that the PJM forecasts for the summer of 2006 were generally consistent with EDC forecasts, what are developed independently.

(4) Responsive to forecasting uncertainty: A distribution of NCP forecasts is produced using a Monte Carlo simulation process based on observed historical weather data. The median result is used as the base (50/50) forecast; the values at the 10^{th} percentile and 90^{th} percentile are assigned to the 90/10 weather bands. Changing economic conditions and energy usage as a result of energy efficiency and demand response programs are captured through updating of inputs in the annual forecasting process.

8.2.1.2 Forecasts of Energy and Capacity

This section presents the historical energy and demand from 1999 to 2008 and the 2008 PJM forecast from 2009 to 2024 for annual energy and peak summer loads. In addition, a comparison of the forecast to historical actual values is presented for 2009 to 2011, and a revised forecast presented for 2021 based on the 2012 PJM forecast. The 2009 projected peak load within the RSA, as determined in the 2008 load forecast report, was 20,200 MWe; the actual peak load was 18,400 MWe, reflecting the impact of the recession. The actual 2010 and 2011 peak loads of 20,480 MWe and 20,900 MWe were only 2-3 percent lower than the forecasted peaks of 20,620 MWe and 21,330 MWe, respectively. The 2008 PJM forecasted peak demand in 2021 was 24,400 MWe. The 2012 PJM forecast for 2021 peak demand is 21,180 MWe, reflecting an expectation of slow growth in peak demand in NJ through the remainder of this decade. From a gross energy perspective, the 2012 forecasted energy use in 2021 is 95,300 gigawatt-hours (GWh), an increase of 14,700 GWh over the actual usage in 2009.

The need for additional baseload capacity in NJ can be established by comparing the 2012 PJM load forecast described in this section to the available NJ power supply described in Section 8.3. This comparison, described in Section 8.4, identifies a definitive need for baseload capacity in NJ in 2021 that can be provided by the new plant.

Figure 8.2-2 shows the actual and forecast energy requirements for NJ based on the 2009 PJM forecast (Reference 8.2-2). Energy consumption grew at an annual rate of 1.8 percent from 1993 to 2005, but fell at an annual rate of 0.9 percent from 2005 to 2008. The forecast projected energy requirements to grow at an annual rate of 2.9 percent from 2008 to 2012 as the economy recovers, and in the long term at an annual rate of 1.2 percent from 2012 to 2024. The growth rate forecast for energy consumption of 1.2 percent from 2012 to 2024 is lower than the historical growth rate of 1.8 percent before the 2008-2009 recession, and reflects the economic forecast driving the 2009 PJM load forecast.

Figure 8.2-3 shows the actual and forecasted peak hourly load for NJ. The forecasted peak load is projected to always be in the summer months. The peak load grew at an annual rate of 2.2 percent from 1993 to 2005. From 2005 to 2008, the annual peak load fell at an annual rate of 0.6 percent, reflecting the impact of the economic recession. The peak load is projected to grow at an annual rate of 2.4 percent from 2008 to 2012 as the economy recovers and, in the long term, at an annual rate of 1.1 percent from 2012 to 2024. The subsequent 2012 load forecast shows an average growth rate of slightly less than 1.1% for the four LDC's within NJ.

Table 8.2-1 shows the historical and forecast load factor for NJ for 1993 to 2024. The actual and forecasted annual load factor is calculated using the peak load and energy forecasts. The annual load factor is the ratio of the average load supplied in a year to the peak load occurring in that period. Changes in load factor are an indication of whether growth in the demand for electricity is primarily in the peak hour periods or generally affecting all hours. The forecasted load factor is nominally constant at 48.9 percent to 49.8 percent, indicating that the load duration curves for forecast years can be assumed to be nominally constant.

Figure 8.2-4 shows the load duration curves for 2003 through 2008 compiled from PJM hourly load data for NJ (Reference 8.2-19). An average load shape is constructed from the load duration curves for 2003 through 2008 by expressing the average hourly load at each percentile on the load duration curve as a percentage of the annual energy. The load duration curve for future years is developed by applying these percentages to the forecasted annual energy. Figure 8.2-4 shows the load duration curve for 2021 based on this approach using the 2021 energy projection in the 2009 load forecast

Figure 8.2-5 shows the historical and forecasted average hourly load, minimum hourly load and minimum of the daily maximum hourly loads of each year. The average load is the annual energy divided by the number of hours in the year. Historical data are analyzed to determine the minimum load during the year and the minimum of the 365 daily peak loads each year. The forecasted minimum load and the minimum of daily maximum load are estimated using the forecasted load duration curves illustrated in Figure 8.2-4. A review of 2003 to 2008 hourly data shows that the minimum of daily maximum loads ranged from 68 percent to 76 percent on the load duration curves for each of these years. Based on analysis of the updated 2012 load forecast, the forecasted minimum of daily maximum loads is estimated to be the 71st percentile on the load duration curve (Reference 8.2-24). The average annual growth rate of the average

load, minimum load, and the minimum of daily maximum loads is 1.6 percent for 2009 through 2024 (Figure 8.2-5).

Forecasted Baseload Demand

Given that PJM only forecasts peak and gross energy demand and does not project the demand for baseload power, the forecast minimum of daily maximum loads is used to serve as the basis for determining future baseload demand. The minimum of the daily maximum load is the basis used by PJM for how load serving entities (LSEs)[h] are allocated auction revenue rights (ARRs) in the annual allocation process (Reference 8.2-22). Stakeholders within PJM (transmission customers, market participants, etc.) have agreed that the baseload level, as defined as the minimum of the daily maximum loads, is the level up to which network customers are guaranteed ARRs.

Baseload demand is defined in the PJM load forecast as the average peak load on non-holiday weekdays with no heating or cooling load (Reference 8.2-23). However, insufficient publicly available data exists to estimate baseload demand using this definition. Defining baseload demand as the minimum of the daily maximum load is a reasonable substitute for the PJM load forecast definition and can be estimated with publicly available data. Based on this definition of baseload demand and its average occurrence at the 71st percentile on the load duration curve, the 2012 PJM load forecast is used to determine a 2021 demand for baseload power of 11,000 MWe.

To summarize the overall energy needs in NJ, the forecast peak demand in 2021, based on the latest PJM load forecast, is 21,180 MWe. The forecasted energy use in 2021 is 95,300 GWh, an increase of 14,700 GWh or 18 percent for the period 2009 to 2021. These forecasts are used to establish a baseload demand, defined as the minimum of daily maximums, forecasted to 2021 based on the expected growth in energy usage. This demand for baseload power is projected to be 11,000 MWe in 2021. Section 8.4 compares the overall baseload demand to the available baseload resources to identify a need for the baseload capacity that can be provided by the new plant.

8.2.2 FACTORS AFFECTING POWER GROWTH AND DEMAND

This section describes several factors affecting the growth of electricity demand in NJ, including economic and demographic trends, substitution effects, energy efficiency and demand side management programs, and price and rate structures. In each case, the effects are incorporated indirectly through the econometric model used to prepare the PJM load forecast, or, in the case of energy efficiency programs, directly through explicit bidding of energy efficiency or demand side management programs into the PJM Reliability Pricing Model (RPM) auction. The RPM process is more fully described in Section 8.3.

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[h] A Load Serving Entities (LSE) is any entity, including a load aggregator or power marketer that (a) serves end-users within the PJM Control Area, and (b) is granted the authority or has an obligation pursuant to state or local law, regulation or franchise to sell electric energy to end-users located within the PJM Control Area.

8.2.2.1 Economic and Demographic Trends

As discussed in Subsection 8.2.1.1, the PJM load forecast for NJ is driven by three factors; calendar effects, economic and demographic trends, and weather variations, with economic and demographic trends having the most significance in the period of interest. This section provides background on economic and demographic trends that impact the load forecast. The Econometric model and its supporting data used by PJM's consultant (Moodys) for load forecasting is proprietary and not publicly available. However, an estimate for the economic and demographic trends within NJ is prepared based on publicly available information. The trends identified from the publicly available sources support the PJM load forecast for growth in electricity demand identified in Subsection 8.2.1.

New Jersey economic trends are examined using historical gross domestic product (GDP) (Reference 8.2-13). Historical data are used because data used to support PJM load forecasting are not publicly available. Figure 8.2-6 shows that about half of NJ's economy is dependent on services such as professional, scientific, technical, health care, and finance and insurance services. The remainder of GDP is split roughly equally among trade, government and construction, manufacturing, utilities, with less than one percent dependent on farming. Historical data for NJ indicate an average annual GDP growth rate of 4.2 percent from 1997 to 2008. Table 8.2-2 shows the annual GDP for NJ from 1997 to 2008.

Historical population trends and projections are available for the NJ from the U.S. Census Bureau (Reference 8.2-12). The NJ population grew at an annual rate of 0.9 percent between the 1990 and 2000 census years, from 7,700,000 in 1990 to 8,400,000 in 2000. The estimated population in 2008 was 8,700,000. Table 8.2-3 shows the historical and forecasted annual population growth rates for NJ. While Table 8.2-3 shows that the Census Bureau projects that NJ will experience population growth over the next 20 years, the state's population growth rate is forecasted to slow from 0.6 percent per year for 2005 to 2010 to 0.3 percent per year in 2025 to 2030.

Historical personal income data are available for the NJ from the Bureau of Economic Analysis (Reference 8.2-13). Figure 8.2-7 shows the personal income for NJ has increased during the 1993 to 2008 period. The average annual income growth rate was 4.4 percent over the 15-year period.

In summary, the PJM load forecast for NJ is substantially driven by economic and demographic trends. Economic data used by PJM for load forecasting is not publicly available; however, economic and demographic trends identified from publicly available sources identified above support PJM's forecasted growth in electricity demand identified in Subsection 8.2.1.

8.2.2.2 Substitution and Energy Efficiency

This section reviews substitution effects and energy efficiency programs in NJ, and how these effects are incorporated into the PJM load forecast. The estimates of the need for baseload capacity in Section 8.4 are based on the PJM load forecast; therefore these effects are incorporated into the need for power analysis. The regional investments in alternative energy projects and efficiency described in this section have produced results in terms of additional electrical production and net reduction in electrical demand. The effect of these results are reflected in and carried through subsequent peak load and energy forecasts developed by PJM.

The discussion below provides background information on alternative energy and energy efficiency initiatives in the RSA.

Current Pattern of Electricity Use

Table 8.2-4 shows that NJ commercial and transportation energy use per customer was greater than the national average. NJ ranks ninth among the 50 states and District of Columbia in commercial energy consumption, and eleventh in transportation use. Table 8.2-4 also shows that NJ residential and industrial use per customer was less than the national average.

Substitution

Substitution describes the effects of changes in relative prices of electricity and alternative fuels on consumption. For example, a decrease in the price of electricity might cause consumers to switch from natural gas to electricity for residential heating, because electricity use for home heating has become relatively inexpensive, and vice versa. The costs of conversion, such as replacement of home heating equipment, must be considered in determining the long term impact on consumption. The effect of substitution is inherent to an econometric model as used by PJM to develop its regional load forecasts.

Energy Efficiency, Demand Response and Renewables

Energy conservation and use of renewable energy sources, such as solar photovoltaic (PV) are being promoted as a replacement for electricity produced from thermal sources within NJ as well as imported from outside of NJ. In an effort to enact energy conservation measures and reduce energy demand, several government and corporate programs have been established. These can be characterized as (1) energy efficiency programs designed to permanently reduce the consumption of energy by residential, commercial and industrial users; (2) demand side management (DSM) programs, designed to reduce peak power demand by temporarily reducing load or by shifting peak period load to off-peak periods; and (3) distributed generation programs, designed to encourage the use of renewable technologies by end users to self-supply some of their electricity need.

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

State Sponsored Energy Efficiency and DSM Programs

New Jersey released an Energy Master Plan in December 2011 that outlines a strategy for developing an adequate, reliable energy supply of electricity that keeps up with the growth in

demand. The major energy conservation goals of the Energy Master Plan are: (1) Maximize energy conservation and energy efficiency by reducing energy consumption at least 20 percent by 2020 using 1999 energy consumption as the baseline; and (2) Reduce peak electricity demand to 18,000 MWe by 2020, a reduction of 3,364 MWe relative to the 2011 PJM load forecast (Reference 8.2-10).

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

PSE&G has explored various disciplined investments and implemented programs to address the NJ state goals regarding energy efficiency in the following manner (Reference 8.2-7):

Residential Programs

- Residential Whole House Efficiency
- Residential Programmable Thermostat Installation Program

Industrial/Commercial Program

- Small Business Direct Installation Program (over 4 years)
- Large Business Best Practices and Technology Demonstration Program
- Hospital Efficiency Program

PSE&G's Energy Efficiency Economic Stimulus Initiative also includes the following (Reference 8.2-8):

Residential Programs

- Residential Whole House Efficiency Program
- Multi-Family Housing program

Industrial/Commercial Programs

- Small Business Direct Install Program
- Municipal/Local/State/Government Direct Install Program
- Hospital Efficiency Program
- Data Center Efficiency Program
- Building Commissioning/O&M Pilot Program
- Technology Demonstration Program

In July 2009, PSE&G received NJBPU approval for $190 million in energy efficiency projects. The energy efficiency program is part of nearly $1.7 billion in spending planned by Public Service Enterprise Group to expand its investment in energy efficiency programs. The efficiency plan results in a slight rate increase for PSE&G customers. The energy efficiency projects include residential customers, businesses and government projects (Reference 8.2-1).

In addition, AE and JCP&L have plans to support 61 MW of solar energy projects and increase the New Jersey renewable energy portfolio by seeking proposals for solar renewable energy certificates (References 8.2-20 and 8.2-21).

Distributed Generation

In July 2009 the NJBPU approved a PSE&G request to invest $515 million through 2013 to install, own and operate up to 80 MWe of solar photovoltaic cells in the state. This initiative includes the world's largest installation of solar panels on utility poles. New Jersey currently ranks second in the nation behind California in installed solar capacity. The new PSE&G program is intended to demonstrate that renewable resources can be deployed at a reasonable cost even in less-than-sunny states. The 200,000 pole-mounted PV systems total 40 MWe of solar energy capacity. (Reference 8.2-11). Through the American Recovery and Reinvestment Act and other government grants, several small-scale PV installations are planned across NJ in locations such as landfill sites, hydropower plants and on rooftops. The solar generation installations described above are not capacity resources that are included in PJM's annual Reliability Pricing Model (RPM) auctions. In this application, solar generation acts as an offset to demand and is not taken into account in the generation profile statistics presented in Figure 8.3-1.

The PSE&G Solar Loan program supports solar PV installation, which may be considered a distributed generation system, on residential, commercial or industrial rooftops or other similar flat surfaces. The Solar Loan program was developed to help achieve the aggressive NJEMP goal to meet 22.5 percent of the state's electricity needs with renewable energy sources by the year 2021. The Solar Loan program also aligns with the NJEMP goal of fulfilling 70 percent of the State's electric needs from "clean" energy sources by 2050. Under the PSE&G Solar Loan program, PSE&G has committed approximately $105 million towards financing the installation of solar power systems over the next two years. The program is intended to reduce the overall cost of project development, installation, financing and maintenance, while providing the best solar energy value for stakeholders. The borrower is able to repay the loans with Solar Renewable Energy Credits (SRECs) or cash. Loans will be granted on a first come, first served basis until the funds are expired. The loans are intended to provide financing for a portion of the overall project cost (Reference 8.2-9).

Under the Federal Energy Policy Act of 2005 (EPACT 2005) a rebate program was established for dwellings and small businesses that install energy efficient systems in their buildings. The rebate was set at the lesser of $3000 or 25 percent of the expenses. EPACT 2005 authorized $150 million for 2006 and up to $250 million in 2010. According to the Act, renewable energy sources included geothermal, biomass, solar, wind, or any other renewable energy used to heat, cool, or produce electricity for a dwelling (Reference 8.2-14). This new act was established to encourage homeowners and small businesses to become more aware of energy efficient technologies.

8.2.2.3 Price and Rate Structure

The effect of price and rate structures has been implicitly incorporated into the PJM load forecast through econometric modeling. Price and rate structures at the retail level can affect electricity consumption by end users. In the traditional model of state regulation of retail prices, rate structures proposed by vertically integrated utilities can have significant influence on consumption patterns. However, in a region such as NJ, where wholesale electricity prices are determined by market outcomes and retail shopping is permitted, the traditional model of state regulation of rates for end users has been replaced by varying degrees of wholesale and/or retail competition. A summary of the status of the restructuring of retail electric services in NJ is provided in Section 8.1.

8.2.3 SUMMARY

The effect of electricity prices and alternative fuel prices on electricity demand are included in the economic forecast upon which the PJM load forecast is based. The effect of energy efficiency programs on future projections of power needs has been incorporated into PJM planning indirectly through load forecast development and directly through the bidding of EE and DR into the annual RPM auctions. The above described regional investments in efficiency and alternative energy projects have produced results in terms of additional electrical production and net reduction in electrical demand. The effect of these results are included in and carried through subsequent peak load and energy forecasts developed by PJM. In addition to the above described EE and DR efforts, the effects of economic and demographic trends, and substitution, as well as price and rate structure impacts on NJ’s electricity consumption are incorporated into the PJM load forecast and in its power supply forecast.

The PJM load forecast described in Section 8.2 is analyzed to determine the forecast demand for baseload power in 2021. This baseload forecast is based on PJM’s assessment of baseload being defined as the minimum of maximum daily loads for a given year. This minimum of daily maximum load is projected to future years based on PJM’s energy forecast to determine a 2021 baseload demand of 11,000 MWe. This need for baseload power is compared to the available NJ baseload power supply described in Section 8.3 to determine the need for additional baseload capacity. This comparison of projected supply and demand, performed in Section 8.4, identifies a definitive need for baseload power that will be provided by the new plant in 2021 and beyond.

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Table 8.2-1
Historical and Forecast Load Factor, New Jersey, 1993 to 2024

Year	Historical Load Factor	Year	Historical Load Factor	Year	Forecast Load Factor	Year	Forecast Load Factor
1993	51.0%	2001	48.7%	2009	48.9%	2017	49.4%
1994	53.0%	2002	49.0%	2010	48.9%	2018	49.5%
1995	50.6%	2003	50.7%	2011	48.9%	2019	49.5%
1996	56.3%	2004	54.3%	2012	49.2%	2020	49.7%
1997	49.3%	2005	48.7%	2013	49.1%	2021	49.5%
1998	51.3%	2006	45.3%	2014	49.3%	2022	49.6%
1999	49.1%	2007	50.3%	2015	49.3%	2023	49.6%
2000	53.1%	2008	48.2%	2016	49.5%	2024	49.8%

Load factor = annual energy use in New Jersey / (peak New Jersey load x 8760 hours).
Energy use and peak load values taken from Reference 8.2-6.

Table 8.2-2
Annual Gross Domestic Product (GDP), New Jersey – 1997 to 2008

(In millions of dollars)

Year	GDP	Year	GDP
1997	$300,910	2003	$389,077
1998	$314,117	2004	$410,096
1999	$327,263	2005	$425,455
2000	$344,824	2006	$445,738
2001	$362,987	2007	$461,295
2002	$372,754	2008	$474,936

Reference 8.2-13

Table 8.2-3
Historical and Forecast Annual Growth Rate of Population, New Jersey, 1990 to 2030

	Actual			Forecast			
	1990-2000	2000-2005	2005-2010	2010-2015	2015-2020	2020-2025	2025-2030
New Jersey	0.9%	0.8%	0.6%	0.5%	0.4%	0.4%	0.3%

Reference 8.2-12 (2009 Forecast)
Reference 8.2-18 (Historical)

Table 8.2-4
Energy Consumption by Customer Class, New Jersey - 2007

	Annual Use in 2007 Per Customer (kWh)				National Rank			
	Residential	Commercial	Industrial	Transportation	Residential	Commercial	Industrial	Transportation
NJ	8765	87,719	811,032	41,857,143	38	9	37	11
U.S.	11,232	76,900	1,294,879	10,897,333				

Reference 8.2-15

8.3 POWER SUPPLY

On a day to day basis, the load in the RSA is supplied by the amount of power generated in NJ, plus the amount of power that can be imported into NJ, less the amount of power that can be exported. Power is imported into the RSA from western PJM to meet the projected power demand and the expansion of exports to New York City and Long Island. Additional exports to NY and Long Island will result from current and planned merchant transmission projects between NJ and NY such as the Neptune transmission line project and the Linden Variable Frequency Transformer (VFT) project described later in this section. The aggregate power supply is negatively affected by the likely increase in deactivation and retirement of generation resources in the foreseeable future due to heightened environmental emission costs and constraints, including potential regulatory constraints on emission of carbon dioxide.

New Jersey's generation resources were determined using data obtained in 2009 from PJM's Reliability Pricing Mode (RPM) auctions (Reference 8.3-7), generator deactivations (Reference 8.3-6), and generation interconnections and upgrades (Reference 8.3-5). These information sources were reviewed in 2012 to determine if there were any changes in NJ's projected generating resources since the 2009 analysis. An updated composition of NJ generation sources in noted later in this section.

The RPM was developed by PJM to ensure adequate capacity resources are available to provide reliable service to loads within the region. Capacity resources in the auction include planned and existing generation resources, planned and existing DR and EE resources, and merchant transmission projects (Reference 8.3-8):

- Generation resources may consist of existing generation, planned generation (new and increases in capacity to existing generation), and bilateral contracts for unit-specific capacity resources.

- DR are load management products by which the resource provider can reduce the metered load, either manually or automatically. DR must be interruptible up to ten times per year for up to six hours per interruption during the peak hours.

- EE resources are projects that achieve a permanent, continuous reduction in electricity consumption that is not included in the load forecast. EE resources may participate in RPM auctions for up to four consecutive years, after which the impact of the resource will be incorporated into the PJM load forecast via econometric modeling. EE resources involve the installation of more efficient devices and equipment, or the implementation of more efficient process and systems, exceeding then-current building codes, appliance standards, or other relevant standards (Reference 8.3-8).

- Merchant transmission projects are projects that increase import capability into a constrained region of PJM or across RTO interfaces.

Base residual auctions are held three years before the beginning of the delivery year when supply offers are cleared against demand. The RPM develops a long term pricing signal for capacity resources and load serving entity (LSE) obligations that is consistent with the PJM RTEP process (Reference 8.3-8). These pricing signals are intended to spur development of additional capacity resources to meet the projected demand.

PJM's existing and planned power supply portfolio consists of nuclear, fossil, renewable, demand and energy efficiency resources, and others. Table 8.3-1 is developed from available PJM data (Reference 8.3-9), and shows a breakdown of NJ's generation resources by fuel type that qualified for the RPM base residual auction through 2013, the last year of the most recent RPM auction in the year the need for power analysis was originally developed. The MWe values in the table reflect the summer installed capacity rating of the units in the region. The table includes generator deactivations and new generator interconnections, including generator upgrades, from the PJM queue-based interconnection process. The table also includes demand and energy efficiency resources within NJ that cleared the Base Residual Auction, and excludes supply resources outside the state such as qualified transmission upgrades. A unit level breakdown of Table 8.3-1 is provided per NUREG-1555 requirements in Appendix 8A. Average variable cost data for the units are not publicly available.

Table 8.3-1 does not include the supply resources that did not clear the RPM Auction. The amount of such resources not clearing the auction in the EMAAC region each year up through the 2011-12 auction has been no more than about 3100 MWe or ten percent of the generation that cleared, and is usually four percent or less (Reference 8.3-10). New Jersey, in which about half of the EMAAC resources are located, would have a similar proportion of un-cleared capacity. Information regarding un-cleared resources specific to NJ is not publicly available. Un-cleared offers can be bid in subsequent Incremental Auctions in which resources can be procured to satisfy potential changes in market dynamics that are known prior to the beginning of the delivery year. Un-cleared capacity also may be sold for export on a short term contract basis from NJ to other PJM regions or NYISO, the independent system operator for the state of New York. There are no known long term (ten years or longer) contracts obligating these resources to serve load outside of NJ, or obligating unit capacity outside of NJ to serve NJ's load.

The current portfolio of NJ generating resources consists largely of fossil fuels, which give rise to growing concerns regarding emissions and greenhouse gasses. Figure 8.3-1 compares the breakdown of NJ resources by fuel type for 2009-2010 and 2012-2013 (Reference 8.3-9). DR and EE resources increase from one percent of supply in 2009-2010 to 5 percent of supply in 2012-2013. Most of this increase resulted from the elimination of the Interruptible Load for Reliability (ILR) product from the auction[i] (Reference 8.3-2). The combined amount of nuclear and fossil resources increased from 2009-2010 to 2012-2013 (Table 8.3-1), but decreased for each resource as a percentage of supply due to load growth (Figure 8.3-1). Renewable generation percentages essentially remain the same over this time period as shown in Figure 8.3-3. Although PSE&G has committed the funds to install, own and operate an additional 80 MW of solar PV cells in NJ, the type of solar power being installed, distributed generation such as solar panels on utility poles, is not a capacity resource that must be included in the RPM Auction process. Long term fuel availability issues that limit capability of the resources shown in Table 8.3-1 are not anticipated. Figure 8.3-2 and Figure 8.3-3 compare a breakdown of the Table 8.3-1 NJ capacity for fossil resource and renewable resources, respectively, for 2009-2010 and 2012-2013. The breakdown of fossil and renewable resources does not change

[i] The Interruptible Load for Reliability (ILR) was a capacity resource that was not offered into the RPM auction, but received the final zonal ILR price after the close of the auction.

significantly over time. Statistics for 2009-2010 indicate that NJ has a diversified fossil portfolio of 63 percent natural gas, 11 percent dual fuel (natural gas and other, coal and other), 15 percent coal, 9 percent oil, and the remaining 2 percent diesel fuel oil (DFO), residual fuel oil (RFO), kerosene, and diesel. The renewable portfolio shown for 2009-2010 is comprised mostly of hydro resources (68 percent pumped storage [capacity while generating] and 1 percent conventional hydro), 7 percent landfill gas (LFG), and 24 percent municipal solid waste and municipal solid biogenic waste (MSW and MSB, respectively). The amount of renewable resources is projected to increase marginally in 2012-2013 and consequently does not increase the relative share of renewable resources in NJ.

The resources included in Table 8.3-1 are further characterized by duty in Table 8.3-2 (Reference 8.3-9). Baseload, intermediate, and peaking capacity resources are differentiated by the historical capacity factor of the generation technology and/or fuel source for 2008-2009. Baseload resources are those that operated with a capacity factor greater than 75 percent. EE resources are assumed to be baseload resources due to their constant net reduction in energy usage. Intermediate resources are those that operated with a capacity factor greater than 15 percent and less than 75 percent. Peaking resources are those that operated with a capacity factor of less than 15 percent. DR resources are assumed to be peaking resources because they are interruptible and typically called upon during peak hours. Figure 8.3-4 compares a breakdown of resources by duty for 2009-2010 and 2012-2013. There is little change in the breakdown of baseload, intermediate and peaking resources forecasted in NJ.

Since 2003, a number of factors have continued to challenge system reliability in NJ. These factors include load growth, power exports to New York City and Long Island, deactivation and retirement of generation resources, modest development of new natural gas fired generation facilities due to low natural gas prices and retirement of coal fired generation due to heightened environmental regulations, and reliance on transmission to meet load deliverability requirements and to obtain access to economical, yet CO_2 intensive, sources of power from the west (Reference 8.3-4). On an annual basis NJ imports more than half of its baseload power needs.

Updated 2012 information on deactivation and retirement of generation resources shows an increased number of retirements of fossil and nuclear units. Almost 3,000 MWe of existing NJ generating capacity is projected to be retired by 2019. The 637 MWe OCGS, a baseload resource, will be decommissioned starting in 2019. PJM anticipates another 2,300 MWe of NJ generation deactivations through 2015, composed of natural gas, oil, kerosene, coal and landfill gas resources. Older fossil-fueled plants in NJ as well as in other areas of PJM are coming under increasing economic pressure caused by age, lower prices for natural gas relative to petroleum liquids and coal, and stricter environmental regulations. Fossil fueled power plants such as coal, oil and kerosene fueled units typically must add both FGD and SCR equipment to reduce emissions. This will require millions of dollars of pollution control modifications to the plants. Generating companies, will in many cases, choose to shutdown rather than incur the added expense of these modifications.

Updated 2012 information on new capacity additions also shows an increased amount of new generation planned in NJ. NJ's LCAPP has resulted in three new natural gas fired combined cycle generation projects totaling 1,949 MWe of projected intermediate generating resources. NJ supports solar photovoltaic and offshore wind energy development. Approximately 1,780 MWe of solar are in the active or under-construction phases and 1,440 MWe of wind projects are in the analytical phase in PJM's generation interconnection queues. The NJ Renewable

Portfolio Standard (RPS) requires that retail suppliers procure 22.5 percent of electricity sold in NJ from qualified renewable resources by 2021. The 2010 Solar Energy Advancement and Fair Competition Act imposes a separate obligation to procure an increasing amount from in-State solar resources, reaching 2518 GWh by 2021. The 2010 Offshore Wind Economic Development Act calls for at least 1100 MWe of offshore wind generation on the outer continental shelf hear NJ. It is important to note that capacity additions presented by renewables are intermittent resources and do not provide baseload capacity. Other capacity additions include the natural gas repowering of the B. L. England coal and oil fired plant, increases in energy efficiency and demand response resources that have cleared recent PJM capacity auctions and an increase in capacity allocation for PSEG's Hope Creek Nuclear Plant.[j]

Table 8.3-3 shows the forecasted composition of NJ generation resources by fuel type in 2021, the planned commercial operation date for the new plant, and in 2018 and 2024, three years before and after, respectively. The updated forecast is based on the PJM auction results reflected in Table 8.3-1 and the updated information on deactivation and retirement of generation resources and capacity additions. Table 8.3-3 shows 18,574 MWe of capacity in NJ in 2021, an increase of about 450 MWe from 2012-2013. Nuclear capacity is reduced due to the retirement of Oyster Creek. Capacity from DR and EE is increased based on the most recent RPM auction results and renewables are projected to increase to meet NJ RPS targets. The amount of fossil resources is almost unchanged, with capacity additions approximately offsetting generation deactivations and retirements.

Though not directly accounted for in load growth forecasts, exports across new merchant transmission facilities to New York City have the same impact as a new load in New Jersey. Beginning in 2007, the Neptune Regional Transmission System (NEPT) interconnected with Northern NJ at the Sayreville substation. In 2009, the Linden Variable Frequency Transformer (VFT) interconnected with Northern NJ at the Linden substation. Updated 2012 information shows that an additional merchant transmission project, the Hudson Transmission Project (HTP) is active in PJM's interconnection queue and will interconnect with Northern NJ at the Bergen substation. The combined potential of these three projects is about 1,650 MWe of exports from Northern NJ to New York City and Long Island (Reference 8.3-4). In 2008, 6938 GWh were exported via the NYISO interface and 5133 GWh were exported via the NEPT interface from the PJM region (Reference 8.3-1). The NEPT interface had a capacity factor of 89 percent in 2008.

One major new backbone transmission facility has been approved by the PJM Board to resolve NERC reliability criteria violations in the MAAC sub-region. The SR 500 kV transmission line creates a strong link from generation sources in northeastern and north-central PA, across northeastern PA and into NJ. The line could also be extended from Susquehanna at its western end to integrate large clusters of wind powered generation including those under consideration in the mid-western United States. Due to lower load growth, the installation of new intermediate and peaking gas fired power plants, and the increase in demand response programs, the PJM Board cancelled the 500 kV circuit MAPP and the 765 kV PATH projects on August 27, 2012. These projects were designed to increase the capability to transfer power from western PJM

[j] PSEG Nuclear has requested a 50 MWe increase in PJM capacity rights to recognize the final net increase in capacity resulting from the Hope Creek extended power uprate completed in 2008.

into the EMAAC, of which NJ is a part (Reference 8.3-3). Consequently, imports of baseload capacity from western PJM to NJ cannot be substantively increased without causing increased congestion, higher power prices, and potential reliability issues.

Overall, the 2009-2010 power supply within NJ is 17,235 MWe, and is projected to increase about 900 MWe by 2012-2013 (Table 8.3-2). Most of the increase results from changes in the PJM market that allow more demand side management resources and energy efficiency programs to be bid into the market with the addition of peaking and intermediate resources. Only 140 MWe of the supply increase by 2012-2013 are considered baseload resources (i.e., operate at a capacity factor of 75 percent or greater). By 2021, baseload resources will decrease by 570 MWe due to the retirement of Oyster Creek, offset by an increase in capacity allocation at Hope Creek, and increased landfill gas and energy efficiency resources. Imported baseload resources are secured as part of RPM to meet the required demand as necessary. The available NJ power supply described in this section is compared to the PJM load forecast, as described in Section 8.2. This comparison, performed in Section 8.4, identifies a need for the baseload capacity that can by provided by the new plant.

8.3.1 REFERENCES

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8.3-3 Pepco Holdings, Inc. News Release, “PJM Reinforces MAPP Need; Adds Year to Schedule,” May 19, 2009.

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Table 8.3-1
Generation Resources by Fuel Type, New Jersey – 2007-2008 to 2012-2013

Fuel	2007-2008	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013
Nuclear (MWe)	3984	3984	4012	4082	4112	4108
Fossil (MWe)	12,438	12,301	12,439	12,511	12,599	12,522
Renewable (MWe)	579	584	584	593	596	623
DR (MWe)	23	88	195	194	210	859
EE (MWe)	0	0	0	0	0	6
Other (MWe)	5	5	5	5	9	9
Total (MWe)	**17,029**	**16,962**	**17,235**	**17,384**	**17,525**	**18,126**

Information is a summary of data shown in Appendix 8A. Refer to Appendix 8A for data sources.

Table 8.3-2
Generation Resources by Type of Duty, New Jersey – 2007-2008 to 2012-2013

Duty	2007-2008	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013
Baseload (MWe)	4119	4126	4154	4227	4264	4293
Intermediate (MWe)	6923	6849	6955	7051	7131	7007
Peaking (MWe)	5988	5987	6126	6107	6131	6826
Total (MWe)	17,029	16,962	17,235	17,384	17,525	18,126

Information is a summary of data shown in Appendix 8A. Refer to Appendix 8A for data sources.

Table 8.3-3
Forecasted Generation Resources by Fuel Type, New Jersey – 2018, 2021, 2024[(a)]

Fuel	2012-2013[(b)]	2018	2021	2024
Nuclear	4108	4158	3521	3521
Fossil	12,522	12,604	12,604	12,604
Renewable	623	896	1057	1312
Demand Response	859	1375	1375	1375
Energy Efficiency	6	12	12	12
Other	9	5	5	5
Total	18,126	19,050	18,574	18,829

a) All values are in MWe
b) 2012-2013 is taken from Table 8.3-1

8.4 ASSESSMENT OF NEED FOR POWER

The new plant is intended to serve the PJM market and addresses a portion of the projected baseload capacity need in NJ. The new plant is expected to become operational in 2021 and operate as a merchant baseload plant producing up to approximately 2200 MWe. As discussed in detail below, the need for additional baseload capacity within NJ is currently over twice the maximum output of the new plant, and will grow to over three times the new plant capacity by 2021. In addition to supplying needed baseload power, the new plant provides benefits to the market area in terms of reducing conditions that can create localized areas of transmission congestion in the region; reduced power costs; reduced and avoided emissions of greenhouse gases from fossil fueled generation; and increased reserve margins.

8.4.1 NEED FOR CAPACITY OF ANY TYPE IN NEW JERSEY

PJM has the overall responsibility of establishing and maintaining the integrity of electricity supply within the PJM RTO. The PJM Operating Agreement and Reliability Assurance Agreement set down the specific rules and guidelines for determining the required amount of generating capacity for the region. PJM is responsible for determining the load forecast and calculating the PJM Reserve Requirement, based on the industry and federal guidelines and standards for reliability established by NERC and RFC.

The reliable supply of electric services within the PJM RTO depends on adequate and secure generation and transmission facilities. PJM is responsible for calculating the amount of generating capacity required to meet the defined reliability criteria. PJM is responsible for evaluating the market and approving a final generating reserve margin for the RTO. The final reserve margin value is the basis for defining the RTO reliability requirement for use in the RPM auction conducted three years prior to the delivery year. PJM conducts an annual Reserve Requirements Study (RRS) to determine the factors used to establish capacity requirements and obligations. The 2009 PJM reserve requirement for the planning period 2010-2011 to 2017-2019 was 15.5 percent (Reference 8.4-2). The reserve requirement for the same period updated by PJM in 2011 is 15.4 percent. The total capacity procured in the auction is allocated as a capacity obligation to all LSEs within PJM (Reference 8.4-4).

PJM uses several factors to establish capacity requirements and obligations. These factors are established three years prior to the applicable delivery year. Among these factors is the Installed Reserve Margin (IRM), which is the installed capacity percent above the forecasted peak load required to satisfy a Loss of Load Expectation (LOLE) of one day over ten years. PJM has adopted an LOLE planning criterion of 1-in-10, which is an RFC Standard [k] (Reference 8.4-1).

This RFC standard is based on a frequency metric and does not consider event duration or magnitude. The LOLE criterion for PJM can be expressed as 0.1 occurrences per delivery year. This standard applies to all RFC Planned Reserve Sharing Groups (PRSG) within the RFC area. The PJM RTO qualifies as one of those PRSGs (Reference 8.4-4).

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[k] RFC Standard BAL-502-RFC-01 effective April 1, 2006, R1. The Loss of Load Expectation (LOLE) for any load in RFC due to resource inadequacy shall not exceed one occurrence in ten years.

PJM also uses the Forecast Pool Requirement (FPR) to establish capacity requirements in the RPM capacity market. The FPR calculation is based on the IRM and the pool wide average equivalent demand forced outage rate (EFORd). This EFORd excludes outage events outside of management control as defined in the Generation Availability Data System (GADS) reporting of events. This EFORd definition is consistent with that used in the capacity market to establish the unforced capacity value of individual generators.

Maintaining adequate winter weekly reserve levels, after scheduling generator planned maintenance outages, ensures that the RFC LOLE standard is met with the recommended IRM. It is desirable to maintain a negligible loss of load risk over the winter period because virtually all the LOLE (99.9 percent) is concentrated in the summer weeks, despite the complete absence of unit planned outages in the summer. Since the summer risk cannot be reduced further (without installing additional capacity resources), winter reserve levels must be held greater than those over the summer to ensure the desired yearly LOLE. PJM coordinates equipment outages to obtain the desired LOLE while minimizing the need for additional generating capacity (Reference 8.4-4).

Table 8.4-1 compares the capacity available within New Jersey from Table 8.3-3 with the total capacity needed to achieve a 15.4 percent reserve margin over the 2012 PJM peak load forecast for NJ. Table 8.4-1 shows a shortfall of about 2600 MWe in generating resources to meet the peak load in NJ in 2021, and a shortfall of over 5800 MWe to meet the peak load and the 15.4 percent reserve margin. Unless new generation is constructed, both the EMAAC region and NJ will be short on capacity to meet the summer peak load and therefore will need to rely on imports to meet summer peak load (Reference 8.4-3).

8.4.2 NEED FOR BASELOAD CAPACITY IN NEW JERSEY

PJM's Reserve Requirements Study establishes the need for all types of supply resources (baseload, intermediate, and peaking) necessary to meet the forecasted peak summer load. The need for additional baseload power is determined by comparing the forecasted NJ baseload demand in the year of expected commercial operation of the new plant (2021) with the forecast of NJ's baseload resources available for that year.

Table 8.4-2 compares the baseload capacity available within NJ from Table 8.3-3 with the baseload demand for NJ for 2018, 2021, and 2024. The baseload demand is the annual minimum of daily maximum loads updated for the 2012 PJM load forecast using the methodology described in Subsection 8.2.1. Table 8.4-2 assumes that baseload capacity supplied to meet any difference between the baseload demand and the forecast for baseload resources is assumed to be operated at a capacity factor of 85 percent. Table 8.4-2 shows a shortfall of over 7,300 MWe in baseload generating resources in NJ in 2021 compared to the 11,000 MWe of baseload capacity needed in NJ. This need can be met with new baseload generation that the new plant provides. The need for additional baseload capacity in 2021 is over three times the proposed new plant capacity.

8.4.3 OTHER CONSIDERATIONS AFFECTING NEED FOR BASELOAD CAPACITY IN NEW JERSEY

The current NJ baseload capacity need is being met through imports and by increased use of peaking and intermediate resources. As discussed in Subsection 9.2.1.3, the alternative of

purchasing power to provide baseload capacity in NJ is neither feasible nor desirable. Importing additional baseload power into New Jersey instead of generating it with new nuclear units at the PSEG Site is not a feasible option because there is not expected to be any surplus baseload capacity available in PJM or NYISO near the PSEG region of interest in the 2021 time period. In addition, there is insufficient transfer capability in the PJM operated transmission system to provide for additional imports into New Jersey from western areas of PJM projected for the 2021 time period. Furthermore, PJM does not plan upgrades to the bulk electric system (BES) to provide for imports beyond what is required to resolve NERC reliability criteria violations.

Imports of baseload capacity from western PJM to NJ also is not desirable because imports cannot be increased without causing increased congestion, higher power prices, and potential reliability issues. Utilization of higher operating cost (and often higher emitting) peaking and intermediate units is a likely cause for higher LMPs in NJ. In addition, the imports and the current fleet of intermediate and peaking resources are predominantly fossil fueled plants, with associated greenhouse gas and other air emissions that are projected to carry increased regulatory costs. As discussed in Section 8.3, exports from NJ to New York City are also increasing imports to NJ, which results in greater air and greenhouse gas emissions from generating units to the west of NJ and can increase the potential for transmission congestion resulting in higher LMPs.

Baseload capacity additions in the remainder of EMAAC and other areas of MAAC immediately adjacent to NJ present potentially importable baseload capacity to NJ. A combined license application (COLA) for the Bell Bend plant in Pennsylvania has been submitted to the U.S. Nuclear Regulatory Commission (NRC) and identifies an RSA that includes all of NJ (Reference 8.4-5). In addition, the RSA in the Bell Bend COLA includes the remainder of the EMAAC region and other portions of MAAC. The scheduled commercial operation date for the Bell Bend plant, which has a proposed capacity of approximately 1600 MWe, originally was 2018 but is now under review. The only other significant baseload capacity additions anticipated in areas near NJ are 648 MWe of uprates to the Limerick and Peach Bottom plants (in PECO territory), the Susquehanna plant in (Pennsylvania Power & Light [PPL] territory), and the Three Mile Island plant (in metropolitan Edison [MET ED] territory). As discussed in Section 8.3, the SR 500 kV transmission line creates a strong link from generation sources in northeastern and north-central PA, across northeastern PA and into NJ. This new line could facilitate limited imports from the Bell Bend plant and the Susquehanna uprates. To the extent that these and the PECO and MET ED plant uprates export into NJ, it may displace some of the imports from fossil-fueled resources.

As discussed in Section 8.3, the PJM Board cancelled the 500 kV circuit MAPP and the 765 kV PATH projects. Consequently, imports of baseload capacity from western PJM to NJ cannot be substantively increased without causing increased congestion, higher power prices, and potential reliability issues. The new plant at the PSEG Site can supply baseload power within NJ and reduce the potential for transmission congestion, and its impact to LMPs resulting from increased imports. This is consistent with the NJEMP goal to promote a diverse portfolio of new, clean, in-state generation and to fulfill 70 percent of the State’s electric needs from “clean” energy sources by 2050 (Reference 8.4-6).

8.4.4 SUMMARY OF THE NEED FOR POWER

The new plant at the PSEG Site operates as a merchant baseload plant producing between 1350 to 2200 MWe and is expected to be operational in 2021. It provides 18 to 30 percent, respectively, of the additional 7300 MWe of the projected baseload capacity needed in the market area served by the new plant in 2021.

Overall, the new plant has several beneficial effects due to its location and operating characteristics. These ancillary benefits supplement the overall need for baseload capacity as discussed in Subsection 8.4.2. As a baseload nuclear plant, the new plant generates electricity at a high capacity factor and produces negligible greenhouse gas or other air emissions. The new plant:

- Reduces the amount of CO_2 generating imports needed to meet baseload demand in NJ
- Supports the NJ Global Warming Response Act, P.L. 2007, goals for the reduction of greenhouse gas emissions in NJ to 80 percent below 2006 levels by 2050.
- Reduces other emissions from fossil fueled generation in NJ and from imports
- Lowers locational marginal prices (LMP) due to reduced generation from fossil fueled resources in NJ. Fossil fueled resources are projected to have increased generation costs due to pending costs associated with regulations on carbon dioxide emissions
- Reduces potential for transmission congestion
- Reduces reliance on imported petroleum to the extent that generation from oil-fired resources is reduced
- Increases the diversity of NJ's generation portfolio, which is currently comprised of 73 percent fossil fuel fired plants (Figure 8.3-1)
- Increases NJ's reserve margins to improve the capability of generating resource within NJ to meet the summer peak load with less dependence on imports and their associated challenge to transmission congestion
- Supports the NJEMP's target of fulfilling 70 percent of the State's electric needs from "clean" energy sources by 2050.

8.4.5 REFERENCES

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Table 8.4-1
Forecasted Surplus (Shortfall) of Capacity in NJ, 2018, 2021, 2024[(a)]

	2018	2021	2024
2012 PJM Peak Load Forecast	20,699	21,181	21,640
Total Capacity Needed for 15.4% Reserve Margin	3,188	3,262	3,333
Total Capacity Required	23,887	24,443	24,973
Capacity Available Within NJ (from Table 8.3-3)	19,050	18,574	19,958
Surplus (Shortfall) of Capacity Within NJ	(4,837)	(5,869)	(6,143)

a) All values are in MWe

Table 8.4-2
Forecasted Surplus (Shortfall) of Baseload Capacity in NJ, 2018, 2021, 2024[a]

	2018	2021	2024
Baseload Demand in NJ[b]	9,133	9,386	9,685
Baseload Capacity @ 85% CF Needed in NJ[c]	10,745	11,042	11,394
Baseload Capacity Available Within NJ[d]	4,359	3,722	3,722
Natural Gas	0	0	0
Nuclear	4,158	3,521	3,521
Coal	0	0	0
NJ Energy Efficiency	12	12	12
Landfill Gas	44	44	44
Solid Waste	115	115	115
Biomass	30	30	30
Baseload Capacity Surplus (Shortfall)	(6,386)	(7,320)	(7,672)

a) All values are in MWe
b) The baseload demand in NJ is estimated as the forecasted annual minimum of the daily maximum load updated using the 2012 PJM Load Forecast.
c) Baseload capacity supplied to meet any difference between the baseload demand and the forecast for baseload resources is assumed to be operated at a capacity factor (CF) of 85 percent.
d) Baseload Capacity available in NJ is that portion of the capacity shown in Table 8.3-3 that is operated with a CF of 75 percent or greater.

Appendix 8A (Sheet 1 of 5)
New Jersey Unit Level Breakdown

					Capacity (MWe)			
RESOURCE	PJM ZONE	STATE	DUTY	FUEL	2009	2010	2011	2012
B.L. ENGLAND 1	AECO	NJ	Intermediate	Coal	113	113	129	113
B.L. ENGLAND 2	AECO	NJ	Intermediate	Coal	151	151	155	155
B.L. ENGLAND 3	AECO	NJ	Intermediate	Oil	148	148	150	148
B.L. ENGLAND EMER DIESEL	AECO	NJ	Peaking	Diesel	8	8	8	8
BALEVILLE	PSEG	NJ	Baseload	Other			4	4
BAYONNE COGEN TECH 1	PS Northern Region	NJ	Peaking	Dual (NG, others)	40	40	40	40
BAYONNE COGEN TECH 2	PS Northern Region	NJ	Peaking	Dual (NG, others)	40	40	40	40
BAYONNE COGEN TECH 3	PS Northern Region	NJ	Peaking	Dual (NG, others)	40	40	40	40
BAYONNE COGEN TECH 4	PS Northern Region	NJ	Peaking	Dual (NG, others)	40	40	40	40
BERGEN 1 CC	PS Northern Region	NJ	Intermediate	Natural Gas	675	675	675	675
BERGEN 2 CC	PS Northern Region	NJ	Intermediate	Natural Gas	550	550	550	550
BERGEN 3	PS Northern Region	NJ	Peaking	Natural Gas	21	21	21	21
BURLINGTON 111	PSEG	NJ	Peaking	Oil	42	46	46	46
BURLINGTON 112	PSEG	NJ	Peaking	Oil	46	46	46	46
BURLINGTON 113	PSEG	NJ	Peaking	Oil	46	46	46	46
BURLINGTON 114	PSEG	NJ	Peaking	Oil	46	46	46	46
BURLINGTON 121	PSEG	NJ	Peaking	Natural Gas	42	42	42	42
BURLINGTON 122	PSEG	NJ	Peaking	Natural Gas	42	42	42	42
BURLINGTON 123	PSEG	NJ	Peaking	Natural Gas	42	42	42	42
BURLINGTON 124	PSEG	NJ	Peaking	Natural Gas	42	42	42	42
BURLINGTON 8	PSEG	NJ	Peaking	Oil	21	21	21	21
BURLINGTON 91	PSEG	NJ	Peaking	Oil	46	46	46	46
BURLINGTON 92	PSEG	NJ	Peaking	Oil	46	46	46	46
BURLINGTON 93	PSEG	NJ	Peaking	Oil	46	46	46	46
BURLINGTON 94	PSEG	NJ	Peaking	Oil	46	46	46	46
BURLINGTON CTY LF	PSEG	NJ	Intermediate	LFG		6	6	6
CAMDEN COGEN TECH	PSEG	NJ	Peaking	Natural Gas	149	145	145	145
CAMDEN COUNTY R.R. NUG	PSEG	NJ	Intermediate	MSW	23	23	23	23
CARLLS CORNER CT 1	AECO	NJ	Peaking	Dual (NG, others)	36	36	36	36
CARLLS CORNER CT 2	AECO	NJ	Peaking	Dual (NG, others)	37	37	37	37
CEDAR STATION CT 1	AECO	NJ	Peaking	Kerosene	46	46	46	46
CEDAR STATION CT 2	AECO	NJ	Peaking	Kerosene	22	22	22	22
CHAMBERS CCLP	AECO	NJ	Intermediate	Natural Gas	225	225	225	225
CUMBERLAND 2	AECO	NJ	Intermediate	Dual (NG, others)		90	90	
CUMBERLAND CT	AECO	NJ	Peaking	Dual (NG, others)	80	80	84	81
CUMBERLAND CTY LF	AECO	NJ	Baseload	LFG		4	4	2
DEEPWATER 1	AECO	NJ	Intermediate	Dual (Coal, others)	78	78	78	78
DEEPWATER 6	AECO	NJ	Intermediate	Dual (Coal, others)	80	80	80	80
EAGLE POINT 1	PSEG	NJ	Peaking	Natural Gas	67	60	60	60
EAGLE POINT 2	PSEG	NJ	Peaking	Natural Gas	67	60	60	60
EAGLE POINT 3	PSEG	NJ	Peaking	Natural Gas	40	40	40	40

Appendix 8A (Sheet 2 of 5)
New Jersey Unit Level Breakdown

					Capacity (MWe)			
RESOURCE	**PJM ZONE**	**STATE**	**DUTY**	**FUEL**	**2009**	**2010**	**2011**	**2012**
EDGEBORO LANDFILL	PSEG	NJ	Baseload	LFG	9	9	9	9
EDISON 11	PSEG	NJ	Peaking	Natural Gas	42	42	42	42
EDISON 12	PSEG	NJ	Peaking	Natural Gas	42	42	42	42
EDISON 13	PSEG	NJ	Peaking	Natural Gas	42	42	42	42
EDISON 14	PSEG	NJ	Peaking	Natural Gas	42	42	42	42
EDISON 21	PSEG	NJ	Peaking	Natural Gas	42	42	42	42
EDISON 22	PSEG	NJ	Peaking	Natural Gas	42	42	42	42
EDISON 23	PSEG	NJ	Peaking	Natural Gas	42	42	42	42
EDISON 24	PSEG	NJ	Peaking	Natural Gas	42	42	42	42
EDISON 31	PSEG	NJ	Peaking	Natural Gas	42	42	42	42
EDISON 32	PSEG	NJ	Peaking	Natural Gas	42	42	42	42
EDISON 33	PSEG	NJ	Peaking	Natural Gas	42	42	42	42
EDISON 34	PSEG	NJ	Peaking	Natural Gas	42	42	42	42
ESSEX 101	PS Northern Region	NJ	Peaking	Natural Gas	42	42	42	42
ESSEX 102	PS Northern Region	NJ	Peaking	Natural Gas	42	42	42	42
ESSEX 103	PS Northern Region	NJ	Peaking	Natural Gas	42	42	42	42
ESSEX 104	PS Northern Region	NJ	Peaking	Natural Gas	42	42	42	42
ESSEX 111	PS Northern Region	NJ	Peaking	Natural Gas	46	46	46	46
ESSEX 112	PS Northern Region	NJ	Peaking	Natural Gas	46	46	46	46
ESSEX 113	PS Northern Region	NJ	Peaking	Natural Gas	46	46	46	46
ESSEX 114	PS Northern Region	NJ	Peaking	Natural Gas	46	46	46	46
ESSEX 121	PS Northern Region	NJ	Peaking	Natural Gas	46	46	46	46
ESSEX 122	PS Northern Region	NJ	Peaking	Natural Gas	46	46	46	46
ESSEX 123	PS Northern Region	NJ	Peaking	Natural Gas	46	46	46	46
ESSEX 124	PS Northern Region	NJ	Peaking	Natural Gas	46	46	46	46
ESSEX 9	PS Northern Region	NJ	Peaking	Natural Gas	81	81	81	81
ESSEX CO. RES. RCRVRY 1	PS Northern Region	NJ	Baseload	MSW	33	33	33	33
ESSEX CO. RES. RCRVRY 2	PS Northern Region	NJ	Baseload	MSW	32	32	32	32
FORKED RIVER C-1	JCPL	NJ	Peaking	Natural Gas	34	34	34	34
FORKED RIVER C-2	JCPL	NJ	Peaking	Natural Gas	32	32	32	31
GILBERT 4	JCPL	NJ	Peaking	Natural Gas	49	49	49	49
GILBERT 5	JCPL	NJ	Peaking	Natural Gas	49	49	49	49
GILBERT 6	JCPL	NJ	Peaking	Natural Gas	51	51	51	51
GILBERT 7	JCPL	NJ	Peaking	Natural Gas	49	49	49	49
GILBERT 8	JCPL	NJ	Peaking	Natural Gas	90	90	90	90
GILBERT 9	JCPL	NJ	Peaking	Oil	150	150	150	150
GILBERT C-1	JCPL	NJ	Peaking	Oil	23	23	23	23
GILBERT C-2	JCPL	NJ	Peaking	Oil	25	25	25	25
GILBERT C-3	JCPL	NJ	Peaking	Oil	25	25	25	25
GILBERT C-4	JCPL	NJ	Peaking	Oil	25	25	25	25
GLEN GARDNER A-1	JCPL	NJ	Peaking	Natural Gas	20	20	20	20
GLEN GARDNER A-2	JCPL	NJ	Peaking	Natural Gas	20	20	20	20
GLEN GARDNER A-3	JCPL	NJ	Peaking	Natural Gas	20	20	20	20

Appendix 8A (Sheet 3 of 5)
New Jersey Unit Level Breakdown

					Capacity (MWe)			
RESOURCE	PJM ZONE	STATE	DUTY	FUEL	2009	2010	2011	2012
GLEN GARDNER A-4	JCPL	NJ	Peaking	Natural Gas	20	20	20	20
GLEN GARDNER B-5	JCPL	NJ	Peaking	Natural Gas	20	20	20	20
GLEN GARDNER B-6	JCPL	NJ	Peaking	Natural Gas	20	20	20	20
GLEN GARDNER B-7	JCPL	NJ	Peaking	Natural Gas	20	20	20	20
GLEN GARDNER B-8	JCPL	NJ	Peaking	Natural Gas	20	20	20	20
GLOUCESTER COUNTY NUG	PSEG	NJ	Baseload	MSW	12	12	12	12
GREAT FALLS HYDRO	PS Northern Region	NJ	Intermediate	Conventional Hydro	5	5	5	5
HOPE CREEK 1	EMAAC	NJ	Baseload	Nuclear	1061	1131	1161	1161
HUDSON 1	PS Northern Region	NJ	Intermediate	Natural Gas	355	355	355	355
HUDSON 2	PS Northern Region	NJ	Intermediate	Coal	568	568	568	608
JCPL COMPOSITE NUG	JCPL	NJ	Peaking	Other	5	5	5	5
KEARNY 10	PS Northern Region	NJ	Peaking	Natural Gas	122	122	122	122
KEARNY 11	PS Northern Region	NJ	Peaking	Natural Gas	128	128	128	128
KEARNY 121	PS Northern Region	NJ	Peaking	Natural Gas	44	44	44	44
KEARNY 122	PS Northern Region	NJ	Peaking	Natural Gas	44	44	44	44
KEARNY 123	PS Northern Region	NJ	Peaking	Natural Gas	44	44	44	44
KEARNY 124	PS Northern Region	NJ	Peaking	Natural Gas	44	44	44	44
KEARNY 9	PS Northern Region	NJ	Peaking	Natural Gas	21	21	21	21
KENILWORTH NUG	PSEG	NJ	Intermediate	Natural Gas	15	15	15	1
KINGSLAND	PS Northern Region	NJ	Baseload	LFG			3	3
KINSLEY LANDFILL	PSEG	NJ	Baseload	LFG	1	1	1	1
LAKEWOOD CT1	JCPL	NJ	Peaking	Dual (NG, others)	156	156	156	156
LAKEWOOD CT2	JCPL	NJ	Peaking	Dual (NG, others)	156	156	156	156
LAKEWOOD NUG	JCPL	NJ	Intermediate	Dual (NG, others)	222	222	222	222
LINDEN 1 CC	PSEG	NJ	Intermediate	Natural Gas	593	593	615	750
LINDEN 2 CC	PS Northern Region	NJ	Intermediate	Natural Gas	593	593	615	436
LINDEN 5	PSEG	NJ	Intermediate	Natural Gas	86	86	86	86
LINDEN 6	PSEG	NJ	Intermediate	Natural Gas	86	86	86	86
LINDEN 7	PS Northern Region	NJ	Peaking	Natural Gas	84	84	84	84
LINDEN 8	PS Northern Region	NJ	Peaking	Natural Gas	80	80	80	84
LOGAN KCS	AECO	NJ	Intermediate	Coal	219	219	219	219
MANCHESTER MRPC NUG	JCPL	NJ	Peaking	Natural Gas	5	5	5	5
MARCAL PAPER NUG	PS Northern Region	NJ	Intermediate	Natural Gas	47	47	47	47
MERCER 1	PSEG	NJ	Intermediate	Coal	319	319	316	316
MERCER 2	PSEG	NJ	Intermediate	Coal	319	319	316	316
MERCER 3	PSEG	NJ	Intermediate	Coal	115	115	115	115
MICKLETON 1 CT	AECO	NJ	Peaking	Natural Gas	53	53	59	59
MIDDLE 1 CT	AECO	NJ	Peaking	Kerosene	20	20	20	20
MIDDLE 2 CT	AECO	NJ	Peaking	Kerosene	20	20	20	20
MIDDLE 3 CT	AECO	NJ	Peaking	Kerosene	37	37	37	37
MISSOURI AVE CT B	AECO	NJ	Peaking	Kerosene	20	20	20	20
MISSOURI AVE CT C	AECO	NJ	Peaking	Kerosene	20	20	20	20
MISSOURI AVE CT D	AECO	NJ	Peaking	Kerosene	20	20	20	20
MONMOUTH NUG	JCPL	NJ	Baseload	LFG	7	7	7	7
NATIONAL PARK	PSEG	NJ	Peaking	Kerosene	21	21	21	21

Appendix 8A (Sheet 4 of 5)
New Jersey Unit Level Breakdown

					Capacity (MWe)			
RESOURCE	**PJM ZONE**	**STATE**	**DUTY**	**FUEL**	**2009**	**2010**	**2011**	**2012**
NEWARK BAY	PS Northern Region	NJ	Peaking	Dual (NG, others)	123	123	123	120
OCEAN COUNTY LF	JCPL	NJ	Baseload	LFG	9	9	9	9
OYSTER CREEK 1	JCPL	NJ	Baseload	Nuclear	619	619	619	615
PARLIN NUG	JCPL	NJ	Intermediate	Natural Gas	114	114	114	114
PEDRICKTOWN PCLP	AECO	NJ	Peaking	Dual (NG, others)	111	111	111	110
PLEASANTVILLE	AECO	NJ	Intermediate	Natural Gas	2	2	2	4
RED OAK CC 1	JCPL	NJ	Intermediate	Natural Gas	244	244	244	244
RED OAK CT 1	JCPL	NJ	Intermediate	Natural Gas	174	174	174	174
RED OAK CT 2	JCPL	NJ	Intermediate	Natural Gas	174	174	174	174
RED OAK CT 3	JCPL	NJ	Intermediate	Natural Gas	174	174	174	174
SALEM 1	EMAAC	NJ	Baseload	Nuclear	1174	1174	1174	1174
SALEM 2	EMAAC	NJ	Baseload	Nuclear	1158	1158	1158	1158
SALEM GT 3	EMAAC	NJ	Peaking	Oil	38	38	38	38
SAYREVILLE C-1	JCPL	NJ	Intermediate	Natural Gas	57	57	57	57
SAYREVILLE C-2	JCPL	NJ	Intermediate	Natural Gas	53	53	53	53
SAYREVILLE C-3	JCPL	NJ	Intermediate	Natural Gas	57	57	57	57
SAYREVILLE C-4	JCPL	NJ	Intermediate	Natural Gas	57	57	57	57
SEWAREN 1	PSEG	NJ	Peaking	Natural Gas	104	104	104	104
SEWAREN 2	PSEG	NJ	Peaking	Natural Gas	118	118	118	118
SEWAREN 3	PSEG	NJ	Peaking	Natural Gas	107	107	107	107
SEWAREN 4	PSEG	NJ	Peaking	Natural Gas	124	124	124	124
SEWAREN 6	PSEG	NJ	Peaking	Oil	105	105	105	105
SHERMAN AVENUE CT 1	AECO	NJ	Peaking	Dual (NG, others)	81	81	81	81
SOUTH RIVER NUG	JCPL	NJ	Intermediate	Natural Gas	260	260	280	280
TRENTON DISTRICT (TDEC)	PSEG	NJ	Peaking	Natural Gas	6	6	4	
UNION COUNTY RES. RCRVRY	PS Northern Region	NJ	Baseload	MSB	39	39	39	39
VINELAND 10	AECO	NJ	Peaking	Dual (NG, others)	23	23	23	23
VINELAND 8	AECO	NJ	Peaking	Dual (NG, others)	11	11	11	11
VINELAND 9	AECO	NJ	Peaking	Dual (NG, others)	17	17	17	17
VINELAND CT	AECO	NJ	Peaking	Dual (NG, others)	26	26	26	26
WARREN COUNTY LF	JCPL	NJ	Intermediate	LFG	4	4	4	4
WARREN COUNTY NUG	JCPL	NJ	Peaking	LFG	10	10	10	10
WERNER C-1	JCPL	NJ	Peaking	Oil	53	53	53	53
WERNER C-2	JCPL	NJ	Peaking	Oil	53	53	53	53
WERNER C-3	JCPL	NJ	Peaking	Oil	53	53	53	53
WERNER C-4	JCPL	NJ	Peaking	Oil	53	53	53	53
YARDS CREEK 1	JCPL	NJ	Peaking	Pumped Storage	140	140	140	140
YARDS CREEK 2	JCPL	NJ	Peaking	Pumped Storage	140	140	140	140
YARDS CREEK 3	JCPL	NJ	Peaking	Pumped Storage	120	120	120	120
MT HOPE MINE	JCPL	NJ	Baseload	Biomass				30
GLOUCESTER	PSEG	NJ	Peaking	Natural Gas				55
BORGATA D1	EMAAC	NJ	Peaking	Diesel	2			
BORGATA D2	EMAAC	NJ	Peaking	Diesel	2			
DEMAND RESOURCES	EMAAC	NJ	Peaking	DR	195	194	210	859
ENERGY EFFICIENCY	EMAAC	NJ	Baseload	EE	0	0	0	6

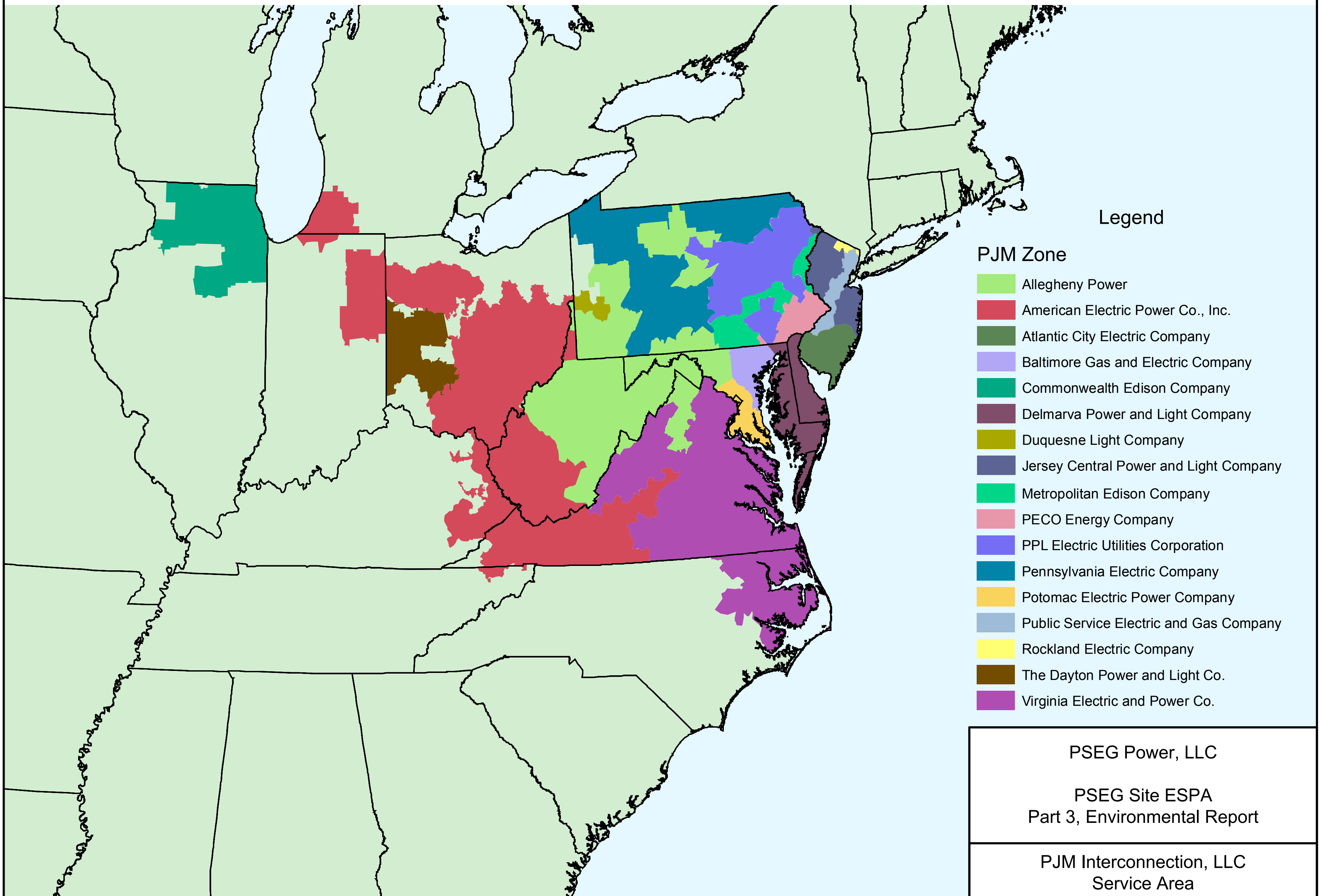
Appendix 8A (Sheet 5 of 5)
New Jersey Unit Level Breakdown

Abbreviations in Appendix 8A

AECO	Atlantic Electric Company
CC	Combined Cycle
COGEN	Cogeneration
CT	Combustion Turbine
DR	Demand Response
EE	Energy Efficiency
EMER	Emergency
GT	Gas Turbine
JCPL	Jersey Central Power & Light
LF	Landfill
LFG	Landfill Gas
MSB	Municipal Solid Waste Biogenic
MSW	Municipal Solid Waste
NUG	Non Utility Generator
PSEG	Public Service Electric & Gas
RES. RCRVRY	Resource Recovery

Generator Data Resources

PJM RPM Resource Model for each year (Reference 8.3-9)
PJM Interconnection Queue (Reference 8.3-5)
PJM List of Generator Retirements (Reference 8.3-6)
NERC GADS data (Reference 8.3-22)
Ventyx Velocity Suite data (Reference 8.3-23)
Supplemented with descriptions of generating units from websites of generation owners



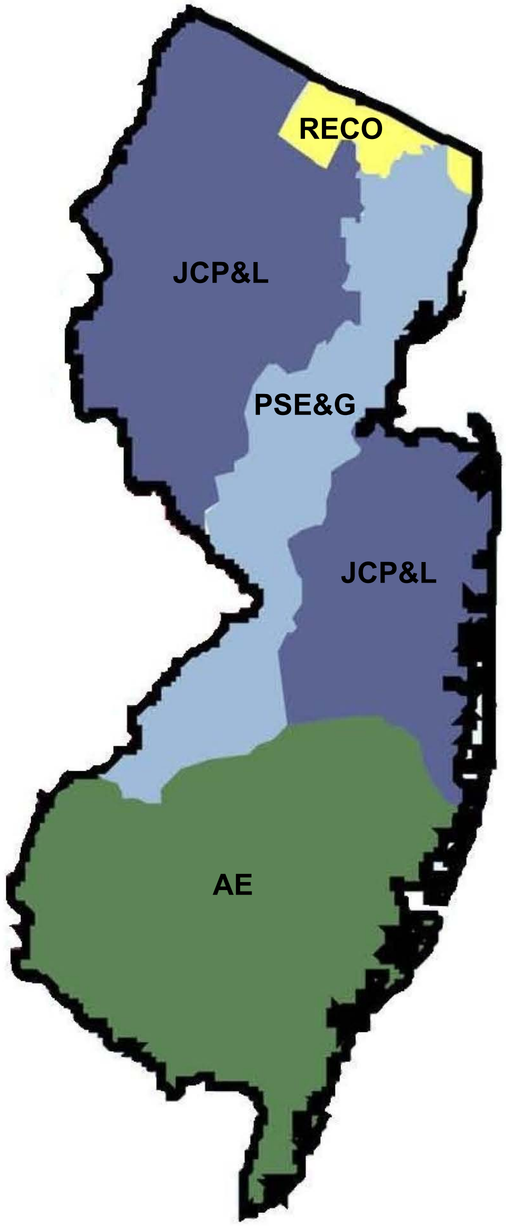
PSEG Power, LLC

PSEG Site ESPA
Part 3, Environmental Report

PJM Interconnection, LLC
Service Area

FIGURE 8.1-1

Rev 0



AE - Atlantic City Electric Power Company
JCP&L - Jersey Central Power & Light
PSE&G - Public Service Electric & Gas
RECO - Rockland Electric Company

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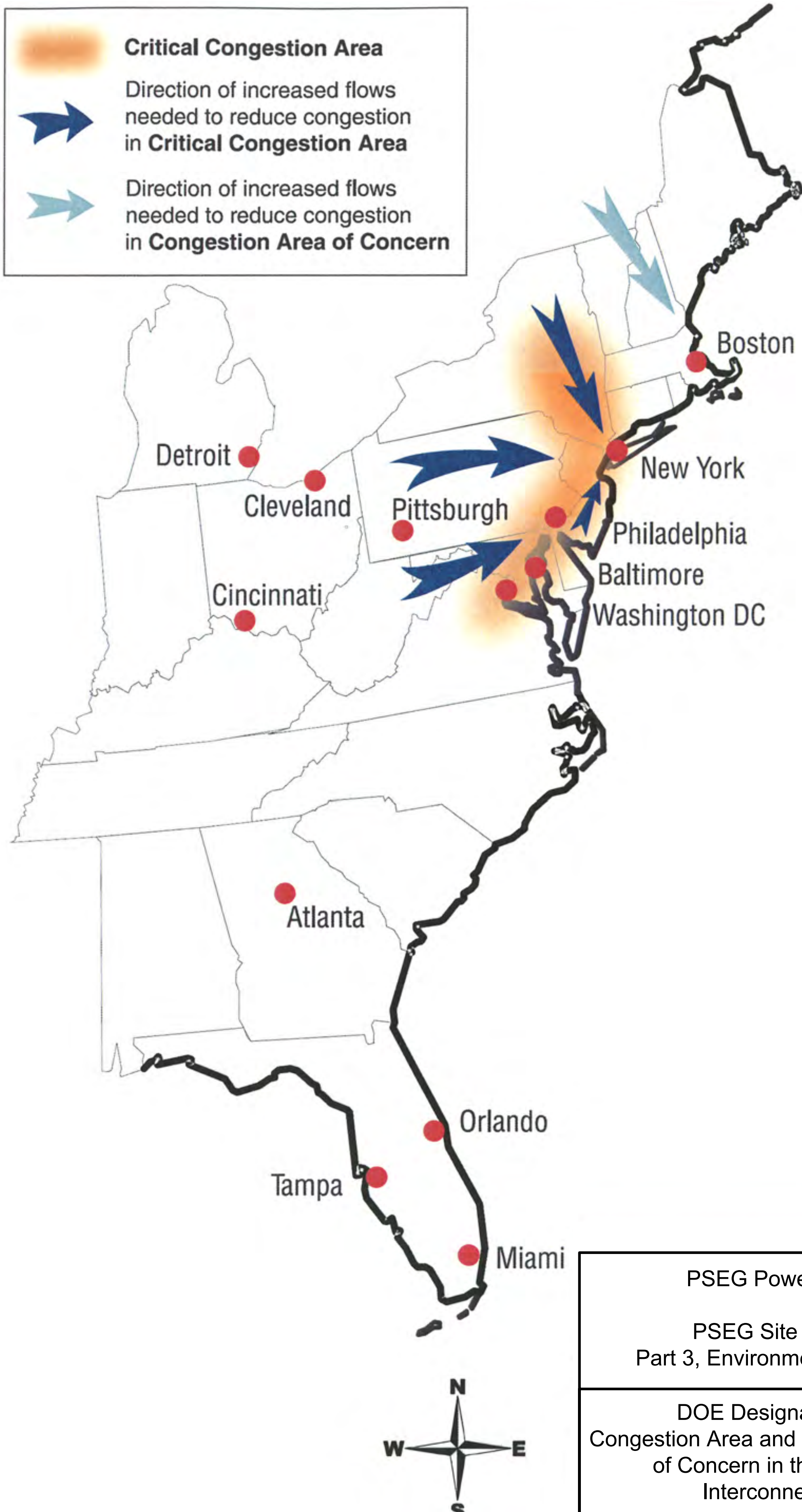
Part 3, Environmental Report

Electric Delivery Companies
Serving New Jersey

FIGURE 8.1-2

Rev 0



PSEG Power, LLC

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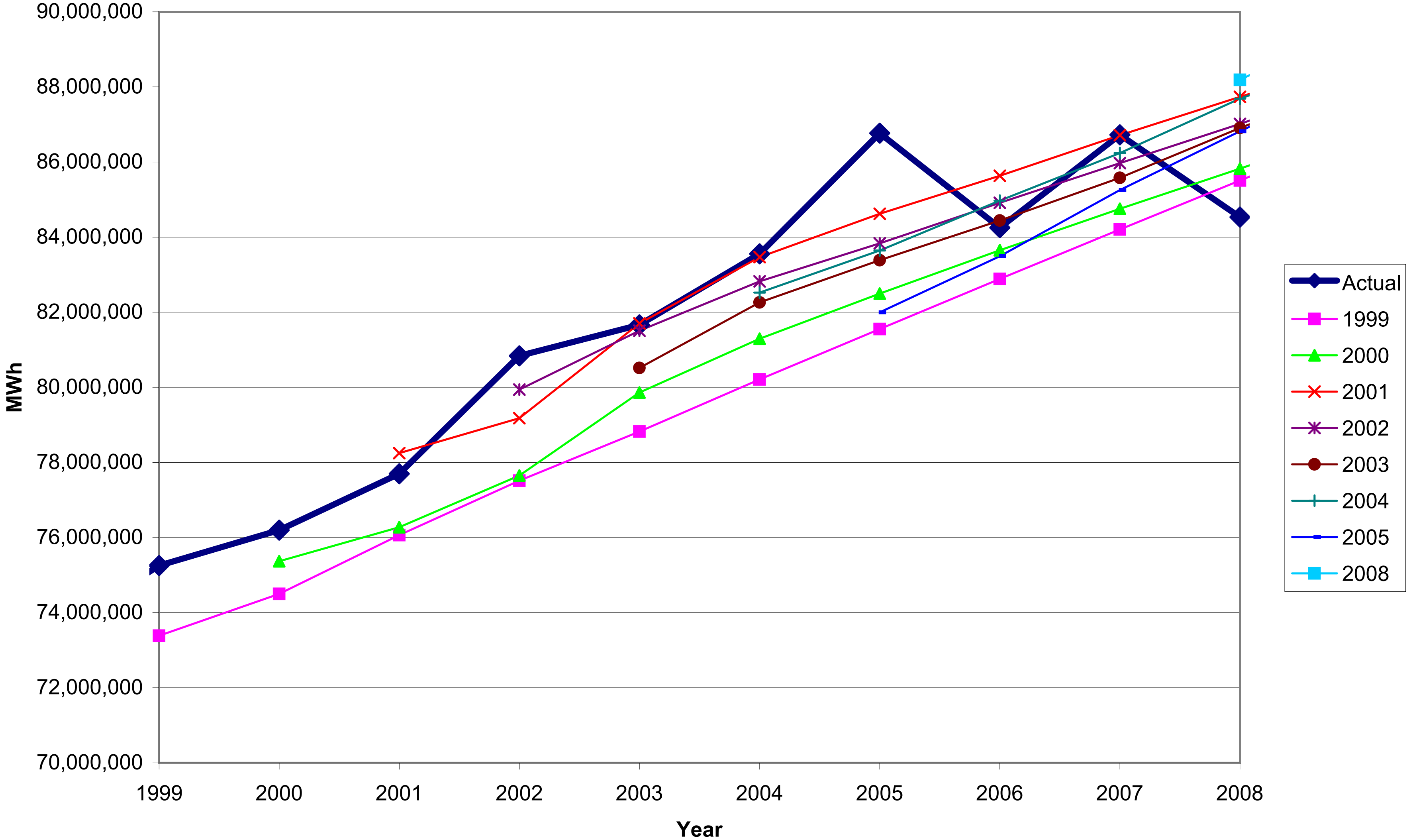
Part 3, Environmental Report

DOE Designated Critical Congestion Area and Congestion Area of Concern in the Eastern Interconnection

FIGURE 8.1-3

Rev 0



PSEG Power, LLC

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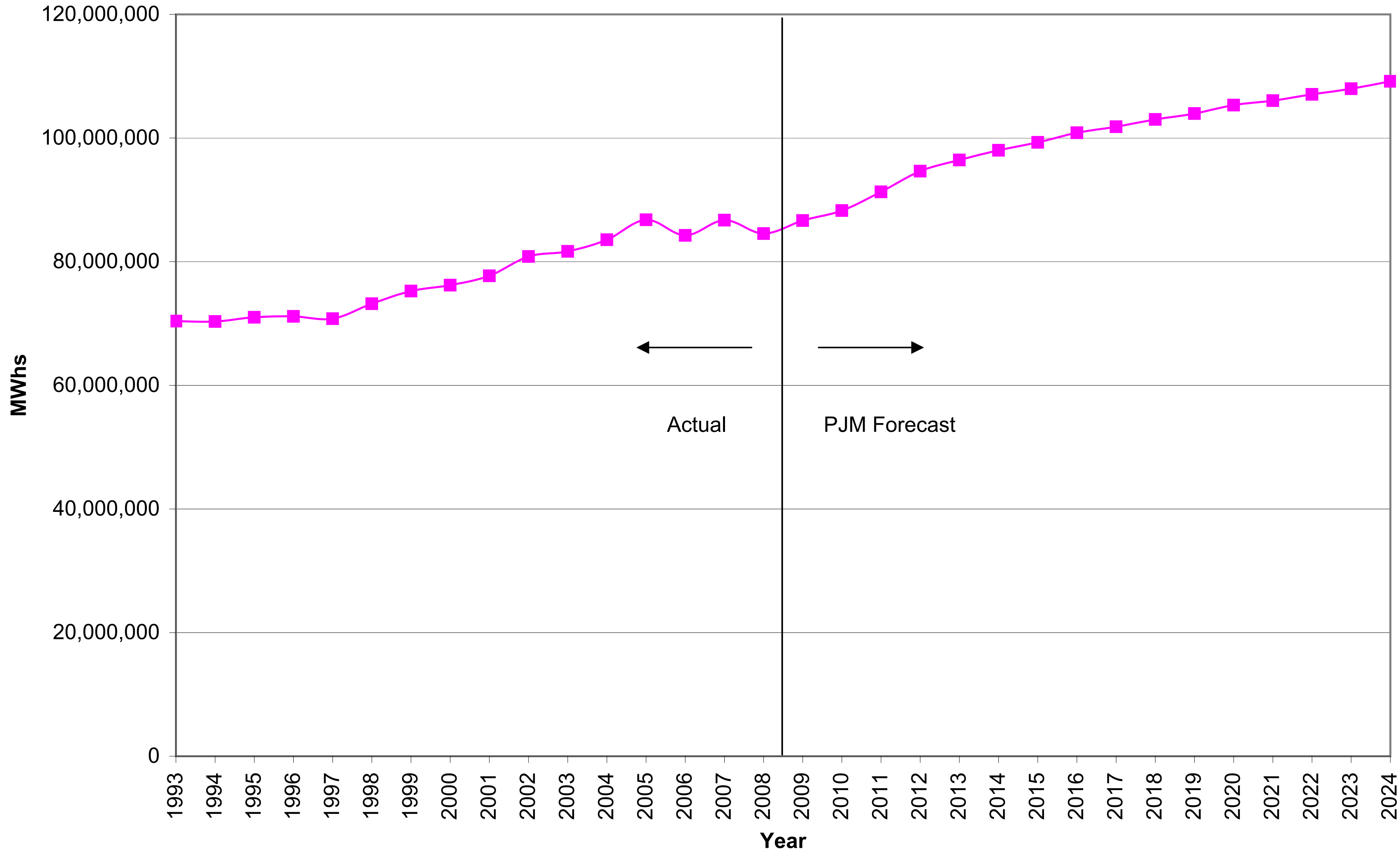
Part 3, Environmental Report

Comparison of Actual
and Forecast Net Energy,
New Jersey, 1999 to 2008

FIGURE 8.2-1

Rev 0



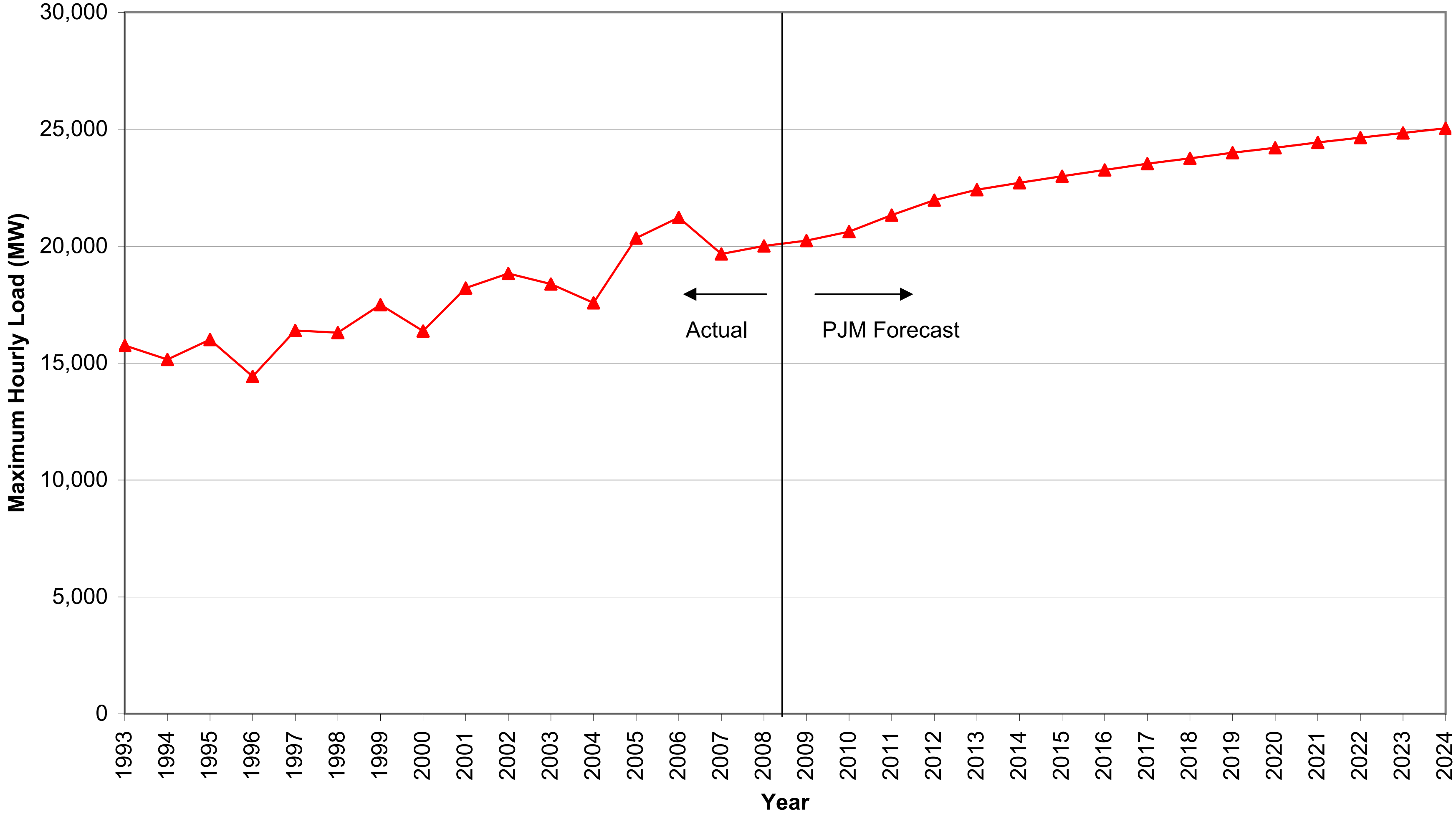
PSEG Power, LLC

PSEG Site ESPA
Part 3, Environmental Report

Historical and Forecast
Total Energy Consumption,
New Jersey, 1993 to 2024

FIGURE 8.2-2

Rev 0



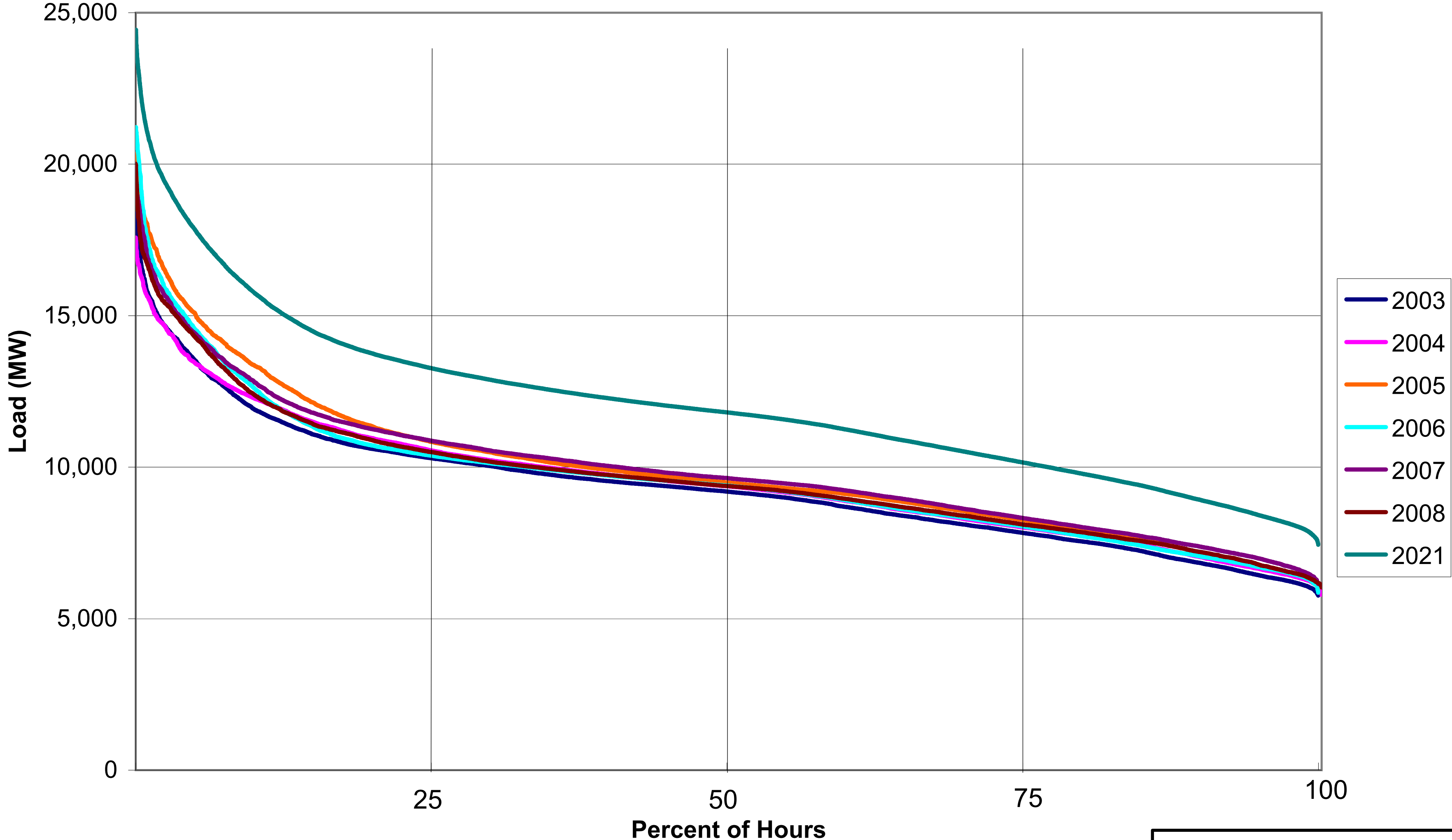
PSEG Power, LLC

PSEG Site ESPA
Part 3, Environmental Report

Historical and Forecast
Maximum Hourly Load,
New Jersey, 1993 to 2024

FIGURE 8.2-3

Rev 0



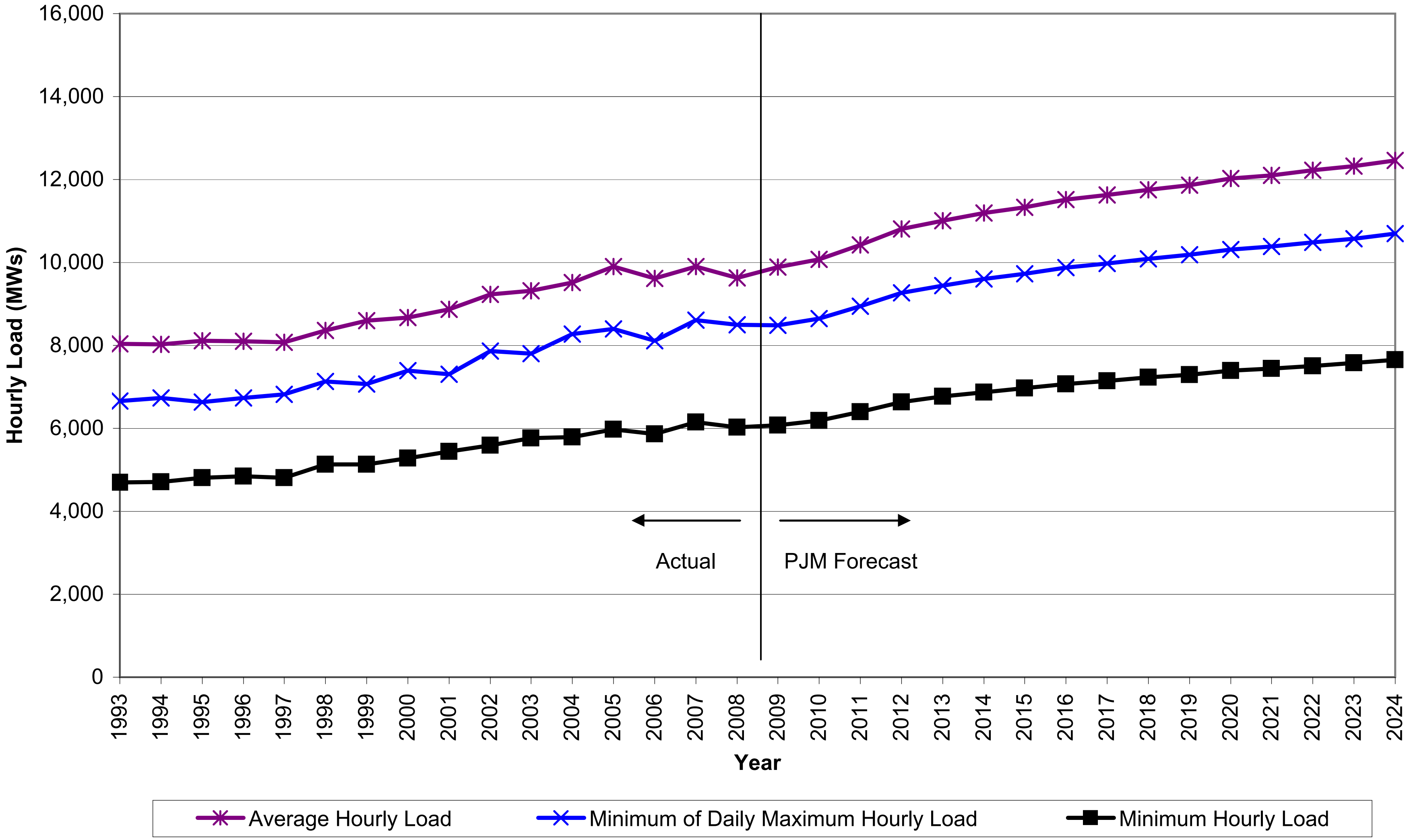
PSEG Power, LLC

PSEG Site ESPA
Part 3, Environmental Report

Actual and Forecast Load Duration Curves, New Jersey, 2003 to 2008 and 2021

FIGURE 8.2-4

Rev 0



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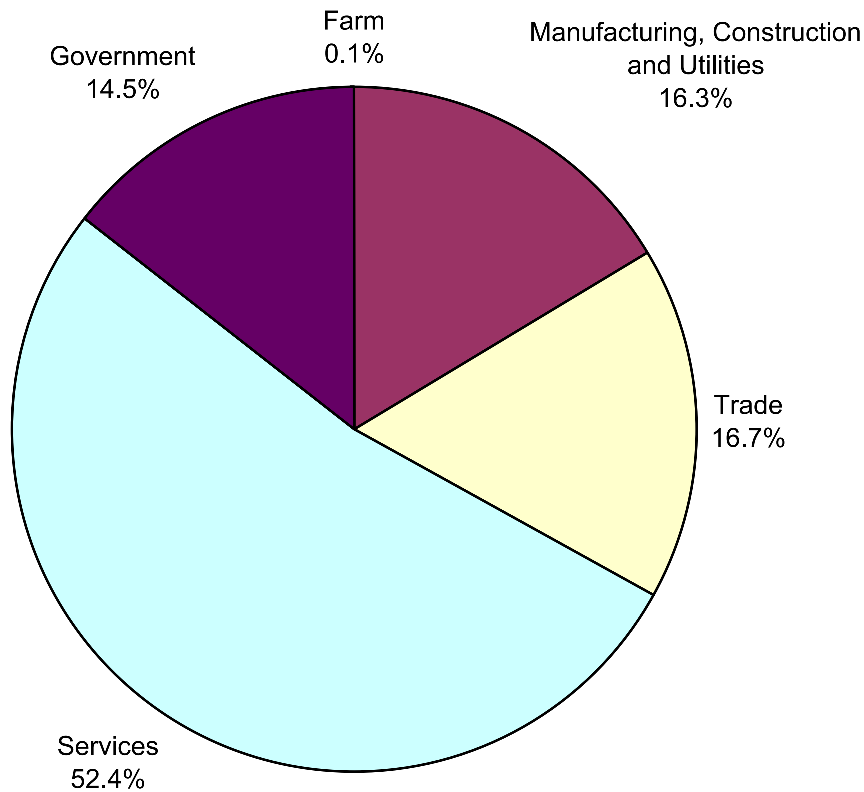
PSEG Site ESPA
Part 3, Environmental Report

Historical and Forecast Average Hourly Load, Minimum of Daily Maximum Loads, and Minimum Load, New Jersey, 1993 to 2024

FIGURE 8.2-5

Rev 0



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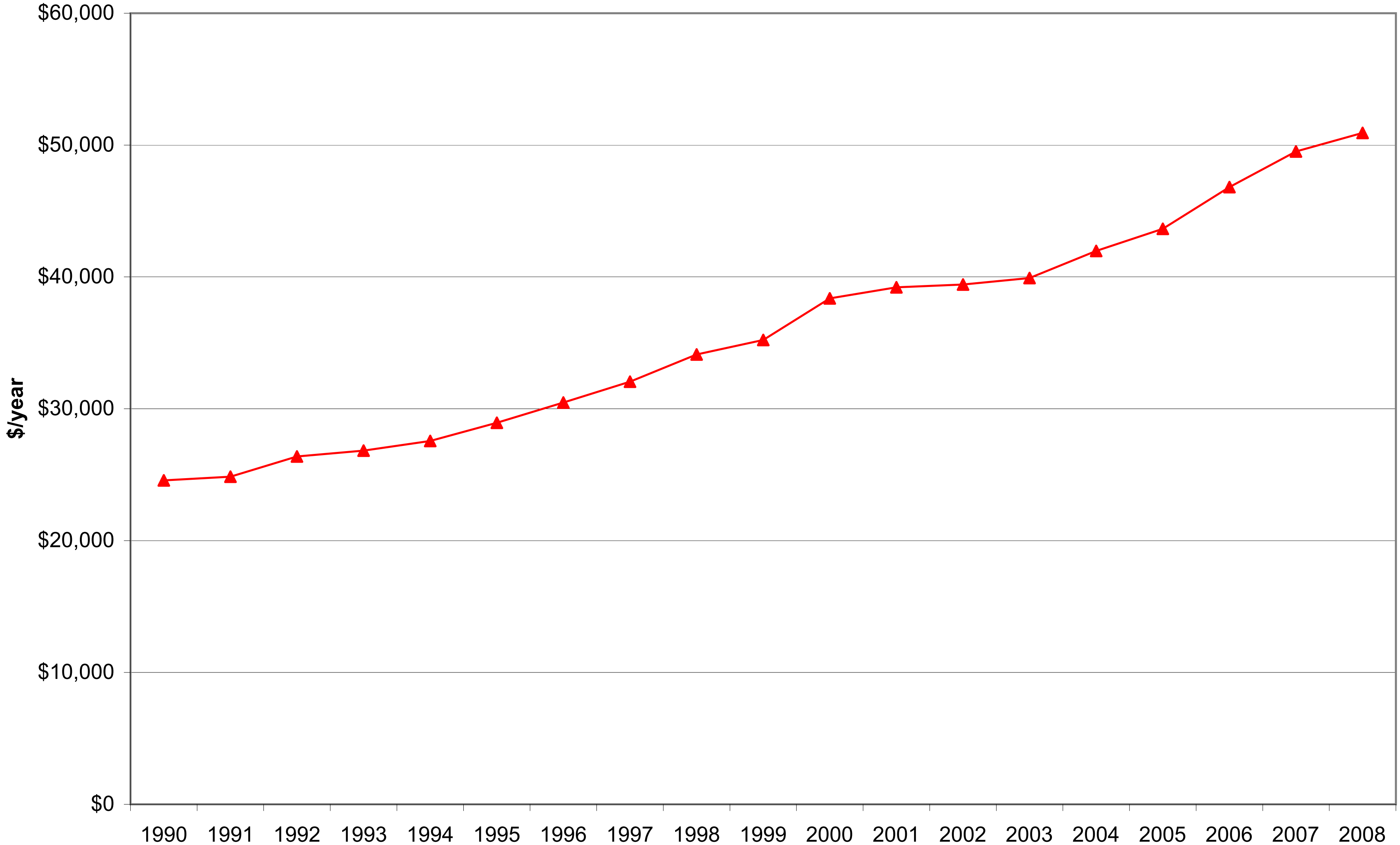
PSEG Site ESPA
Part 3, Environmental Report

2008 Gross Domestic
Product, New Jersey

FIGURE 8.2-6

Rev 0



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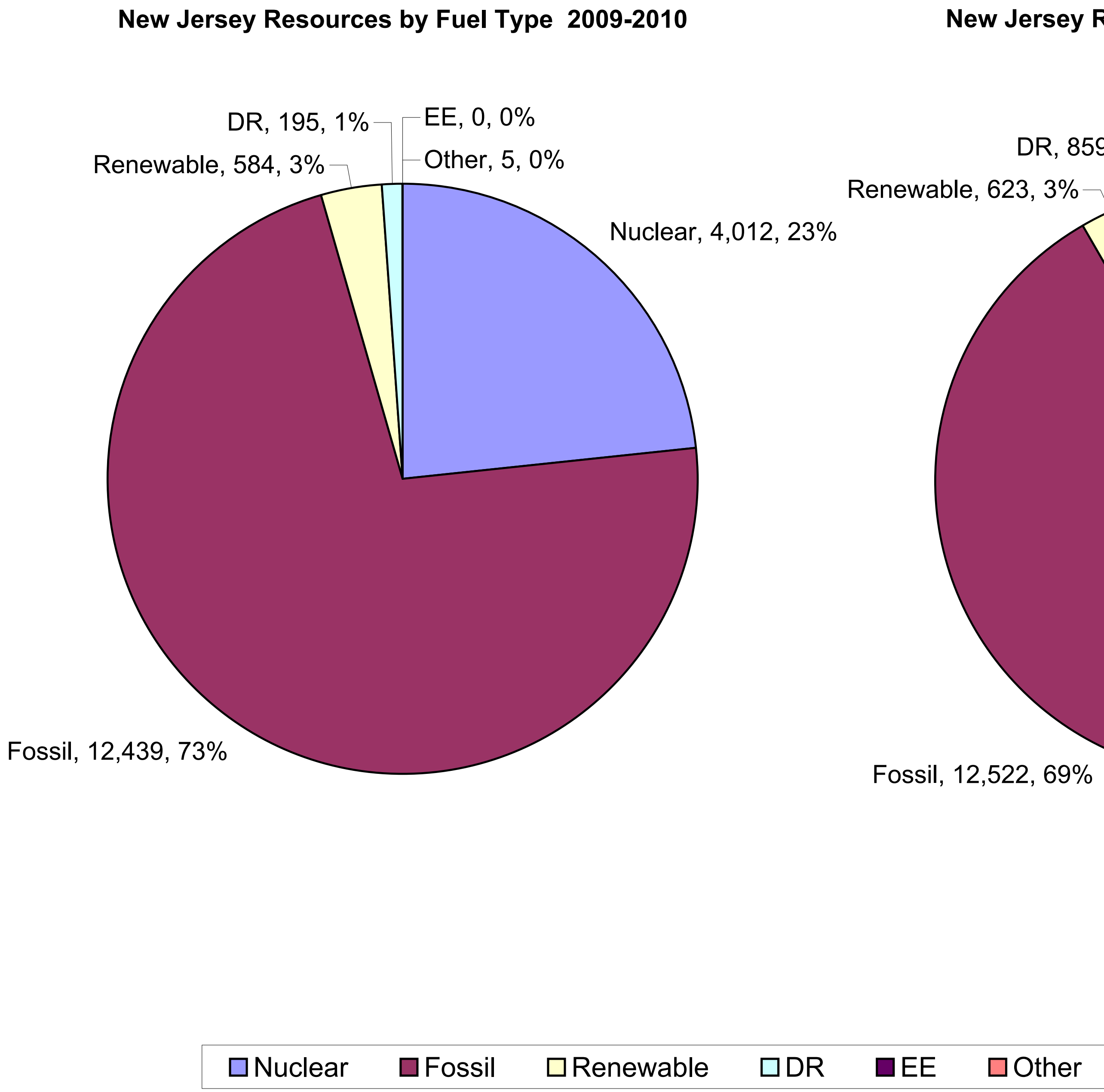
PSEG Site ESPA
Part 3, Environmental Report

Historical Personal Income, New Jersey, 1990 to 2008

FIGURE 8.2-7

Rev 0



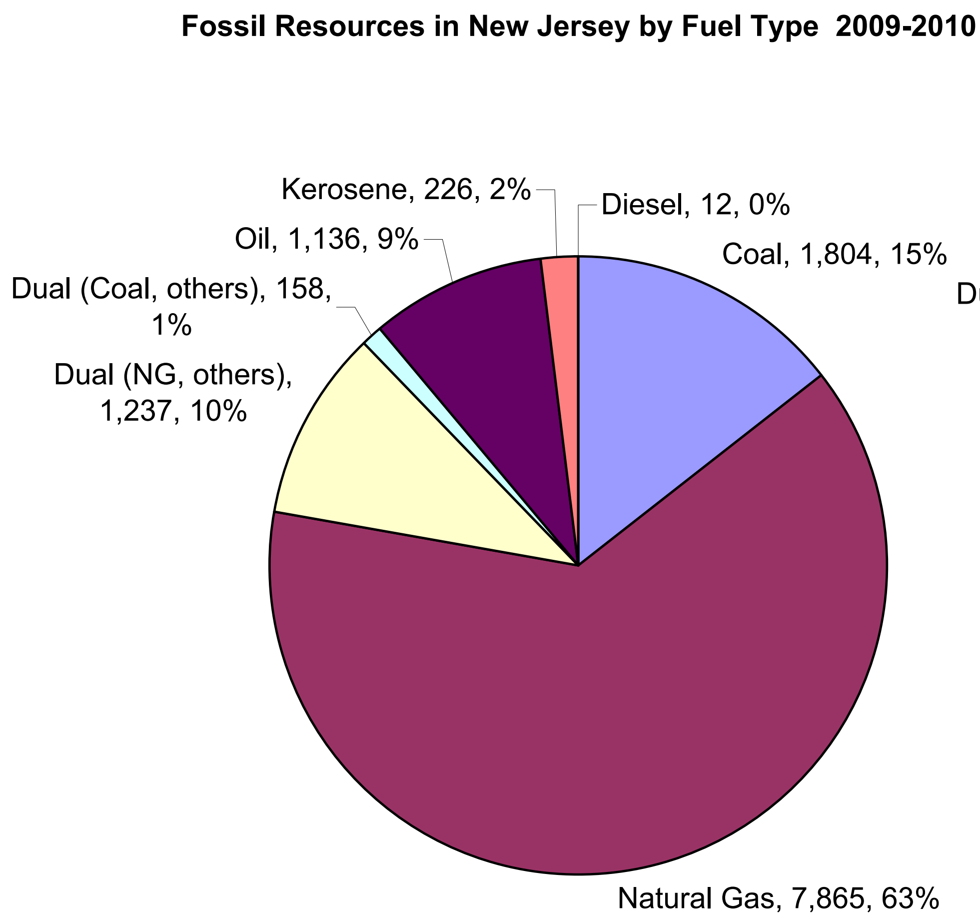
PSEG Power, LLC

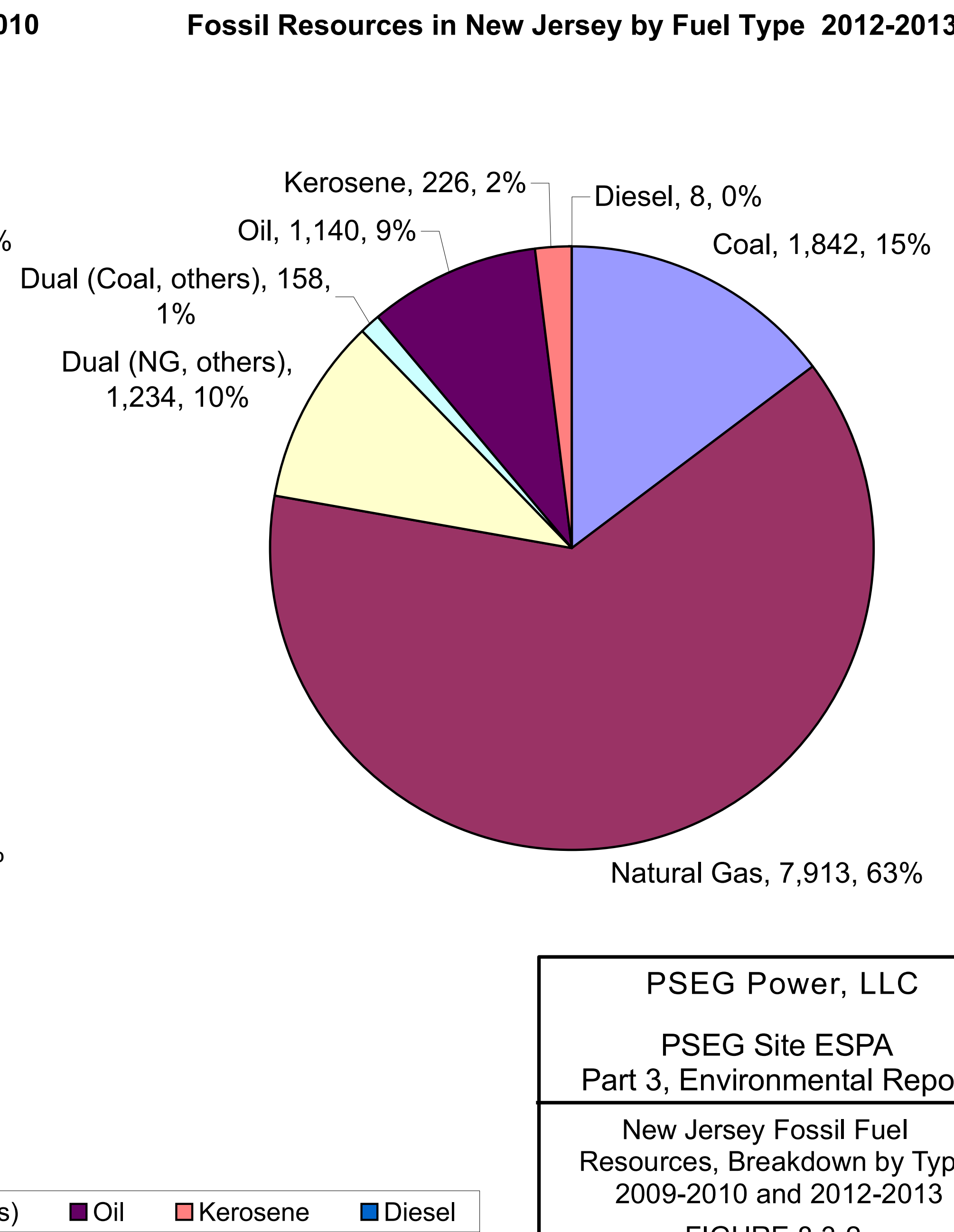
PSEG Site ESPA
Part 3, Environmental Report

New Jersey Generation Resourcesby Fuel Type, 2009-2010 and 2012-2013

FIGURE 8.3-1

Rev 0





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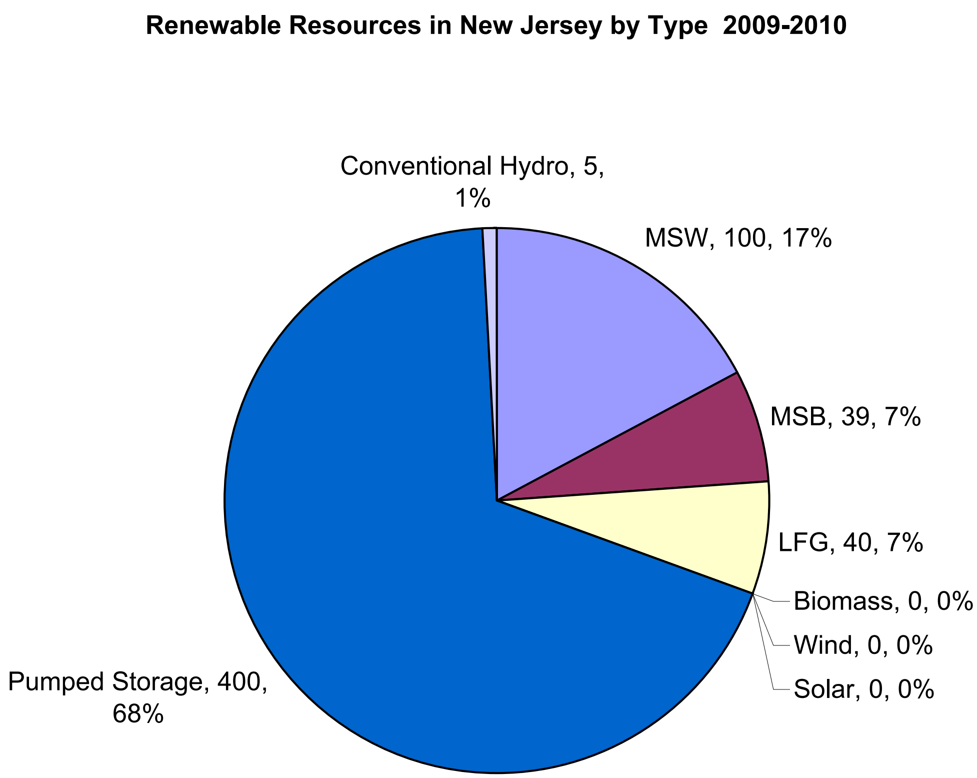
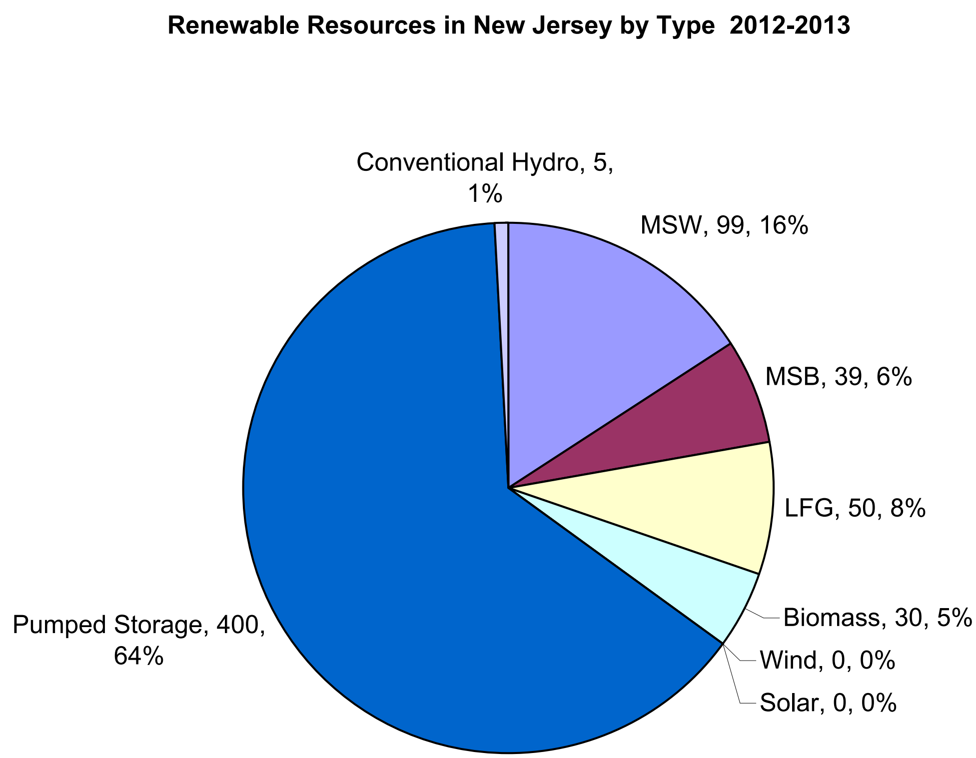
New Jersey Fossil Fuel Resources, Breakdown by Type, 2009-2010 and 2012-2013

FIGURE 8.3-2

Rev 0





MSW | MSB | LFG | Biomass | Wind | Solar | Pumped Storage | Conventional Hydro

PSEG Power, LLC

PSEG Site ESPA
Part 3, Environmental Report

New Jersey Renewable Resources, Breakdown by Type, 2009-2010 and 2012-2013

FIGURE 8.3-3

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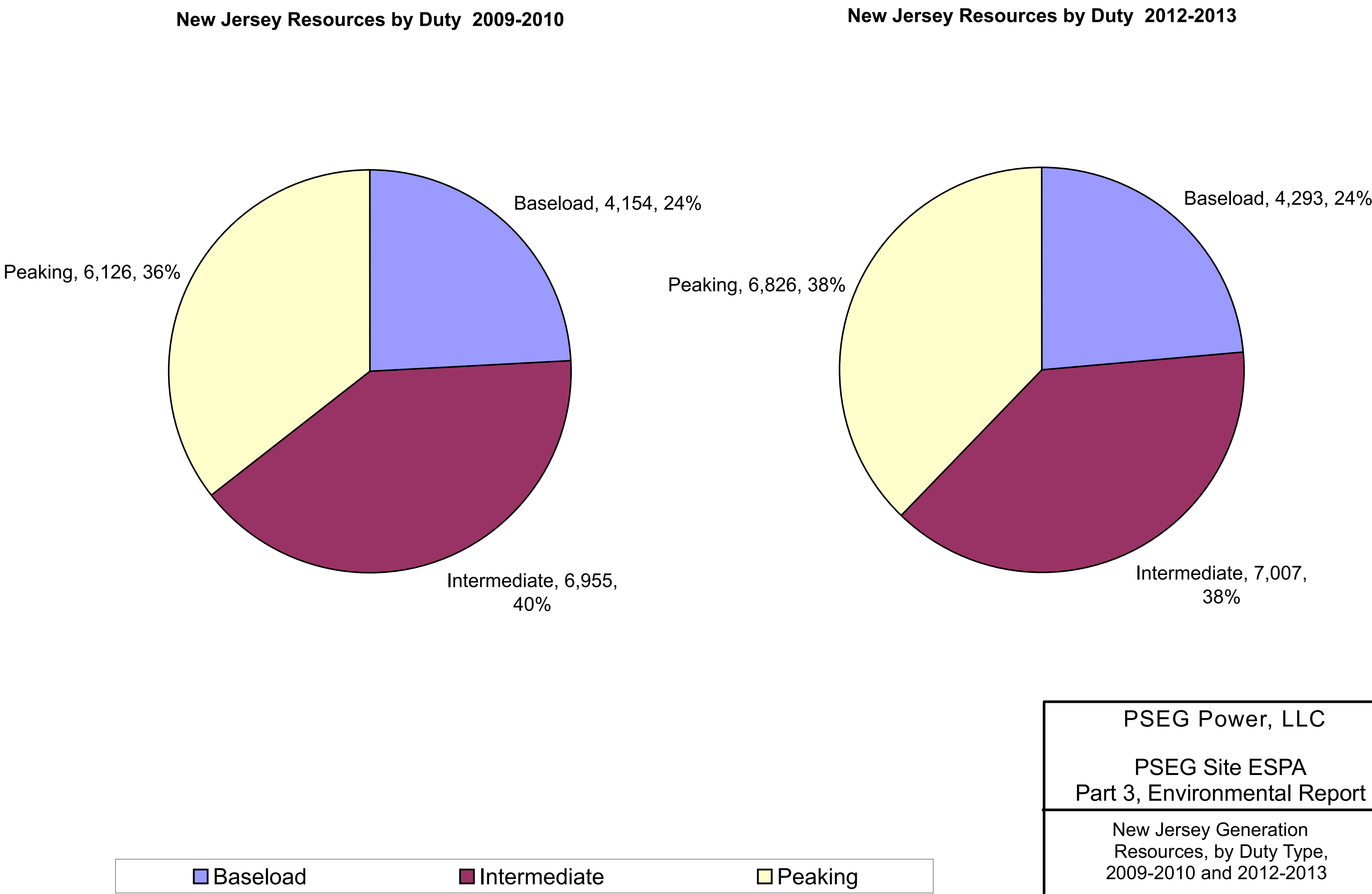

PSEG Power, LLC

PSEG Site ESPA
Part 3, Environmental Report

New Jersey Generation Resources, by Duty Type, 2009-2010 and 2012-2013

FIGURE 8.3-4

Rev 0

CHAPTER 9

ALTERNATIVES

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ACRONYMS AND ABBREVIATIONS

Acronym	Definition
7Q10	7-day, 10-year low flow
ABWR	Advanced Boiling Water Reactor
ac.	acre
AP1000	Advanced Passive 1000
APWR	U.S. Advanced Pressurized Water Reactor
BMPs	best management practices
Btu	British thermal unit
CAES	compressed air energy storage
CCS	carbon capture and storage
CCW	coal combustion wastes
CFR	Code of Federal Regulations
cfs	cubic feet per second
CO_2	carbon dioxide
COD	commercial operating date
COLA	combined license application
COL	combined license
CSP	concentrated solar power
CWS	circulating water system
dBA	A-weighted decibel
DOE	U.S. Department of Energy
DR	Demand Response
DRBC	Delaware River Basin Commission

ACRONYMS AND ABBREVIATIONS (CONTINUED)

Acronym	Definition
DSM	demand side management
EA	Environmental Assessment
EE	Energy Efficiency
EIA	Energy Information Administration
EIF	equivalent impact factor
EMAAC	Eastern Mid-Atlantic Area Council
EPACT	Energy Policy Act of 2005
ER	Environmental Report
EPA	U.S. Environmental Protection Agency
EPR	U.S. Evolutionary Power Reactor
ESP	Early Site Permit
ESRI	Environmental Systems Research Institute
FERC	Federal Energy Regulatory Commission
FRA	Federal Railroad Administration
ft.	feet
GEIS	Generic Environmental Impact Statement
GIS	geographic information system
gpm	gallons per minute
GWh	gigawatt hour(s)
HCGS	Hope Creek Generating Station
IGCC	integrated gasification combined cycle
kV	kilovolt(s)

ACRONYMS AND ABBREVIATIONS (CONTINUED)

Acronym	Definition
LMP	locational marginal prices
LOS	level of service
LULC	Land Use/Land Cover
MAPP	Mid-Atlantic Power Project
MGD	million gallons per day
MSW	municipal solid waste
MW	megawatt
MWe	megawatt electric
MWt	megawatt thermal
mi.	mile
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NERC	North American Electric Reliability Corporation
NJBPU	New Jersey Board of Public Utilities
NJDEP	New Jersey Department of Environmental Protection
NJDOT	New Jersey Department of Transportation
NJEMP	New Jersey Energy Master Plan
NJHPO	New Jersey Historic Preservation Office
NJPDES	New Jersey Pollutant Discharge Elimination System
NJRHP	New Jersey Register of Historic Places
NOx	nitrogen oxide
NRC	U.S. Nuclear Regulatory Commission

ACRONYMS AND ABBREVIATIONS (CONTINUED)

Acronym	Definition
NRCS	Natural Resources Conservation Service
NREL	National Renewable Energy Laboratory
NRHP	National Register of Historic Places
NWI	National Wetlands Inventory
NYISO	New York Independent System Operator
OPEC	Organization of the Petroleum Exporting Countries
PECO	PECO Energy Co.
PJM	PJM Interconnection, LLC
PM	particulate matter
PSEG	PSEG Power, LLC and PSEG Nuclear, LLC
PSE&G	Public Service Electric and Gas
PV	photovoltaic
RCRA	Resource Conservation and Recovery Act
RG	regulatory guide
RGGI	Regional Greenhouse Gas Initiative
ROI	Region of Interest
ROW	right-of-way
RPM	Reliability Pricing Model
RSA	relevant service area
RTEP	regional transmission expansion plan
RTO	Regional Transmission Organization
SCR	selective catalytic reduction

ACRONYMS AND ABBREVIATIONS (CONTINUED)

Acronym	Definition
SECA	Solid State Energy Conversion Alliance
SGS	Salem Generating Station
SMCRA	Surface Mining Control and Reclamation Act
SO_2	sulfur dioxide
SO_x	sulfur oxide
SWIS	service water intake structure
TES	thermal energy storage
USCB	U.S. Census Bureau
USGS	U.S. Geological Survey

CHAPTER 9

ALTERNATIVES

This chapter identifies and describes alternatives to siting, constructing, and operating the new plant at the PSEG Site, which is designed and operated as a baseload generator. The descriptions provide sufficient detail to facilitate evaluation of the impacts of the no-action alternative, energy alternatives, alternative sites, and alternative plant and transmission systems for the new plant proposed by PSEG Power, LLC and PSEG Nuclear, LLC (PSEG). The chapter is divided into four sections:

- No-Action Alternative (Section 9.1)

  Section 9.1 describes the environmental impact and energy consequences if an Early Site Permit (ESP) is not issued and the new plant is not constructed or operated.

- Energy Alternatives (Section 9.2)

  Section 9.2 examines the potential environmental impacts associated with alternatives to the construction of a new baseload nuclear generating facility.

- Alternative Sites (Section 9.3)

  Section 9.3 describes and evaluates alternative sites considered for the new plant.

- Alternative Plant and Transmission Systems (Section 9.4)

  Section 9.4 describes and evaluates plant and transmission system alternatives for the new plant.

9.1 NO-ACTION ALTERNATIVE

In this section, the No-Action Alternative is defined and the consequences of adopting the No-Action Alternative are described. The purpose of the ESP is to approve the site for eventual construction and operation of a nuclear power plant as a merchant generator to provide baseload power for sale on the wholesale market.

Under the No-Action Alternative, (1) the U.S. Nuclear Regulatory Commission (NRC) would not issue an ESP for the new plant at the PSEG Site, and (2) the construction and operation of the new plant would not occur. In accordance with NUREG-1555, *Standard Review Plans for Environmental Reviews for Nuclear Power Plants: Environmental Standard Review Plan,* the No-Action Alternative presupposes that no other generating station, either nuclear or non-nuclear, would be constructed in place of the new plant. The No-Action Alternative also presupposes that no additional conservation measures beyond current levels would be enacted to decrease the amount of electrical capacity that would otherwise be required.

If the ESP is not issued and the new plant not built, the following benefits would not be realized:

- Resolution of siting and environmental issues before large investments of financial capital and human resources in new plant design and construction are made

- The ability to bank a site on which a nuclear plant may be located

- The need for power that could be met by the new plant would have to be met by means that involve no new generating capacity. This would result in the loss of up to 2200 megawatts electric (MWe) additional baseload generating capacity that the new plant will provide to the relevant service area (RSA), which is New Jersey (NJ). The RSA is where the majority of the power from the new plant is expected to be consumed.

Although the environmental impacts associated with construction and operation of the proposed plant would not occur under the No-Action Alternative, the following ancillary benefits of the new plant as described in Subsection 8.4.4 also would not occur:

- Reduces the amount of carbon dioxide (CO_2) generating imports needed to meet baseload demand in NJ

- Supports Global Warming Response Act, P.L. 2007, goals for the reduction of greenhouse gas emissions in NJ to 80 percent below 2006 levels by 2050.

- Reduces emissions from fossil fueled generation in NJ and from imports

- Lowers locational marginal prices (LMP)[a] due to reduced generation from fossil fueled resources in NJ. Fossil fueled resources are projected to have increased generation costs due to costs associated with pending carbon legislation

- Reduces potential for transmission congestion

- Reduces reliance on imported petroleum to the extent that generation from oil-fired resources is reduced

- Increases the diversity of the NJ generation portfolio, which is currently comprised of 73 percent fossil fuel fired plants (Figure 8.3-1)

- Increases NJ reserve margins to improve the capability of generating resources within NJ to meet the summer peak load with less dependence on imports and their associated challenge to transmission congestion

The following paragraphs describe how selected federal, regional, state and corporate programs would be affected by the loss of the ancillary benefits of the new plant under the No Action Alternative.

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[a] Transmission constraints are relieved by dispatching higher cost units out of economic order to assure the reliability of the power grid in the congested area. LMPs are the cost of power where power is injected into or obtained from the transmission system, and reflect the higher cost of re-dispatched units. Higher LMPs ultimately result in higher prices to electricity customers.

PJM Interconnection, LLC, (PJM) is the regional transmission organization (RTO) that coordinates the movement of wholesale electricity and manages the high-voltage electric grid in NJ as part of a broader multi-state region. As discussed in Section 8.3, a number of factors continue to adversely impact system reliability in NJ. These factors include load growth, power exports to New York and Long Island, deactivation and retirement of existing generation facilities, modest development of new generation facilities, continued reliance on carbon-based imports to meet baseload needs and their resulting power flow challenges to bulk transmission facilities managed by PJM (Reference 9.1-1). The new plant at the PSEG Site improves system reliability by providing new baseload generation in NJ and reducing imports and their associated transmission, emissions and carbon challenges. These benefits are not realized under the No-Action Alternative.

Under the No-Action Alternative, the new plant would not be available to help avoid the economic, reliability, and environmental consequences of the business as usual scenario identified in the New Jersey Energy Master Plan (NJEMP). The NJEMP estimates that NJ will use 97,800 gigawatt hours (GWh) of electricity and 542 trillion British thermal units (Btu) of natural gas or heating oil in 2020 if no changes in energy supply and demand trends are made. This total energy consumption will cost consumers more than $30.7 billion in 2020, which is 96 percent more than the total annual energy expenditures in 2005. The NJEMP also indicates that if no changes in energy supply and demand trends are made, greenhouse gas emissions will increase, with CO_2 emissions totaling 84 million metric tons in 2020 (Reference 9.1-4). The new plant at the PSEG Site reduces LMPs and greenhouse gas emissions in NJ. These benefits are not realized under the No-Action Alternative.

If the No-Action Alternative is enacted, the current reliance on electricity produced by fossil-fueled generation would continue for the states participating in the Regional Greenhouse Gas Initiative (RGGI). The RGGI was developed by ten Northeast and Mid-Atlantic States to cap and then reduce power plant CO_2 emissions. Under the RGGI agreement, states must stabilize CO_2 emissions from 2009 to 2014 and then reduce the emissions by 2.5 percent per year from 2015 to 2018 (10 percent total) (Reference 9.1-3). New Jersey was one of the ten participating states, in RGGI, but withdrew in 2011. However, NJ remains committed to reductions in greenhouse gas emissions through its commitment to renewable energy sources, energy conservation, and development of new, clean generation within NJ.

Under the No-Action Alternative, the new plant would not be available to provide an alternative source of electric generation that produces almost none of the greenhouse gases subject to pending federal regulatory and legislative initiatives. The U.S. Environmental Projection Agency (EPA) has issued a finding that greenhouse gases contribute to air pollution that may endanger public health or welfare. This finding could result in regulations to reduce greenhouse gases under the Clean Air Act (Reference 9.1-6). In addition, the U.S. House of Representatives has passed the American Clean Energy and Security Act of 2009, which sets goals and establishes a cap-and-trade system for reductions in greenhouse gas emissions (Reference 9.1-5). Both the EPA finding and the House bill are indicative of an intention to require reductions in greenhouse gases. The new plant at the PSEG Site can replace generating sources that emit significant amounts of greenhouse gases affected by these initiatives, but would not be available under the No-Action Alternative.

PSEG currently is implementing several programs to reduce CO_2 emissions, one of the greenhouse gases subject to the EPA and House initiatives. PSEG has been pursuing a low-carbon business strategy since 1993, and voluntarily pledged to reduce its U.S. greenhouse

gas emissions intensity by 18 percent from 2000 to 2008. It surpassed this goal by achieving a 31 percent reduction (Reference 9.1-2). Under the No-Action Alternative, PSEG would be less likely to meet its continuing CO_2 emissions reduction goals because of continued consumption of natural gas, heating oil and coal for electric generation. The construction of the new plant at the PSEG Site allows PSEG to further exceed its CO_2 emission reduction goals.

In summary, under the No-Action Alternative, the NRC does not issue an ESP, the construction and operation of the new plant at the PSEG Site would not occur, and the benefits of the ESP would not be realized. If the new plant were not constructed or operated, the environmental impacts associated with construction and operation would be avoided, but there would be negative consequences, including the loss of up to 2200 MWe additional baseload generating capacity and the loss of ancillary benefits of the new plant. The ancillary benefits described above that would not be realized include reduced electricity imports, reduced local transmission constraints resulting from imports, lower LMPs, reduced air pollution and CO_2 emissions. In addition, the avoidance of anticipated higher fossil-based generating costs in light of pending carbon legislation, reduced reliance on imported petroleum, increased diversity of generating resources, and increased reserve margins and improved system reliability in NJ would not occur.

9.1.1 REFERENCES

9.1-1 PJM Interconnection, LLC, "PJM 2008 Regional Transmission Expansion Plan," Section 6.1 – PJM Sub-Regional Key Issues, pg 113, February 27, 2009.

9.1-2 PSEG Media Centers, Press Release, "PSEG Exceeds EPA Climate Leaders Goal", July 23, 2009.

9.1-3 Regional Greenhouse Gas Initiative, About RGGI, website, http://www.rggi.org/about, accessed, September 16, 2009.

9.1-4 State of New Jersey, "New Jersey Energy Master Plan", October 2008, website, http://www.state.nj.us/emp/, accessed, November 9, 2009.

9.1-5 United States Congress, H.R.2425 American Clean Energy and Security Act of 2009, website, www.opencongress.org/bill/111-h2454/, accessed, November 16, 2009.

9.1-6 United States Environmental Protection Agency, Endangerment and Cause or Contribution Findings for Greenhouse Gases under the Clean Air Act, website, http://www.epa.gov/climatechange/endangerment.html, accessed, December 21, 2009.

9.2 ENERGY ALTERNATIVES

This section examines the potential environmental impacts associated with alternate ways to satisfy the purpose of the proposed action, which is to approve the site for eventual construction and operation of a nuclear power plant as a merchant generator to provide baseload power for sale on the wholesale market. This section is organized as follows

- Alternatives Not Requiring Generating Capacity (Subsection 9.2.1)

  This section assesses conservation (energy efficiency) programs, reactivation or life extension of existing plants in NJ, and purchasing power from other utilities or power generators outside of NJ.

- Alternatives Requiring New Generating Capacity (Subsection 9.2.2)

  This section assesses wind, geothermal, hydro, solar, biomass, petroleum liquids, fuel cells, coal, natural gas and Integrated Gasification Combined Cycle generation sources. Competitive alternatives are identified based on availability in the region, overall feasibility, ability to generate baseload power and environmental consequences.

- Assessment of Competitive Energy Alternatives and Systems (Subsection 9.2.3)

  Potentially competitive alternatives identified in Subsections 9.2.1 and 9.2.2 are assessed in further detail in Subsection 9.2.3.

9.2.1 ALTERNATIVES NOT REQUIRING NEW GENERATING CAPACITY

This subsection provides an assessment of the economic and technical feasibility of meeting the demand for energy without constructing new generating capacity. Alternatives considered in this section include the following:

- Initiating conservation measures
- Reactivating or extending the service life of existing plants within NJ
- Purchasing power from other utilities or power generators outside of NJ

As discussed in the following sections, none of these alternatives are potentially viable, and so are eliminated from further consideration.

9.2.1.1 Initiating Conservation Measures

Energy conservation measures and programs to reduce energy demand can be characterized as (1) energy efficiency programs, designed to permanently reduce the consumption of energy by residential, commercial and industrial users; (2) demand side management (DSM) programs, designed to reduce peak power demand by temporarily reducing load or by shifting peak period load to off-peak periods; and (3) distributed generation programs, designed to encourage the use of renewable technologies by end users to self-supply some of their electricity need. Subsection 8.2.2.2 provides a summary of the government and corporate programs that have been initiated to enact these programs.

The overall impact of these programs is not adequate to obviate the need for the new plant. The effect of these programs on future projections of power demand has been incorporated into PJM planning indirectly through the development of the load forecast and directly through the bidding of Energy Efficiency (EE) and Demand Response (DR) resources into the annual Reliability Pricing Model (RPM) auctions. As described in Subsection 8.2.1.1, PJM uses an econometric modeling approach to forecasting of future peak power demand and energy use. The effect of energy efficiency, DSM and distributed generation programs affect the forecast to the extent that the historical data used to develop the econometric model reflects the impact of the programs. As discussed in Section 8.3, the EE and DR resources that clear the RPM auction become part of the regional power supply and reduce the need for additional generation.

After including the impact of conservation programs, Subsection 8.4.2 shows 7300 MWe of additional baseload capacity is still needed by 2021, the expected year of commercial operation of the new plant at the PSEG Site. This means that conservation programs alone cannot replace the need for baseload capacity in NJ and therefore do not satisfy the purpose of the project. Accordingly, energy conservation is not a viable alternative to the construction of a merchant baseload generating facility, because it cannot reduce the use of electricity enough to eliminate the need for additional baseload capacity.

9.2.1.2 Reactivating or Extending Service Life of Existing Plants

This section discusses the alternative of reactivating plants that have been taken out of service, or of extending the service life of units scheduled for deactivation.

Retired fossil-fuel plants and those slated for retirement tend to be plants that have difficulty meeting current restrictions on air emissions or are otherwise uneconomical to operate. Accordingly, plant reactivations and/or service life extensions of fossil-fueled plants are typically not desirable or feasible due to the increasing stringency in state and federal air emissions standards as well as the higher operating and maintenance costs of older plants. In addition, the New Jersey High Electric Demand Day Rule implemented in May 2009 requires additional emissions reductions on days of peak power demand from high emitting fossil-fueled units to aid attainment of the federal 8-hour ozone standard (Reference 9.2-29). In light of increasingly rigorous environmental restrictions, delaying retirement or reactivating plants typically requires major construction to upgrade or replace plant components without increasing plant output, as is the case with PSEG's Mercer and Hudson steam plants. Both of these coal-fired power plants are undergoing significant retrofits to install pollution control technology on some units that result in an overall net decrease in capacity.

Updated 2012 information on deactivation and retirement of generation resources shows an increased number of retirements of fossil and nuclear units. As discussed in Section 8.3, almost 3,000 MWe of existing NJ generating capacity is projected to be retired by 2019. PSEG retired several fossil-fueled units in recent years and has plans to retire several more. Kearny Units 7 and 8 steam plants (150 MWe each) were retired in 2005. Kearney Units 10 and 11 (122 MWe and 128 MWe, respectively) were retired in 2012. Kearney Unit 9 (21 MWe) will be retired in 2013. Hudson Unit 3 (129 MWe) was retired due to generator damage in 2003 and Hudson Unit 1 (383 MWe) was retired in 2011. Burlington Units 101-105 (260 MWe) were retired in 2004 and the turbine-generators were sold in 2005. Bergen Unit 3 (21 MWe), Burlington Unit 8 (21 MWe), Mercer Unit 3 (115 MWe), National Park Unit 1 (21 MWe), and Sewaren Units 1 through 4 and 6 (558 MWe) are scheduled for retirement in 2015. There are no plans to return any of these

units to service. None of the recently retired or to be retired fossil-fueled units are reasonable candidates for reactivation or life extension. These retirements of fossil-fueled units are predominantly the result of age, high maintenance costs, high cost to reduce emissions, and overall inefficiency resulting in uneconomic operation. In addition to the announced retirements, the potential exists for future deactivations of coal-fired units within PJM due to the expected increase in generation costs from pending carbon legislation.

All four operating nuclear plants located in NJ have been approved by the NRC for license renewal. The 637 MWe Oyster Creek Generating Station (OCGS) however, will be decommissioned starting in 2019.

HCGS Unit 2 is not a candidate for reactivation. PSEG originally planned for a second unit at HCGS and was granted construction permits for both units in November 1974. Construction of HCGS Unit 2, which is structurally contiguous with HCGS Unit 1, was formally abandoned by PSEG in December 1981 due to financial constraints and a reduced demand for power at that time. The reactivation of the HCGS Unit 2 construction permit as an alternative to the new plant is not feasible. The containment shell and reactor vessel planned for HCGS Unit 2 were cut up for salvage as part of the rate case settlement with the New Jersey Board of Public Utilities (NJBPU) for cancellation of the unit. Additionally, HCGS Unit 2 is not a suitable location/alternative for a new nuclear unit for the following reasons:

1) Significant portions of the HCGS Unit 2 turbine building are now utilized for maintenance and administrative office space and laydown support for HCGS Unit 1.
2) The structural components of the HCGS Unit 2 Reactor Building currently provide flood and missile protection for HCGS Unit 1. Alteration of the HCGS Unit 2 Reactor Building to accommodate a new reactor could impact these protective functions, hence impacting the operation of HCGS Unit 1.
3) Constructing a new generation reactor design at the HCGS Unit 2 location is not feasible given the high likelihood that the existing HCGS Unit 2 footprint is not physically able to accommodate any of the standardized reactor designs.
4) Construction activities associated with the completion of HCGS Unit 2 would impact operation of HCGS Unit 1 due to the above described inter-reliance of structures and overall proximity of heavy construction (cranes, ultra-heavy modules, etc.) to critical HCGS Unit 1 structures systems and components.

Given the above negative impacts on the operation of HCGS Unit 1 that would result from constructing a new plant at the HCGS Unit 2 location, reactivation of the HCGS Unit 2 is not a reasonable or competitive alternative to the new plant.

In summary, there are no known plant reactivations or service life extensions identified in PJM long term planning (extending to the sixth year past commercial operating date) in NJ beyond those discussed above. Based on the current state of all active and retired plants in NJ as well as planned retirements, there are no available reactivations or service life extensions that can replace the baseload need that is provided by the new plant.

9.2.1.3 Purchasing Power from Other Utilities or Power Generators

This section discusses the alternative of purchasing power to provide the baseload capacity needed in NJ instead of constructing the new plant at the PSEG Site.

New Jersey is a net importer of power through its interties with PJM, and a net exporter of power to New York Independent System Operator (NYISO), as discussed in Chapter 8, Need for Power. For the reasons described below, the alternative of purchasing imported power to provide baseload capacity in NJ is neither feasible nor desirable.

Importing additional baseload power into New Jersey instead of generating it with new nuclear units at the PSEG Site is not a feasible option for two reasons:

- There is not expected to be any surplus baseload capacity available in PJM or NYISO near the PSEG region of interest in the 2021 time period.

- There is insufficient transfer capability in the PJM operated transmission system to provide for additional imports into New Jersey from western areas of PJM projected for the 2021 time period. Furthermore, PJM does not plan upgrades to the bulk electric system (BES) to provide for imports beyond what is required to resolve North America Electric Reliability Corporation (NERC) reliability criteria violations.

Availability of Surplus Capacity for Import

PJM is a net exporter to NYISO through the Neptune and Linden Variable Frequency Transformer (VFT) transmission interties in New Jersey and the NYIS intertie in Pennsylvania. There are no plans to construct additional capacity in NYISO beyond its load requirements. Consequently there is no expectation of being able to import power from NYISO into PJM.

The State of the Market (SOM) Report for PJM for January through September 2012 provides an estimate of the Eastern Mid-Atlantic Area Council (EMAAC) capacity available in 2018 (Reference 9.2-39). New Jersey comprises four of the six Load Deliverability Areas (LDAs) in EMAAC; the four LDAs in NJ are described in Section 8.1. The forecasted capacity in EMAAC in 2018 is 40,748 MWs, based on the existing capacity, new capacity with active interconnection requests, and retirements of any unit greater than 40 years old (excluding hydro). Adjusting non-baseload solar and wind resources to reflect the capacity values attributed to intermittent capacity resources, the forecasted EMAAC capacity in 2018 is 37,887 MW.

The 2016/2017 RPM Base Residual Auction Planning Period Parameters report shows a target capacity level of 38,786 MW to be procured for EMAAC in the May 2013 RPM auction (Reference 9.2-40). This amount is comparable to the forecasted 2018 capacity in EMAAC. Based on these forecasts and their associated accuracies, there is no expectation for excess capacity available in EMAAC in the 2016-2018 time period. The same comparison shows a deficit of capacity in the Southwestern MAAC (SWMAAC) (10,506 MW available vs. a target capacity level of 16,932 MW) and no excess capacity in MAAC (71,238 MW available vs. a target capacity level of 70,634 MW). SWMAAC and MAAC are comprised of LDAs in eastern Pennsylvania and Maryland.

The PJM SOM Report states that excess capacity is available for import into MAAC or EMAAC from the western portion of PJM, which is not adjacent to or near New Jersey. The SOM report notes "that new capacity is being added disproportionately in the west, and includes a substantial amount of wind capacity." Consequently, the only new excess capacity to import into EMAAC must come from western PJM. A large portion of these new western resources are non-dispatchable renewable resources or are natural gas fired simple and combined cycle resources which are predominantly intended for peaking or intermediate service. Almost all of the new western resources do not provide baseload power as intended by the proposed nuclear plant at the PSEG Site.

Availability of Transfer Capability for Imports

Based on transmission planning parameters established by PJM, there is insufficient transfer capability planned to accommodate importation of baseload power into NJ commensurate with the proposed new nuclear plant at the PSEG Site. Planned development of transmission enhancements beyond the Susquehanna-Roseland (SR) Power Line Project will not result in substantial importation capability into EMAAC.

In preparation for the Base Residual Auction conducted each May for the Reliability Pricing Model (RPM), PJM calculates several planning parameters to establish that the capacity to be procured in the auction will be deliverable in each LDA. Two key planning parameters are the Capacity Emergency Transfer Objective (CETO) and the Capacity Emergency Transfer Limit (CETL) (Reference 9.2-41):

- The CETO is the amount of electric energy that a given area must be able to import in order to remain within a loss of load expectation of one event in 25 years when the area is experiencing a localized capacity emergency.

- The CETL is the capability of the transmission system to support deliveries of electric energy to a given area experiencing a localized capacity emergency as determined in accordance with the PJM Manuals.

The ratio of CETL to CETO is an important determinant of the need for additional transmission capability. The CETL to CETO ratio is monitored for EMAAC, SWMAAC and MAAC in each year's RPM process. If the CETL to CETO ratio for EMAAC, SWMAAC, MAAC or any individual LDA falls below 115 percent, a Variable Resource Requirement (VRR) Curve is established, which could result in a price adder for capacity because import capability to the LDA is becoming constrained. This price adder is intended to spur development of generation in areas that are constrained. If the CETL to CETO ratio falls below 100 percent, additional transmission capability is needed.

The trend in the CETL to CETO Ratio for the past five Delivery Years for which RPM auctions have been held (Reference 9.2-42) shows that import capability into EMAAC is constrained prior to the expected completion of various transmission enhancement projects, most notably the Susquehanna Roseland (SR) Power Line Project in 2015. These identified constraints justify the need for the transmission enhancement projects. Among the several transmission enhancement projects planned by PJM, the SR project provides the predominant amount of constraint relief in EMAAC. To accommodate delays in the completion of the SR project, PJM has implemented interim operational contingencies that manage flow on constrained

transmission facilities in real time operation and adjusts generation and implements Demand Side Response (DSR) as required to maintain grid reliability. The CETL to CETO ratio for Delivery Year 2015/2016 shows that the import capability into EMAAC increases substantially following the planned completion of the SR project. However, the import capacity decreases in the following years as load increases and older fossil fueled units in New Jersey are retired.

With the cancellation of the Mid-Atlantic Power Pathway (MAPP) and the Potomac-Appalachian Transmission Highline (PATH) projects by PJM in 2012, no major projects to supply additional import capability into EMAAC are planned. By 2021, the proposed Commercial Operation Date (COD) of the new nuclear units at the PSEG Site, it is unlikely that there will be any substantial excess import capability available into EMAAC other than what is needed to resolve reliability criteria violations. This conclusion is equally applicable to import capability into NJ since NJ comprises four of the six LDAs in EMAAC.

<u>Cost and Reliability Issues in New Jersey due to Imports</u>

Currently NJ is a net importer of power which presents cost and reliability challenges to the region. Table 8.4-1 shows a shortfall of over 5,800 MWe in generating resources to meet the peak load in NJ in 2021. Consequently, a combination of development of new native generation, demand response curtailments, and, to the extent possible imports, are needed to meet the summer peak load. However, Table 8.4-2 also shows that the need for baseload capacity in NJ is 7300 MWe by the year 2021. The finding of Section 8.4 that the need for baseload capacity in NJ is greater than the need for generating resources to meet the peak load in NJ helps explain why the cost of power in NJ is high. To assure the reliability of the power grid in congested areas of NJ, transmission congestion is relieved by dispatching higher cost intermediate and peaking units in NJ because insufficient baseload capacity with lower dispatch costs is available. This is the cause for higher LMPs in NJ. In addition, the potential for more power exports to New York City and Long Island further increase the demand for in-State generating resources and/or transmission capability, as discussed in Sections 8.1 and 8.3 and depicted in Figure 8.1-3. This increased demand challenges bulk transmission facilities and potentially increases congestion, costs and reliability criteria violations in NJ.

As discussed in Section 8.3, construction of new transmission lines and upgrades to existing transmission lines is a long, costly and publicly contentious process that will be required to allow more purchase power imports. One major new backbone transmission facility has been approved by the PJM Board to resolve NERC reliability criteria violations in the MAAC sub-region. The SR 500 kV transmission line creates a strong link from generation sources in northeastern and north-central PA, across northeastern PA and into NJ. However, due to lower load growth, the installation of new gas fired intermediate and peaking power plants, and the increase in demand response programs, the PJM Board cancelled the 500 kV circuit MAPP and the 765 kV PATH projects. These projects were designed to increase the capacity to transfer power from western PJM into the EMAAC, of which NJ is a part.

Consequently, imports of baseload capacity from western PJM, to the extent it is available, cannot be increased without causing increased congestion, higher power prices, and potential reliability issues. Transmission projects in NJ also present financial and permitting challenges due to the dense commercial and residential development in congested areas. Therefore, in addition to not being feasible, increasing the reliance on imported power purchases is not aligned with one of the five overarching goals of the NJ Energy Master Plan (NJEMP), to drive down the cost of energy for all customers.

The intermediate and peaking units in NJ that are dispatched due to the lack of baseload capacity also are fossil-fueled. Even considering the congestion relief projected by the approved Susquehanna Roseland transmission project, the types of generating units that supply imported power from the western portion of PJM also are often fossil-fueled and typically coal-fired. In addition to the environmental impacts of imported fossil-fueled generation, the prospect of federal limits on power plant emissions of greenhouse gases creates uncertainty about the cost of power from these fossil-fueled sources. The uncertainty arises from the likelihood of paying emissions allowance for CO_2 and/or laws or regulations to remove or reduce CO_2 in the future. This increase in emissions cost of fossil-based generation, especially coal-fired generation, will likely lead to financially-driven deactivations of units that are currently relied on for imports. The Department of Energy's Energy Information Administration projects that 30,000 MW of coal capacity is projected to be retired by the next decade due to age and financial impacts from carbon legislation (Reference 9.2-23).

Nuclear capacity additions in the remainder of EMAAC and other areas of MAAC immediately adjacent to NJ present potentially importable baseload capacity to NJ, as discussed in Section 8.4.3. A combined license application (COLA) for the Bell Bend plant in Pennsylvania has been submitted to the U.S. Nuclear Regulatory Commission (NRC) and identifies an RSA that includes all of NJ. The scheduled commercial operation date for the Bell Bend plant, which has a proposed capacity of approximately 1600 MWe, originally was 2018 but is now under review. The only other significant baseload capacity additions anticipated in areas near NJ are 648 MWe of uprates to the Limerick and Peach Bottom plants in PECO, the Susquehanna plant in PPL, and the Three Mile Island plant in MET ED. The SR 500 kV transmission line could facilitate limited imports from Bell Bend and the Susquehanna uprates. To the extent that nuclear baseload capacity additions are exported into NJ, they may displace some of the imports from fossil-fueled resources, but they are still imports. Increasing the reliance on imported power purchases, whether fossil or nuclear fueled, is therefore not aligned with a second of the five overarching goals of the NJEMP, to promote a diverse portfolio of new, clean, in-State generation.

Summary

Given the lack of available baseload resources in the adjacent and western regions of PJM as well as a lack of planned transmission projects beyond the SR line to accommodate increased imports into EMAAC, the importation of baseload power commensurate with the levels of a new nuclear power plant is not a feasible alternative to the new plant at the PSEG Site. Importing power also is undesirable due to higher costs to consumers, environmental impacts, and potential reliability issues. It is also inconsistent with the goals of the NJEMP. Accordingly, importation of power does not warrant further consideration.

9.2.1.4 Summary

As discussed in this section, conservation (energy efficiency) programs have already been factored into the need for power analysis, and so are not viable alternatives to building the new plant. The possible options for reactivating or extending the service life of existing plants within NJ are also not viable. Purchasing power from other utilities or power generators is neither feasible nor desirable and is inconsistent with the goals of the NJEMP. Accordingly, none of

these alternatives are considered to be viable, they do not satisfy the purpose of the proposed project, and therefore they are not considered further.

9.2.2 ALTERNATIVES REQUIRING NEW GENERATING CAPACITY

This section assesses possible alternative energy sources to determine if they are competitive or noncompetitive with the proposed new plant. The following alternative energy sources are considered in this assessment:

- Wind
- Geothermal
- Hydropower
- Solar Power
    - Solar Thermal Power
    - Photovoltaic Cells
- Biomass
    - Energy Crops and Forest Residues
    - Municipal Solid Waste and Urban Wood Residues
    - Methane from Landfills and Wastewater Treatment
- Petroleum Liquids (Oil)
- Fuel Cells
- Coal
- Natural Gas
- Integrated Gasification Combined Cycle

The alternative energy sources are analyzed in the subsequent sections based on the following evaluation criteria:

- The alternative energy conversion technology is developed, proven, and available in the RSA within the life of the new plant.

- The alternative energy source provides baseload-generating capacity equivalent to the capacity needed and to the same level as the proposed nuclear plant. The new plant at the PSEG Site is proposed to serve as a baseload generator; therefore, any feasible alternative would also need to be able to generate baseload power.

- The alternative energy source does not result in environmental impacts in excess of a nuclear plant.

Alternative energy sources are considered to be competitive only if they are able to satisfy all of these criteria. Accordingly, if an alternative energy source is unable to satisfy all of the criteria it is considered to be noncompetitive and is not given further consideration as a sole alternative energy source for the proposed plant. However, it may be a competitive alternative acting in combination with other alternatives. This section addresses alternative energy sources listed above when acting as sole replacement power, while Subsection 9.2.3 addresses alternative energy sources when they act in potential combinations with other alternatives.

Each of the potential alternative technologies considered in this analysis is consistent with national policy goals for energy use and are not prohibited by federal, state, or local regulations. NUREG-1437, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*, provides a useful analysis of alternative sources. The NRC considered these reasonable alternatives pursuant to its statutory responsibility under the National Environmental Policy Act (NEPA). Although NUREG-1437 is specific to license renewal, the analysis in it can be used to determine if the alternate energy source is a competitive alternative to the proposed new plant. Additionally, because NUREG-1437 is now more than ten years old and is undergoing a revision with a corresponding revision to 10 CFR 51 (74 FR 38,117), PSEG's evaluation also considers recent evaluations of generating technologies.

During the lifetime of the proposed new plant, technology is expected to continue to improve operational and environmental performance of the alternatives assessed in this section. Any analyses of future relative competitiveness or impacts of these alternatives are subject to that uncertainty. However, as in the case of alternatives evaluated in Subsection 9.2.1, PSEG believes that sufficient knowledge is currently available to make a reasonable assessment.

As discussed in the following sections, natural gas and coal are the only alternatives that are considered to be solely competitive alternate energy sources to the new plant, and are discussed further in Subsection 9.2.3. The other alternative energy sources are noncompetitive acting alone, and are only considered potentially competitive when considered in combination with other alternate energy sources.

9.2.2.1 Wind

Due to its low capacity factor, wind is not a competitive alternative energy source because it cannot reliably supply baseload-generating capacity equivalent to the proposed new plant. Capacity factor is an indication of how much energy a plant is able to produce compared to the plant's capacity, and is therefore related to the reliability of plant equipment, how often the plant is dispatched, fuel availability, and other factors that keep the plant from operating. For thermal power plants, fuel availability does not typically impact capacity factor because fuel can be purchased, transported, and stored. By its nature, wind is a limited and intermittent resource, and cannot be purchased, transported or stored. Overall, the typical capacity factor for wind generation is 30 percent (Reference 9.2-5), which is in the range identified as an intermediate resource in Section 8.3. Accordingly, wind power, by itself, cannot generate baseload power.

It should be noted that wind cannot become competitive solely by adding more facilities in the region to compensate for the low capacity factors. The capacity factor of a thermal power facility is typically independent of other thermal power facilities; i.e., equipment reliability problems at one plant do not impact the capacity factor at another plant. However, because wind acts over a large area or region, the low capacity of wind energy plants is not independent. In other words, the cause for a low capacity factor at one facility can also result in a low capacity factor at another facility.

In general, wind areas identified as Class 4 and above are regarded as potentially economical for energy production with current technology. As a result of technological advances and the current level of financial incentive support, other areas with a slightly lower wind resource (Class 3) could be suitable for wind development. Class 3 resource sites operate at a lower annual capacity factor than Class 4 areas. The majority of the wind resources along the NJ shoreline are rated as Class 3 resources. Offshore areas are rated as Class 4 and in limited

areas, Class 5 (Reference 9.2-34). In June 2009, the first five renewable energy leases for the Outer Continental Shelf were granted to three NJ based wind developers to build meteorological testing facilities off the coast. PSEG is currently developing offshore wind energy resources in NJ and DE with one of these developers. The meteorological facilities will test the potential for producing offshore wind power on a commercial scale (Reference 9.2-16).

In terms of direct costs, larger wind farms in more favorable areas are now considered economically competitive with conventional fossil-fueled power plants in many locations (Reference 9.2-35). Even though large wind farms may be an economic alternative to traditional fossil fuel plants, there are several characteristics that make it unsuitable as a baseload resource:

- Wind generation is not considered dispatchable, meaning that the wind turbine generator cannot be controlled to match load and economic requirements. Energy from wind turbines is available as long as wind speeds are above a minimum threshold and below a maximum threshold, and hence is highly variable. If wind velocity is very high, wind turbines shut down to avoid overspeed conditions that can damage turbine equipment. Wind generation cannot provide baseload capacity without backup generation capabilities because of these characteristics.

- Wind generation is best sited where higher winds are most prevalent. These areas often are remote and valued for scenic quality:

    - Visual impacts – Critics of large-scale offshore wind farms, or wind farms located on the coastline, consider them to be an aesthetic problem. Local residents near the wind farms might lose what they consider their pristine scenic view of the area. High-speed wind turbine blades can also be noisy, although technological advancements continue to lessen this problem.

    - Interconnection of wind farms located in offshore areas requires new transmission lines to connect the wind farm to the grid. Existing transmission infrastructure might need to be upgraded to handle the additional supply. The choice of a location might be limited by land use regulations and the ability to obtain the required permits from local, regional, and national authorities. The farther a wind energy development project is from transmission lines, the higher the cost of connection to the transmission system.

- Wind farms occupy large amounts of land not only for the physical footprint of the wind turbine facilities themselves but also to allow sufficient spacing to avoid interference among turbines and to maximize capture of the available wind energy. If the turbines are too close together, one turbine can affect the efficiency of another turbine. Approximately 2025 2-MWe wind turbines operating at a typical capacity factor of 30 percent would be needed to replace the energy equivalent of a 1350 MWe nuclear unit operating at a capacity factor of 90 percent at the PSEG Site. The turbines would be distributed over an area of 243,000 acres to avoid interference between turbines, and approximately 12,150 acres would be disturbed to accommodate the physical turbine equipment and facilities. Depending upon the location, most of the adjoining land could be used for productive purposes, such as farming To replace the energy equivalent of 2200 MWe of nuclear capacity operating at a 90 percent capacity factor, approximately

3300 2-MWe wind turbines operating at a capacity factor of 30 percent would be required. These turbines would be sited on 396,000 acres (619 square miles) and disturb 19,800 acres (31 square miles) to accommodate the physical footprint of the towers themselves. As a point of comparison, the lower bound of this land area is almost 15 times the area of the city of Newark.

- Wind farms have other environmental impacts, such as bird mortality and noise. Bird mortalities per MWe average one to six per year, or less (Reference 9.2-4). Sound levels are typically 35 to 45 dBA at a distance of 350 meters (Reference 9.2-3). Additionally, offshore wind turbine foundations can present a hazard to recreational boaters.

Though wind is not suitable for baseload generation alone due to several factors, it may be possible to combine wind energy with other technologies to increase the capacity factor of wind energy to approach that of baseload resources. One potential combination is gas generation which could be dispatched when wind generation is not available to fill the gap; this is discussed further in Subsection 9.2.3.3. Another possibility is to store wind energy using pumped storage plants, in batteries or flywheel technology for use during periods of higher demand or for use in frequency regulation. Wind energy could also be combined with compressed air storage technology, which is currently under development.

Compressed air energy storage (CAES) technology stores off peak energy in the form of compressed air in an underground reservoir and releases the compressed air to a combustion turbine to produce electricity during peak hours. The compressed air from the underground storage increases the efficiency of the combustion turbine, but still requires natural gas or oil to heat already compressed air. In August 2008, PSEG Global LLC formed Energy Storage and Power LLC, a joint venture to exclusively market, license, support the development and supervise project execution of the second generation of CAES technology (Reference 9.2-24). However, there are currently no facilities in which CAES is used in conjunction with wind or other generating resources to produce baseload power, and there are no CAES projects planned on the scale of a 1350 to 2200 MWe plant. Overall, the combination of wind farms and storage technologies is in the development stage and is unproven as a baseload resource.

Using CAES in combination with a wind facility is not a feasible alternative to the new plant due to the size of the necessary wind farm as described above as well as the size of the air storage volume necessary to provide up to 2200 MWe of baseload power. The Atlantic Coastal Plain geology at the PSEG Site, and within southern NJ, is not conducive to underground storage as there are no salt domes or other underground geologic features that would allow for the large air storage volumes required to provide baseload power at the levels of the new plant. It is unlikely that the geology elsewhere in NJ can accommodate underground air storage at the volumes and capacities necessary to produce up to 2200 MWe of power for even brief periods of time.

The low capacity factor associated with wind generated power is due to the fact that wind resources are intermittent and can degrade to minimal levels for extended periods of time, ranging from several hours to days, especially during summer periods when electric demand is typically highest. The air storage capacity required to maintain 1350 to 2200 MWe of baseload power during periods of little to no wind would be substantially larger than any CAES installation planned or developed to date. It is estimated that an underground reservoir the size of a large stadium would be required to provide 900 MWe of power for 8 hours (Reference 9.2-38). Given

the low capacity factor associated with wind, 8 hours is inadequate to serve as a backup baseload resource. The reservoir necessary to accommodate 1350 to 2200 MWe for the longer period of time necessary to constitute a baseload power resource, would be proportionally larger.

Similarly, construction of above ground tanks for air storage purposes to supply 1350 to 2200 MWe of power for a period of time commensurate with a baseload resource would require significant amounts of land, far in excess of the land requirements for a new nuclear plant. Finally, the wind farm associated with a combined wind-CAES installation would need to be built in excess of the size to support 1350 to 2200 MWe of capacity. This overbuild would be necessary in order to provide the required baseload wind power concurrent with the generation of excess power that is specifically designated for air compression and storage for use during times of little to no wind. It is for these reasons that CAES installations currently in service and under development are intended primarily to provide peaking margin for renewable energy sources. The most aggressive applications planned for CAES allow only up to limited intermediate generation capacity, whereas the new nuclear plant is intended to serve as baseload generation with an expected capacity factor in excess of 90 percent. As a result, CAES in combination with wind is not feasible as a combination of alternatives and is not evaluated further.

In summary, wind power (either alone or in combination with CAES or other energy storage technology such as battery or flywheel storage) is noncompetitive because it cannot provide baseload-generating capacity equivalent to the capacity needed and to the same level as the proposed nuclear plant. Additionally, wind energy has significant visual and land use impacts, impacts avian populations and requires additional transmission facilities to connect all of the turbines to the transmission system. Consequently, wind is not addressed further.

9.2.2.2 Geothermal

Geothermal energy is a non-competitive alternative to the new nuclear plant at the PSEG Site. Geothermal technologies such as geothermal heat pumps are considered a candidate renewable energy technology at the residential or commercial level as part of ongoing energy efficiency programs (Subsection 9.2.1.1). However, based on the known geothermal regions of the United States, NJ is not a candidate for geothermal generation technologies and could not produce the proposed 1350 to 2200 MWe of baseload energy (Reference 9.2-13). Geothermal plants are best located in the western continental United States, Alaska, and Hawaii, where hydrothermal reservoirs are prevalent. Consequently, geothermal is not addressed further.

9.2.2.3 Hydropower

Hydropower is not a competitive alternative to the new nuclear plant at the PSEG Site because the feasible hydropower available for development in NJ would not provide an adequate amount of baseload generation. Additionally, hydropower has potentially negative impacts to aquatic species in the region.

Hydroelectric power is a fully commercialized technology. The percentage of U.S. generating capacity is expected to level-off due to environmental concerns and a scarcity of new large-scale sites. The growth of conventional hydropower continues to be limited and from 2007 to 2030 its share of total generation is expected to remain stagnant between 6 percent and 7 percent (Reference 9.2-9).

New Jersey was evaluated to determine the total amount of MWe that is feasible for hydropower development. The evaluation is based on a January 2006 U.S. Department of Energy (DOE) study, *Feasibility Assessment of the Water Energy Resources for the United States for New Low Power and Small Hydro classes of Hydroelectric Plants*. The study examined all sources of hydropower, including large scale hydropower development opportunities (defined as greater than 30 MWe of equivalent annual energy), but found that 99 percent of sites across the U.S. were suitable only for small or low hydropower. No large scale hydro opportunities were found in NJ. Only 64 MWe was found to be feasible for development including 44 MWe for small hydropower projects (greater than 1 MWe in size) and 20 MWe for low power technologies (less than 1 MW) (Reference 9.2-36).

Land use for a large scale hydropower facility is estimated in NUREG-1437 to be approximately 1000 acres per MWe. This is compared to permanent changes in land use of 225 ac. for the new plant per Section 4.1.

Operation of a hydroelectric facility can alter the aquatic habitats above and below the dam being used to generate power, thereby affecting existing aquatic species. Constructed dams put constraints on migrating fish species in the area. New dams are extremely challenging to permit and license, and can be expected to face significant opposition. Construction of new dams entails large land usage and displacement of local populations by flooding a new reservoir. These activities disrupt the current use of the river system for recreational activities (but do create new recreational uses). In total, hydropower is not a competitive alternative to a new plant.

Technologies are being developed to convert waves, tides and ocean thermal gradients into electric energy. These technologies have only been recently demonstrated on a small exploratory scale and are not commercially available, and thus are noncompetitive alternatives.

In summary, due to the lack of suitable sites in NJ, the amount of land required and the adverse environmental impacts, hydropower is not a competitive alternative for baseload power to the new plant at the PSEG Site.

9.2.2.4 Solar Thermal Power

Solar thermal technologies include linear concentrator (trough) systems, dish/engine systems, and power tower systems. Trough and tower systems produce electric power by using various mirror configurations to transfer solar energy into high temperature heat transfer systems. The heat transfer systems are routed through heat exchangers where the heat is used to produce steam, which is subsequently used to generate electricity via a steam turbine driven generator. Solar trough and tower technologies use many of the same technologies and equipment used by conventional power plants, simply substituting the concentrated power of the sun for the combustion of fossil fuels to provide the heat necessary to generate steam. Dish engine systems use mirrors to heat gas in an enclosed piston, which then generates electricity as the piston moves due to the internal pressure variance. Each dish engine produces about 25kW (Reference 9.2-8); an array of dish engines is interconnected to create an integrated large scale power facility.

Concentrated solar thermal power (CSP) plants are designed to be large-scale grid-connected plants, but at present they generally cannot be used as baseload generators because of low capacity factors. Solar thermal plants without energy storage capabilities do not produce heat at

night or during the times when clouds block the sun (Reference 9.2-11). The annual capacity factor of any solar thermal technology is generally limited to 25 percent (Reference 9.2-27). Some solar thermal systems use thermal energy storage (TES), setting aside heat transfer fluid in its hot phase during cloudy periods or at night. However, even if a thermal storage technique is used with a concentrating solar power system, the capacity factor has the potential to increase to only 40 percent (Reference 9.2-14). Consequently, even with thermal storage, solar thermal capacity factors are more typical of peaking or mid-merit intermediate resources as opposed to baseload resources.

Independent of the capacity factor of solar thermal power plants, however, solar thermal power is not considered to be a competitive alternative to the new plant primarily due to the limited nature of solar resources available in NJ. Solar energy is dependent on the availability and strength of sunlight in a given geographical location. Solar insolation (incoming solar radiation) is used to measure feasibility of solar resources for power production in a given geographical location. The amount of insolation received at the surface of the earth is determined by the angle of the sun, the state of the atmosphere, altitude at the given point and location. Solar insolation is expressed in kWh/m^2 per day (sun hours/day). Geographic locations with low insolation levels require larger surface area for collectors than locations with higher insolation levels (Reference 9.2-28). Figure 9.2-1 is an insolation map showing the feasibility of solar thermal technologies throughout the U.S. The southwest part of the U.S. is the most favorable region for development of solar thermal technologies due to the extensive period of intense sunlight and high solar-to-electric conversion efficiencies. Potential locations with insolation values below approximately 6.75 kWh/m^2 per day are typically eliminated as they generally have a higher cost of electricity (Reference 9.2-2). Insolation levels in the southwest U.S. are typically between 6 to 8 kWh/m^2 per day (Reference 9.2-20). The annual average solar thermal insolation for NJ is less than 4 kWh/m^2 per day for solar thermal technologies. Accordingly, CSP is not viable in NJ, and is noncompetitive and is not considered further.

9.2.2.5 Photovoltaic Cells

Solar Photovoltaic (PV) technologies convert sunlight directly into electricity by using photons from the sun’s light to excite electrons into higher states of energy. The resultant voltage differential across cells allows for a flow of electric current. Individual solar cells are small and produce a few watts of power at most and therefore are connected together in solar panels that can be arranged in arrays to increase electricity output (Reference 9.2-11).

Solar PV is not a competitive alternative to the proposed new plant because the resource is not suitable in the region for baseload power and the economics of solar PV power generation make it an impractical alternative compared to the proposed new plant. Figure 9.2-2 is an insolation map showing the feasibility of PV technology throughout the U.S. The annual average PV insolation value is 4.7 kWh/m^2/day in Atlantic City, NJ. The PV capacity factor in NJ, where the PSEG Site is located, is estimated to be 15 percent, which is significantly less than the capacity factor required for a baseload power plant (Reference 9.2-26). Similar to wind generation, the low capacity factor associated with solar PV in NJ precludes it from replacing baseload generation, making solar PV an uncompetitive alternative energy source.
Based on the annual average PV insolation value for NJ and technology efficiencies, it is estimated that 66,000 ac. of photovoltaic panels would be required to replace the energy equivalent of a 1350 MWe nuclear unit at the PSEG Site. To replace the energy equivalent of 2200 MWe of nuclear capacity, approximately 107,000 ac. of photovoltaic panels would be required.

While solar PV provides energy only in the presence of insolation, similar to wind it could be combined with energy storage technologies to transform intermittent production energy into baseload energy. For example, as discussed in Subsection 9.2.2.1, CAES can be used for load management of intermittent renewable energy resources. These energy storage technologies are either in the development or demonstration phase, or not developed to the scale of accommodating the quantity of power associated with the new nuclear plant for the durations commensurate with a baseload resource.

In summary, capacity factors for PV solar power are more typical of peaking power alternatives as compared to the required baseload capacity factor. Solar PV power requires a large area covered with photovoltaic panels to replace the energy equivalent of the new nuclear plant at the PSEG Site. This area is 300 to 500 times larger than the land requirements for the new nuclear plant. For these reasons, the solar PV alternative is not competitive with the proposed new plant at the PSEG Site as a sole energy source. Combination of solar PV with other sources is discussed further in Subsection 9.2.3.3.

9.2.2.6 Biomass

Per NUREG-1437, biomass energy includes a wide variety of sources and materials including agricultural crop residues and wastes, energy crops, forest residues, urban wood wastes, municipal solid waste, landfill gas, and refuse-derived fuel. Biomass resources are widely available throughout the U.S. Biomass energy conversion is accomplished using a variety of technologies, including:

- Direct combustion in a boiler or incinerator to produce steam
- Biomass co-firing along with fossil fuels (primarily coal) in boilers to produce steam,
- Production of synthetic liquid fuels that are subsequently combusted
- Gasification to produce gaseous fuels that are subsequently combusted
- Anaerobic digestion to produce biogas, which is typically consumed in combined heat and power plants

Although fossil and biomass-fueled facilities both release CO_2, biomass-fueled facilities using energy crops or forest industry wastes are said to be carbon-neutral since the energy crops offset the amount of CO_2 produced. This is not true for biomass facilities relying on municipal solid waste, refuse-derived fuel or landfill gas. Depending on the fuel, the combustion technology and the operating conditions, biomass energy systems impact air quality and generate solid wastes that must be properly managed.

Biomass co-firing with coal is technically feasible and is a potential near-term alternative for commercial power generation. Additionally, it would reduce emissions of criteria pollutants.[a] Wood has been the most widely used biomass fuel for electricity generation. Of the nearly 1000 operating biomass power plants, the majority involve direct biomass combustion while only a small number involve biomass co-firing with coal.

[a] EPA uses six criteria pollutants as indicators of air quality, and has established for each of them a maximum concentration above which adverse effects on human health may occur. The criteria pollutants are ozone, carbon monoxide, nitrogen dioxide, sulfur dioxide, particulate matter, and lead.

In 2005, DOE's National Renewable Energy Laboratory (NREL) conducted a review of biomass technologies and projected future performance based on anticipated technological advances through 2030. The results of the review are documented in a report entitled, *A Geographic Perspective on the Current Biomass Resource Availability in the United States*. The technologies studied included biomass-only integrated gasification combined-cycle facilities, direct burn biomass facilities, and biomass co-fired with coal facilities. Energy crops (wood) or agricultural crop residues offer the greatest potential for energy production. There are three types of municipal solid waste incinerators which are often co-fired with other fuels such as coal in modified burners. Landfill gas (methane) is another potential source of biomass energy for electric power production (Reference 9.2-1). Based on data for NJ in the 2005 NREL report, up to 240 MWe of biomass generation has the potential of being developed within NJ. However, some of the biomass sources evaluated in the 2005 report may already be developed or may have been put to alternative use, such as steam or heat production. Figure 8.3-3 shows that NJ currently has 179 MWe of biomass, municipal solid waste, municipal solid waste biogenic, and landfill gas generation.

A study completed in 2007 for the New Jersey Board of Public Utilities by Rutgers University estimated the maximum potential for biomass generation in NJ based on modifications to collection infrastructure, development of supporting governmental policies, development of biomass technologies, and cost reductions in generation technology and collection infrastructure (Reference 9.2-25). If the ideal conditions to produce the maximum potential as identified by the Rutgers study were in place, then 1124 MWe of biomass generation would be available in NJ. However, given that biomass energy production is costly and time-consuming to develop, the 240 MWe estimate developed using National Renewable Energy Laboratory (NREL) data is a more realistic representation of current potential for biomass generation in NJ. In either case, neither estimate of the potential biomass generation provides as much generation as the new plant.

9.2.2.6.1 Energy Crops and Forest Residues

The use of wood waste to generate electricity is mostly limited to those states with significant wood resources. Electric power is generated by the pulp, paper, and paperboard industries, which consume wood and wood waste for energy, benefiting from the use of waste materials that otherwise represent a disposal problem. The largest wood waste power plants are 50 to 75 MWe in size; therefore up to 45 wood waste power plants would be required to produce 2200 MWe of baseload capacity (Reference 9.2-7).

Nearly all of the wood-energy-using electricity generation facilities in the United States use steam turbine conversion technology. The technology is relatively simple to operate and it can accept a wide variety of biomass fuels. However, at the scale appropriate for biomass, the technology is expensive and inefficient. Therefore, the technology is relegated to applications where there is a readily available supply of low, zero, or negative cost delivered feedstock.

Biomass fuel from wood, energy crops or crop residues generate fewer criteria pollutants per unit of energy delivered than coal. Facilities using wood waste for fuel would be built on smaller scales. Like coal-fired plants, wood waste plants require large areas for fuel storage, processing, and waste disposal (i.e., ash). Additionally, operation of wood-fired plants has environmental impacts, including impacts on the aquatic environment and air.

Gasifying energy crops (including wood waste) is another alternative for fueling electric generators. The overall level of construction impacts from a crop-fired plant is estimated to be the same as a wood-fired plant. Crop-fired plants have similar operational impacts, including impacts on the aquatic environment and air. In addition, these systems have the potential for significant impacts on land use because of the acreage needed to grow the energy crops.

Energy crop gasification is in the early stages of technological development and is not currently mature or reliable enough to be a competitive source of baseload capacity at the scale commensurate with the new plant.

9.2.2.6.2 Municipal Solid Waste and Urban Wood Residues

There are three types of municipal solid waste (MSW) incinerators: mass burn, modular and refuse-derived fuel incinerators. Mass burn incinerators generally burn unprocessed MSW. Modular units are smaller in capacity and more selective of the type of waste utilized as fuel and often contain dual combustion chambers to ensure more complete combustion. Refuse-derived fuel incinerators utilize processed MSW which removes hazardous and recyclable constituents. While it is technically feasible to operate a biomass combustion plant on MSW or refuse derived fuel, source material may not be reliable or consistent. The decision to burn MSW to generate energy is usually driven by the need for an alternative to landfills, rather than by energy considerations.

The initial capital costs for MSW plants are greater than those of comparable steam turbine technology at wood waste facilities. This difference in cost results from the need for specialized waste collection, separation, and handling equipment required for MSW plants along with increased transportation costs. The overall level of construction impacts from an MSW-fired power generation plant would be approximately the same as that for a coal-fired plant. Additionally, MSW-fired power generation plants have the same or greater operational impacts, including impacts on the aquatic environment, air, and waste disposal. Research shows that toxic pollutants may be released from unprocessed municipal solid waste due to incomplete combustion. These environmental threats have slowed the development of MSW-fired plants.

Almost 75 percent of NJ's biomass resource is produced directly by the state's population and the majority is solid waste. Increases in the population are expected which will ultimately lead to an increased amount of solid waste available (Reference 9.2-25). Of the 240 MWe of biomass generation that has the potential for being developed in NJ, approximately 150 MWe could be produced from urban wood and secondary mill residues. All of the energy produced by MSW would be baseload generators, but collection systems would have to be developed for each facility. To minimize transportation costs, a larger number of smaller, more dispersed units would be needed resulting in increased land usage and environmental impacts.

9.2.2.6.3 Methane from Landfills and Wastewater Treatment

Landfill gas is another potential source of biomass energy for electric power production. Per NUREG-1437, landfills in which organic materials are disposed represent the largest source of methane in the United States. Landfill gas composition varies depending on the type of waste. Collecting landfill gas is a relatively straightforward process that involves placing recovery wells and simple gas collection systems. Methane emissions from landfills depend on three key factors: (1) total waste in place; (2) landfill size; and (3) location in an arid or non-arid climate. Data on the landfill locations and the waste in place was obtained from EPA's Landfill Methane

Outreach Program (LMOP), 2003 database. A large landfill is one containing more than 1.1 million tons of waste in place. Landfills in non-arid climates are believed to produce more methane than those in arid climates (Reference 9.2-1). NUREG-1437 states that, of the approximately 2300 operating or recently closed landfills in the U.S., 427 landfills are currently equipped with gas collection systems. In 2006, landfills produced enough gas to generate 10 million MWh of electricity. An additional 560 landfills could be adapted to landfill gas-to-energy production. Landfill gas is produced continuously; thus landfill gas-to-energy plants can have capacity factors greater than 90 percent and can be relied upon as a source of replacement power. Landfill gas and wastewater treatment generation is located near each of these methane capture facilities and each one is generally less than 10 MW, as shown in Appendix 8A.

New Jersey, located along the Atlantic coast, is considered to be a non-arid climate and therefore has the ability to produce an increased supply of methane. Of the 240 MWe of biomass generation that has the potential for being developed in NJ, approximately 70 MWe of generation could be obtained from landfill gas and methane from wastewater treatment facilities. As shown in Appendix 8A, a portion of this 70 MWe of unutilized generation from landfill gas is under development in NJ. Landfill gas and wastewater treatment methane generation facilities would be small in capacity and widely dispersed in the region. The amount of methane-based generation available from sources within NJ is substantially smaller than the proposed 1350 to 2200 MWe of baseload energy output of the new nuclear plant and is not a viable alternative to the new plant.

9.2.2.6.4 Summary

Overall, biomass generation alone is not a competitive alternative to development of the new nuclear plant at the PSEG Site because of the minimal amount of biomass energy that is feasible for development. However, biomass generation is technically viable and could be considered in combination with other generation resources. This is discussed further in Subsection 9.2.3.3.

9.2.2.7 Petroleum Liquids (Oil)

Oil-fired generation is not a competitive option with the new plant at the PSEG Site due to its environmental impacts and the increasingly high cost of petroleum-based fuels.

New Jersey has several petroleum-fired units producing nine percent of the state’s electricity (Figure 8.3-2). While capital costs for new petroleum-fired plants are similar to the cost of a new gas-fired plant, petroleum-fired operation is more expensive due to the high cost of petroleum. Future increases in petroleum prices are expected to make petroleum-fired generation increasingly more expensive relative to other alternatives.

The high cost of petroleum has prompted a steady decline in its use for electricity generation in recent decades and no new oil-fired units have been constructed in the U.S. since 1981 (Reference 9.2-30). Due to the constant fluctuations and the steady rise in oil prices experienced over the years, oil-fueled power (including units fired by distillate fuel oil, residential fuel oil, petroleum coke, jet fuel, kerosene, other petroleum and waste oil) continues to experience a decline.

Oil-fired steam plants produce more greenhouse gases than almost all electric generating systems, and have one of the largest carbon footprints of the electricity-generating systems

analyzed. The average emissions rates in the U.S. from oil-fired generation are: 1672 lbs/MWh of CO_2, 12 lbs/MWh of sulfur dioxide (SO_2) and 4 lbs/MWh of nitrogen oxides (NOx). In addition, oil wells and oil collection equipment are a source of methane emissions, a potent greenhouse gas. Large engines used in the oil drilling, production, and transportation process burn natural gas or diesel that also produce emissions (Reference 9.2-31). The emissions from an oil-fired power plant are approximately 130 times higher than the carbon footprint of a nuclear power generation facility (Reference 9.2-22). Technological developments such as carbon capture and storage (CCS) and co-firing with biomass, have the potential to reduce the carbon footprint of oil-fired electricity generation. Ongoing small scale trials of CCS are currently underway in Norway, Algeria, Australia and the United States. However, utility-scale CCS technology has yet to be demonstrated, is currently extremely costly, and the impacts associated with large scale CO_2 storage pose significant permitting challenges (Reference 9.2-6).

Overall, an oil-fired power generation plant is a noncompetitive alternative to the new plant at the PSEG Site because of the unfavorable economics and environmental impacts associated with oil-fired generation, therefore, this alternative is not considered further.

9.2.2.8 Fuel Cells

Based on technical immaturity, high costs, and limited generation potential, fuel cell technology is not a competitive alternative for the proposed new plant. Fuel cells have not been developed to the point where they are technologically mature. Phosphoric acid fuel cells are the most mature fuel cell technology, but they are only in the initial stages of commercialization. Fuel cells are not cost effective when compared with other generation technologies, both renewable and fossil-based. DOE has launched an initiative, the Solid State Energy Conversion Alliance (SECA), to significantly reduce fuel cell cost. The DOE’s goal is to cut costs to as low as $400 per kW of installed capacity over the next few years, which would make fuel cells competitive for virtually every type of power application (Reference 9.2-37). However, the projected size of natural gas fuel cell plants (expected to be in the 50 to 100 MWe range as market acceptance and manufacturing capacity increase) is insufficient to meet the baseload demand that would be provided by the new plant. Accordingly, fuel cells are not considered further.

9.2.2.9 Coal

Coal is an affordable technology for reliable, near-term development. Coal can currently produce more energy than most forms of clean or renewable energy and is a competitive alternative to the new nuclear plant at the PSEG Site.

Coal plants currently generate 48.5 percent of the electric power in the U.S. (Reference 9.2-15). Coal generation currently accounts for 15 percent of the total generation in NJ (Figure 8.3-2). Conventional coal-fired plants generally include two or more generating units and have total capacities of 100 MWe to more than 2000 MWe. Although coal has been a reliable energy source for decades, the substitution of renewable energy and other alternatives having lower emissions and environmental impacts has caused a decrease in coal-fired power production in the U.S.

The Energy Information Administration (EIA) Annual Energy Outlook 2009 forecasts the growth of coal-fired power production to continue at a reduced rate. The average annual growth for coal-fired generation from 1980 to 2007 was 0.9 percent and is expected to shrink to 0.6 percent from 2007 to 2030. In 2008, U.S. coal consumption declined by every coal-consuming

sector and U.S. exports of coal were significantly higher (Reference 9.2-10). Electricity produced by coal-fired plants in NJ between 2008 and 2009 decreased by over 44 percent (Reference 9.2-12).

The environmental impacts of constructing a typical coal-fired steam plant are well known because coal is the most prevalent type of power generating technology in the United States. The impacts of constructing a 1000 MWe coal plant on a location that has not previously been developed for any use (i.e., a greenfield site) can be substantial, particularly if it is sited in a rural area with considerable natural habitat. Per NUREG-1437, Supplement 35, an estimated 1700 acres would be needed, and this could amount to the loss of about three square miles of natural habitat and/or agricultural land for the coal-fired plant site alone, excluding land required for mining and other fuel cycle impacts.

The United States has abundant low-cost coal reserves, and the price of coal for electricity generation is likely to increase at a relatively slow rate. Pulverized coal-fired plants are likely to continue to be a reliable energy source well into the future, assuming environmental constraints do not cause the gradual substitution of other fuels. Even with recent environmental legislation, new coal capacity is expected to be an affordable technology for reliable, near term development.

In summary, based on the well-known technology, fuel availability and generally understood environmental impacts associated with constructing and operating a coal-fired power generation plant, new coal capacity is considered a potential replacement for nuclear power and is therefore further discussed in Subsection 9.2.3.

9.2.2.10 Natural Gas

Based on well-known technology, fuel availability, and known environmental impacts associated with constructing and operating a natural gas-fired power generation plant, this source of energy is considered a competitive alternative to development of the new nuclear plant at the PSEG Site.

Due to economic, environmental and technological changes over the past three decades, natural gas has become a preferred option for new power generation. In 2009 approximately 23,000 MWe of new generation capacity was planned in the U.S. and over 50 percent of the new generation was projected to be natural gas-fired additions (Reference 9.2-17). While environmental impacts of constructing natural gas-fired power generating plants are similar to those of other large power generating stations; natural gas is considered the cleanest of the fossil fuels (Reference 9.2-18). Siting at a greenfield location requires new transmission lines and increased land-related impacts; whereas, co-locating the gas-fired plant with an existing plant reduces land-related impacts. Also, gas-fired plants, particularly combined cycle and gas turbine, take significantly less time to construct than other baseload plants.

Natural gas-fired generation currently exists in NJ. Figure 8.3-1 shows that 73 percent of the current generating resources in NJ are fossil-fueled. Of these, Figure 8.3-2 shows that 73 percent are fueled by natural gas or dual fueled with natural gas as a primary fuel.

Based on the well-known technology, fuel availability, and generally understood environmental impacts associated with construction and operating a natural gas-fired power generation plant,

natural gas is considered a competitive alternative and is therefore examined further in Subsection 9.2.3.

9.2.2.11 Integrated Gasification Combined Cycle (IGCC)

Integrated Gasification Combined Cycle (IGCC) power generation has not been demonstrated to achieve an acceptable level of reliability and cost competitiveness to be a competitive alternative to the construction of the new nuclear plant at the PSEG Site.

IGCC, also known as clean coal, is an emerging, advanced technology for generating electricity with coal that combines modern coal gasification technology with both gas turbine and steam turbine power generation. The technology is substantially cleaner than conventional pulverized coal plants because major pollutants can be removed from the gas stream before combustion.

The IGCC alternative generates substantially less solid waste than the pulverized coal-fired alternative. The largest solid waste stream produced by IGCC installations is slag, which is a black, glassy, sand-like material that is a potentially marketable byproduct. Slag production is a function of ash content. The other large-volume byproduct produced by IGCC plants is sulfur, which is extracted during the gasification process and can be marketed rather than placed in a landfill. IGCC units do not produce ash or scrubber wastes.

IGCC technology still has insufficient operating experience for widespread expansion into commercial-scale utility applications. Each major component of IGCC has been broadly used in industrial and power generation applications. However, the integration of coal gasification with a combined cycle power block to produce commercial electricity as a primary output is relatively new and has been demonstrated at only a handful of facilities around the world, including five in the United States.

Because IGCC technology has not been demonstrated to achieve an acceptable level of reliability and cost competitiveness, an IGCC facility is not a competitive alternative to the construction of the new nuclear plant at the PSEG Site.

9.2.3 ASSESSMENT OF COMPETITIVE ALTERNATIVE ENERGY SOURCES AND SYSTEMS

This section assesses energy sources that are competitive alternatives to the new plant at the PSEG Site. The alternative energy sources assessed include coal and natural gas, which are the only competitive alternative energy sources that could solely produce a baseload of up to 2200 MWe. Additionally, this section assesses combinations of alternative energy sources that include sources that are noncompetitive when acting alone (such as wind, solar PV, and biomass).

The alternatives are evaluated by comparing the environmental impact of the new plant to the environmental impacts of the competitive alternative energy sources and potential combinations of energy sources. The evaluations of the environmental impacts for coal-fired and natural gas generation are organized as follows:

- Land use and visual resources
- Air Quality and Noise
- Waste Management and Pollution Prevention

- Other impacts

Other impacts that are considered include Water Use and Quality, Ecology, Historic and Cultural Resources, Socioeconomics, Human Health, and Environmental Justice. The evaluation of combinations of alternative energy sources subsequently builds on the coal-fired and natural gas generation evaluations.

PSEG has characterized the significance of the impacts associated with each category as SMALL, MODERATE, or LARGE. This characterization is consistent with the criteria established in 10 CFR 51, Subpart A, Appendix B, Table B-1, footnote 3:

> SMALL–Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource.
>
> MODERATE–Environmental effects are sufficient to alter noticeably, but not to destabilize, any important attribute of the resource.
>
> LARGE–Environmental effects are clearly noticeable and are sufficient to destabilize any important attributes of the resource.

Table 9.2-1 summarizes the characterizations associated with various impact categories. The environmental impacts of alternatives provided in this table and the discussion in the following sections is based upon NUREG-1437 and other references noted in the text and tables.

As shown in Table 9.2-1, and discussed in the following sections, none of the alternatives are environmentally preferable to the new nuclear plant. Accordingly, an economic analysis is not necessary.

9.2.3.1 Coal-Fired Generation

The following subsections discuss the significant environmental impacts associated with the coal-fired generation alternative.

9.2.3.1.1 Land Use and Visual Resources

Per NUREG-1437, coal-fired generation would require approximately 1700 ac. for a 1000 MWe plant and up to twice as much land would be required for a 2200 MWe new coal-fired plant. Construction of the power block and coal storage area would disturb land and associated terrestrial habitat. Additional land would also need to be developed for waste management. As a result, land use impacts would be MODERATE during construction and operation.

The PSEG Site is aesthetically altered by the presence of the existing HCGS and SGS units and structures. The coal-fired power plant buildings would be up to 200 ft. tall, and the stacks would be up to 600 ft. tall. These are similar to the size of the existing structures associated with the SGS and HCGS units; therefore, the aesthetic impact of a new coal-fired plant would be SMALL during operation. Visual impact of construction activities would be similar to that of the new plant, as discussed in Chapter 4. Therefore, visual impacts of construction and operations would be SMALL.

9.2.3.1.2 Air Quality and Noise

The air quality impacts of coal-fired generation are considerably different than those of nuclear power. A coal-fired plant emits sulfur dioxide (SO_2, as SOx surrogate), oxides of nitrogen (NOx), particulate matter (PM), and carbon monoxide (CO), all of which are regulated pollutants. Air quality impacts from fugitive dust, water quality impacts from acidic runoff, and aesthetic and cultural resources impacts are all potential adverse consequences of coal mining. Air emissions were estimated for a coal-fired generation facility based on the emission factors contained in NUREG-1437 Table 4.3.2.1-2. The emissions from this facility are based on a net power generation capacity of 2200 MWe. The coal-fired generation facility assumes the use of bituminous coal, fired in a supercritical pulverized coal boiler. The sulfur content of the coal is assumed to be 2.5 percent by weight. Emissions controls include a wet scrubber system to control acid gas emissions, selective catalytic reduction (SCR) to minimize NOx emissions, and a bag house to control PM emissions. Table 9.2-2 summarizes the air emissions produced by a 2200 MWe coal-fired facility.

Operating impacts of a new coal plant include concerns related to adverse human health effects. Air quality is impacted by the release of CO_2, regulated pollutants, and radionuclides. Carbon dioxide has been identified as a leading cause of climate change and is facing federal regulation within the Clean Air Act, and SO_2 and NOx emissions have been identified as contributing causes of acid rain.

Coal burning power systems have the largest carbon footprint of all the electricity generation systems analyzed. Conventional coal systems result in emissions of greater than 1000 gCO_2eq/kWh, which is 200 times the size of the carbon footprint of a nuclear power generation facility (approximately 5 gCO_2eq/kWh). Lower emissions (less than 800 gCO_2eq/kWh) can be achieved using new gasification plants, but this is still an emerging technology and not as widespread as proven combustion technologies. Future developments in CCS and co-firing with biomass have the potential to reduce the carbon footprint of coal-fired electricity generation (Reference 9.2-22). The NRC indicates that air emission impacts from fossil-fueled generation are greater than nuclear power generating facility air emission impacts. The NRC notes that human health effects from coal combustion are also greater based on the health effects from air emissions. Based on the emissions generated by a coal-fired facility, air impacts would be MODERATE.

Noise impacts during construction and operation of a coal-fired plant would be similar to that of the new nuclear plant; and therefore, the impact would be SMALL.

9.2.3.1.3 Waste Management and Pollution Prevention

Substantial solid waste, especially coal combustion wastes (CCWs) such as scrubber sludge bottom ash and fly ash, are produced during plant operation and require constant management. Per NUREG-1437, approximately 360 ac. would be required for waste disposal over a 40-year period for a coal-fired facility at the PSEG Site.

EPA has determined that CCWs do not warrant regulation as a hazardous waste under Subtitle C of the Resource Conservation and Recovery Act (RCRA). However, EPA has determined that CCWs disposed of in landfills and surface impoundments should be regulated under Subtitle D of RCRA (i.e., the solid waste regulations) and that CCWs used to fill surface or underground mines should be regulated under authority of Subtitle D of RCRA, the Surface Mining Control

and Reclamation Act (SMCRA), or a combination of these authorities (Reference 9.2-32). This determination could cause owners of surface impoundments holding CCWs to undertake costly modifications or change to dry ash handling methods.

With proper placement of the facility, coupled with current waste management and monitoring practices, waste disposal would not destabilize any resources. As a result of the above mentioned factors, waste management impacts would be MODERATE. Impacts from construction wastes, such as debris from land clearing and solid wastes would be SMALL.

9.2.3.1.4 Other Impacts

Current regulations require control of discharges and land activities such that impacts to aquatic resources and surface water quality are minimized; the impact generally is SMALL. Losses to aquatic biota occur through impingement and entrainment and discharge of cooling water to natural water bodies.

Impacts from construction activities to surficial groundwater would be localized and SMALL. The groundwater would be expected to recover during operations mode; therefore, impact to groundwater would be SMALL. Although coal pile runoff could affect surface water quality, impacts to water resources and quality would be SMALL due to the coal power generating facility's use of a new cooling water system with cooling towers.

The proposed coal-fired plant would use previously disturbed areas near the HCGS and SGS units. As discussed in Section 4.3, best management practices (BMPs) would be used to minimize wetlands impacts, and wetland construction on PSEG-owned or other property would mitigate loss of wetland habitat. Wetland habitat loss during construction would be small in comparative acreage to the region but may be locally significant. Impacts from construction activity to other terrestrial habitats and the aquatic ecosystem would be limited and temporary; therefore, impacts during construction would be SMALL. Recovery of some species during operations is anticipated, and impacts would be SMALL. Impact to wetlands and wetland buffer would require mitigation and therefore, wetland impacts would be MODERATE.

As previously described, as a result of increased air emissions and public health risks associated with those emissions, such as cancer and emphysema, human health impacts during operation of a coal-fired generating plant would be MODERATE. Impacts during construction would be SMALL due to BMPs to curb fugitive dust emissions. As a result of improved safety practices, accident impacts would be SMALL. Mining safety is not considered within this impact category.

Environmental justice impacts during construction of a coal-fired plant would be similar to that of the new nuclear plant as discussed in Subsection 4.4.3, based on the distribution of environmental justice populations around the PSEG Site and the other characteristics of the site area, construction impacts are expected to be SMALL. Operation of a coal-fired plant would require transportation of large quantities of coal to the site and disposal of large quantities of CCWs. It is assumed that coal would be delivered to the site by barge and CCWs would be disposed of in undeveloped land near the site. As environmental justice populations are not located near the site, operation impacts would be SMALL.

The historic and cultural resource impact of the development of the PSEG Site for a coal-fired plant would be SMALL because the on-site soils consist of fill materials and the site is already altered by the presence of the existing HCGS and SGS units and structures.

Regarding socioeconomic impacts, it should be noted that there would be beneficial impacts related to construction, operations, and mining employment. A coal-fired plant would provide socioeconomic benefits from several hundred mining and construction and operation jobs as well as additional tax revenues associated with coal mining and plant operations.

9.2.3.1.5 Summary

Table 9.2-1 shows the environmental impacts associated with the coal-fired alternative as discussed above as well as the impacts of the new plant as discussed in Chapters 4 and 5. By comparison, it can be seen that a coal-fired generating facility is not environmentally preferable to the new nuclear plant at the PSEG Site.

9.2.3.2 Natural Gas Generation

The following sections discuss the significant environmental impacts associated with the gas-fired generation alternative.

9.2.3.2.1 Land Use and Visual Resources

Per NUREG-1437, gas-fired generation would require approximately 110 ac. for a 1000 MWe plant; up to twice as much land would be required for a 2200 MWe gas-fired plant. Additional land would be required for a gas pipeline that would be needed to connect to an existing line and for the gas well field, but this would have a minor impact on land use. As a result, land use impacts would be SMALL during construction and operation of this type of facility.

The PSEG Site is aesthetically altered by the presence of the existing HCGS and SGS units and structures, and the gas-fired plant structures would be smaller than the existing structures. Per NUREG-1437, gas-fired units would be approximately 100 ft. tall and the exhaust stacks would be at least 174 ft. tall, as compared to the existing HCGS cooling tower (in excess of 500 ft. tall) and the SGS and HCGS containments (approximately 250 ft. tall). A new turbine building and exhaust stacks would need to be constructed. Visual impacts would be SMALL.

9.2.3.2.2 Air Quality and Noise

Natural gas is a relatively clean-burning fossil fuel. Also, because the heat recovery steam generator in a combined cycle configuration typically does not receive supplemental fuel, the combined cycle operation is highly efficient (56 percent versus 33 percent for the coal-fired alternative). Therefore, the gas-fired alternative would release similar types of emissions, but in lesser quantities than the coal-fired alternative. Control technology for gas-fired turbines typically focuses on the reduction of NO_x emissions.

Generally, air quality impacts for all natural gas technologies are less than for other fossil fuel technologies because fewer pollutants are emitted and SO_2, a contributor to acid precipitation, is emitted in negligible quantities compared to coal-fired generation. Air emissions were estimated for a gas-fired generation facility based on the emission factors contained in NUREG-1437 Table 4.3.2.1-2. The emissions from this facility are based on a net power generation

capacity of 2200 MWe using combined cycle technology. Emissions controls include SCR to minimize NOx emissions. Table 9.2-2 summarizes the air emissions produced by a 2200 MWe natural gas-fired facility.

Current gas-powered electricity generation has a carbon footprint that is approximately 100 times higher than the carbon footprint of a nuclear power generation facility (approximately 5 gCO_2eq/kWh) (Reference 9.2-22). Like coal-fired plants, gas plants could co-fire biomass to reduce carbon emissions in the future.

Based on the emissions generated by a natural gas-fired power generation facility, air quality impacts would be MODERATE.

Noise impacts during construction and operation of a gas-fired plant would be similar to that of the new nuclear plant; therefore, the impact would be SMALL.

9.2.3.2.3 Waste Management and Pollution Prevention

Construction wastes (land clearing and solid wastes) would be minimal and would be subject to regulatory control. Therefore, the impact of construction waste management would be SMALL.

Gas-fired generation would result in very little solid waste generation, producing minor impacts. Spent SCR catalyst would be shipped off-site for disposal. As a result, waste management impacts would be SMALL.

9.2.3.2.4 Other Impacts

Water consumption is relatively low for combined cycle power generating facilities. Water quality impacts and potential impacts to aquatic biota through impingement and entrainment and increased water temperatures in receiving water bodies would be minimized; the overall impact would be SMALL. Impacts from construction activities to surficial groundwater would be localized and SMALL. The groundwater would be expected to recover during operation; therefore, impacts to groundwater would be SMALL.

The proposed gas-fired plant would use previously disturbed areas near the HCGS and SGS units. As discussed in Section 4.3, BMPs would be used to minimize wetlands impacts, and wetland construction on PSEG-owned or other property would mitigate loss of wetland habitat. Wetland habitat loss during construction would be small in comparative acreage to the region but may be locally significant. Impacts from construction activity to other terrestrial habitats and the aquatic ecosystem would be limited and temporary; therefore, impacts during construction would be SMALL. Recovery of some species during operations is anticipated, and impacts would be SMALL. Impact to wetlands and wetland buffer would require mitigation; therefore, wetland impacts would be MODERATE.

As previously mentioned, because of increased air emissions and associated public health risks, human health impacts during operation would be MODERATE. Impacts during construction would be SMALL due to BMPs to curb fugitive dust emissions. As a result of improved safety practices, accident impacts would be SMALL.

Environmental justice impacts during construction and operation of a gas-fired plant would be similar to that of the new nuclear plant; therefore, the impact would be SMALL.

The historic and cultural resource impact of the development of the PSEG Site for a gas-fired plant would be SMALL because the on-site soils consist of fill materials and the site is already altered by the presence of the existing HCGS and SGS units and structures.

Regarding socioeconomic impacts, there would be beneficial impacts related to construction and operations employment. A gas-fired plant would provide socioeconomic benefits from several hundred construction and operation jobs as well as additional tax revenues associated with plant operations.

9.2.3.2.5 Summary

Table 9.2-1 shows the environmental impacts associated with the gas-fired alternative as discussed above as well as the impacts of the proposed new plant as discussed in Subsection 9.2.3.1. By comparison, the gas-fired generating facility is not environmentally preferable to the new nuclear plant at the PSEG Site.

9.2.3.3 Combination of Alternatives

The new plant will operate as an independent merchant baseload power producer. The ability to generate baseload power in a consistent, predictable manner meets the business objectives for the new plant. Therefore, when examining combinations of alternatives, the ability to consistently generate baseload power must be a determining factor when analyzing the suitability of the combination. Based on the discussions in Subsection 9.2.2, the energy sources considered in combination with other sources are wind, solar PV, biomass, coal-fired generation, and natural gas generation. Subsection 9.2.2.1 addresses technologies that can be combined to increase the capacity factor of an intermittent resource, such as wind energy, to approach that of baseload generation. Energy storage technologies such as compressed air, which in combination with wind and PV energy might be able to provide the same baseload power levels of the new nuclear plant, are in the development stage and are unproven as a baseload resource. Therefore storage technologies are not included in the combination alternative.

As discussed in Subsections 9.2.2.1 and 9.2.2.4, wind and solar PV technologies are not sufficient on their own to generate the equivalent baseload capacity of the new plant because of the intermittent nature of the resources. This variability creates low capacity factors that are not suitable for baseload generation and that cannot be addressed by increasing the scale of the facility. Combining solar or PV generation with energy storage technologies such as CAES is not feasible due to the limitations of these technologies to provide baseload generation at the levels of the new nuclear plant. Accordingly, combinations that include an intermittent renewable power source (for either all or part of the capacity of the new plant) must be combined with a fossil-fueled facility equivalent to the generating capacity of the new nuclear plant. This combination allows the fossil-fueled portion of the combination alternative to produce the full amount of power needed if the renewable resource is unavailable. For example, if the renewable portion is provided by some amount of wind generation and that resource became unavailable, then the output of the fossil fueled generation portion of the combination alternative could be increased to offset the lost generation from the renewable portion. This facility, or facilities, would satisfy business objectives of the new plant in that it would be capable of providing the requisite baseload power regardless of the availability of the renewable power source.

As discussed in Subsections 9.2.3.1 and 9.2.3.2, and as shown in Table 9.2-1, coal and natural gas power generating facilities have been determined to have environmental impacts that are equivalent to or greater than the impacts of the new nuclear plant. Since a coal or natural gas power generation facility would be designed to deliver the full 2200 MWe during periods when any or all of the generation from the wind or solar sources is unavailable, the environmental impact of this combination would be equivalent to or greater than the coal or natural gas power generation alone and greater than the impact of a new nuclear plant. In addition, it should be noted that the environmental impacts would be even greater when considering the additional impacts that wind and solar PV facilities would have on the environment primarily due to the large additional land usage required by the solar PV or wind facility. Therefore, the combination of wind and solar PV with coal-fired or natural gas generation is not environmentally preferable to the new nuclear plant at the PSEG Site, and no additional analysis is required.

Biomass may be combined with coal-fired or natural gas generation to represent a potentially viable mix of non-nuclear alternative energy at the PSEG Site. Co-firing biomass alongside fossil fuels in existing power plants can increase efficiency and reduce carbon emissions. However, biomass fuels are much lower in energy than traditional fossil fuels and large quantities must be grown and harvested to produce enough feedstock for a generating station, thus effectively increasing the amount of land used for power generation. Biomass fuels are also more expensive than coal although purchasing renewable energy credits can make this an economical alternative (Reference 9.2-19).

The combination of biomass and coal-fired or natural gas generation would have a greater environmental impact than the new nuclear plant due to emissions as well as large land area required for the biomass planting and harvesting, for collection of urban wastes, and for the large number of biomass generation facilities needed due to the disperse locations of biomass resources. In addition, the combination of biomass generation and coal-fired or natural gas generation has higher air emissions and associated health impacts. Therefore, this combination would have equivalent or greater environmental impacts than a nuclear power generating facility at the PSEG Site. Accordingly, biomass in combination with other technologies is not an environmentally preferable option.

In summary, none of the potential combinations of energy sources (wind, solar PV, biomass, coal-fired generation, and natural gas generation) are environmentally preferable to the proposed new plant to provide baseload generation.

9.2.3.4 Conclusion

Overall, the new nuclear plant is environmentally preferable to an alternative power generating facility fueled by coal, natural gas, or a combination of alternatives including biomass, wind and/or PV solar power together with coal or gas-fired generating facilities. Furthermore, each of these types of alternatives has a significantly greater environmental impact on air quality than a new nuclear power generating facility. To achieve a SMALL air quality impact in the combination alternative by using larger amounts of wind or solar PV generation, a MODERATE to LARGE impact on land use results. Therefore, neither a power generating facility fueled by coal, nor one fueled by natural gas, nor a combination of coal-fired or natural gas generation with biomass, wind and/or solar PV alternatives, is environmentally preferable to the new nuclear plant at the PSEG Site to provide baseload generation.

None of the alternatives is considered to be environmentally preferable to the proposed action. Therefore, as allowed in NUREG-1555, additional cost data (e.g. decommissioning costs, and fuel cost estimates) are not provided for alternatives that are not deemed to be environmentally preferable to the proposed action.

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Table 9.2-1
Comparison of Environmental Impacts of Construction and Operation

Impact Category	Proposed New Plant at PSEG Site	Coal-Fired Generation	Gas-Fired Generation	Combination (wind, biomass and solar PV with natural gas)
Land Use and Visual Resources	SMALL	SMALL TO MODERATE	SMALL	SMALL TO LARGE
Air Quality & Noise	SMALL	SMALL TO MODERATE	SMALL TO MODERATE	SMALL TO MODERATE
Water Use and Quality	SMALL	SMALL	SMALL	SMALL
Ecology	SMALL TO MODERATE	SMALL TO MODERATE	SMALL TO MODERATE	SMALL TO MODERATE
Historic and Cultural Resources	SMALL	SMALL	SMALL	SMALL
Socioeconomics	SMALL	SMALL	SMALL	SMALL
Human Health	SMALL	SMALL TO MODERATE	SMALL TO MODERATE	SMALL TO MODERATE
Environmental Justice	SMALL	SMALL	SMALL	SMALL
Waste Management and Pollution Prevention	SMALL	SMALL TO MODERATE	SMALL	SMALL

Table 9.2-2
Air Emissions from Alternative Power Generation Facilities

	PC Supercritical	
CO_2 capture	No	Yes
Net Power Output (MWe)	2,200	2,200
CO_2 emissions (Tons/yr)	15,375,434	2,202,765
SO_2 emissions (Tons/yr)	6410	Negligible
NOx emissions (Tons/yr)	5293	7611
PM emissions (Tons/yr)	982	1412
Hg emissions (Tons/yr)	0.085	0.124
	NGCC Advanced F Class	
CO_2 capture	No	Yes
Net Power Output (MWe)	2,200	2,200
CO_2 emissions (Tons/yr)	6,907,756	803,260
SO_2 emissions (Tons/yr)	63	Negligible
NOx emissions (Tons/yr)	528	614
PM emissions (Tons/yr)	662	662
Hg emissions (Tons/yr)	Negligible	Negligible

9.3 ALTERNATIVE SITES

As required by 10 CFR 52.17(a)(2), this section provides an evaluation of alternatives to the proposed PSEG Site for construction and operation of the new plant. The National Environmental Policy Act mandates the evaluation of reasonable alternatives to a proposed action. This section summarizes the process used to select the PSEG Site as the proposed location for the new plant and evaluates whether any alternative site is “environmentally preferable” to the PSEG Site, and if so, whether it is “obviously superior” for the eventual construction and operation of the new plant.

9.3.1 SITE SELECTION PROCESS

PSEG conducted a comprehensive site selection study in 2008 and 2009. The objective of this study was to select a Proposed Site for the new plant using a systematic process that considered relevant factors related to nuclear licensing, environmental acceptability, and engineering / cost issues. The process used in the study complied with the process outlined in NUREG-1555, including 10 CFR 100 criteria. It generally followed the site selection procedures described in an Electric Power Research Institute report on site selection for Early Site Permit Applications (Reference 9.3-2). The process also was generally consistent with other nuclear power plant siting studies as reported in licensing submittals to the NRC.

The basic parameters of the site selection study were determined based on regulatory guidance, benchmarking, and previous nuclear power plant experience. These basic parameters included the following:

- Site acreage and make-up water requirements should bound the requirements of the four reactor designs being considered by PSEG. The designs being considered are:
  - U.S. Evolutionary Power Reactor (U.S. EPR)
  - Advanced Boiling Water Reactor (ABWR)
  - U.S. Advanced Pressurized Water Reactor (US-APWR)
  - Advanced Passive 1000 (AP1000)
- Sites should be able to support one large unit (e.g., U.S. EPR) or two smaller units (i.e., AP1000) of the designs being considered.
- The potential to expand sites with additional units in the future should not be considered.
- The new plant has a maximum generating capacity of 2200 megawatts (MWe) (the nominal capacity of two AP1000 units).
- The new plant must interconnect with a transmission line or substation with a voltage of 500 kilovolts (kV) (the maximum voltage currently available in NJ, and the voltage considered necessary to provide maximum margin against thermal overloads).
- The minimum make-up water requirement for the new plant is 35,000 gpm (conservative estimate of cooling tower and essential service water make-up for one U.S. EPR unit).

The site selection study included the following major tasks, as defined in NUREG-1555:

- **Establish the Region of Interest (ROI).** The ROI is the area to be considered in searching for potential power plant sites.
- **Identify Candidate Areas.** Candidate Areas are areas within the ROI that remain after unsuitable areas are eliminated.
- **Identify Potential Sites.** Potential Sites are specific locations within the Candidate Areas that are identified for preliminary assessment in establishing Candidate Sites.
- **Identify Candidate Sites.** Candidate Sites are those Potential Sites that are considered to be among the best sites that can reasonably be found for the siting of a nuclear power plant.
- **Evaluate Candidate Sites.** The Candidate Sites were evaluated numerically and ranked according to their overall favorability.
- **Select the Proposed Site.** PSEG considered the preceding evaluations and other relevant factors in order to select the Proposed Site and Alternative Sites.

The methods and results of these tasks are summarized in the following subsections.

9.3.1.1 Region of Interest

NUREG-1555 defines the ROI as the area to be considered in searching for potential power plant sites. NUREG-1555 provides the following guidance on the selection of the ROI:

> The ROI is typically selected based on geographic boundaries (e.g., the state in which the proposed site is located) or the relevant service area for the proposed plant. In cases where the proposed plant would not have a service area, the applicant should define a reasonable ROI and provide a justification. The ROI must be more extensive if environmental diversity would be substantially improved or if candidate sites do not meet initial threshold criteria (including the site criteria in 10 CFR 100), and added geographic areas would not increase costs substantially. The ROI may be smaller if sufficient environmental diversity exists, threshold criteria are satisfied, and costs would be exorbitant for considering sites outside the state or relevant service area.

The new plant studied by PSEG is a merchant plant and will not have a regulated service area. However, PSEG's parent company, Public Service Enterprise Group, is primarily a NJ company, with its Corporate Headquarters located in Newark, NJ. As shown in Figure 9.3-1, Public Service Enterprise Group has power plants and offices located throughout NJ. One of Public Service Enterprise Group's principal subsidiaries is Public Service Electric and Gas (PSE&G), which is a regulated public utility company engaged in the transmission and distribution of gas and electricity. As shown in Figure 9.3-2, PSE&G's electric service area is limited to NJ and extends throughout much of the state, encompassing most of the higher population areas of the state. Public Service Enterprise Group's generation subsidiary is PSEG Power, LLC, one of the nation's largest independent power producers. PSEG Nuclear is a subsidiary of PSEG Power, LLC, with its nuclear headquarters located at the existing SGS-HCGS Nuclear Site in southern

NJ. Most of the electricity generated by the SGS and HCGS power plants is sold into NJ markets.

Given Public Service Enterprise Group's long corporate history (over 100 years) and strong presence in NJ, the new plant is expected to supply much of its output to important load centers in NJ via existing transmission circuits. Locating the facility in NJ facilitates the delivery of power to these load centers and allows Public Service Enterprise Group to make optimal use of its existing resources in the state. Locating the facility in NJ also promotes the state's energy self-sufficiency, which is one of the objectives of the New Jersey Energy Master Plan (Reference 9.3-7). In addition, NJ provides a good diversity of environmental and geographic conditions for potential power plant sites, as illustrated in Figure 9.3-3. It is unlikely that any reasonable expansion of the ROI beyond NJ will significantly improve environmental diversity.

Based on the considerations discussed above, NJ was established as the ROI for the site evaluation study. This ROI is shown in Figure 9.3-4. The ROI encompasses an area of approximately 8700 square miles, including water areas. Major cities located within the ROI include Newark, Jersey City, Paterson, Elizabeth, Camden, and Trenton, NJ. Major water bodies available as a potential source of cooling water for a nuclear power plant include the Delaware River, Hudson River, and Atlantic Ocean. Major highways within the ROI include Interstate Routes 78, 80, 95, 280, 287, and 295, as well as the New Jersey Turnpike, Garden State Parkway, and Atlantic City Expressway. There are several major railroads in the ROI, including Amtrak, Norfolk Southern/Canadian Pacific Railway, Southern Railroad Company of New Jersey, and New York & Atlantic Railroad. Major land and use categories found in the ROI include residential, agricultural, urban, industrial, commercial, public facilities, parks, public and private recreation areas, natural areas, transportation, communications, utilities, government special designation, and education. Topographic features in the ROI range from flat floodplains along the rivers and coastal areas to steep bluffs, rolling hills, deep ravines, and mountain ranges. There are several military bases in the ROI, including Fort Dix Military Reservation, McGuire Air Force Base, Lakehurst Naval Air Station, Fort Monmouth, and Earle Naval Weapons Station.

Information on the need for power is included in Chapter 8. Descriptions of other generating facilities in NJ and the regional transmission system are discussed in Chapter 8 and Sections 9.1, 9.2, and 9.4.

9.3.1.2 Identification of Candidate Areas

Candidate Areas were identified by constructing digitized Geographic Information System (GIS) maps of the entire ROI and applying exclusionary criteria to eliminate areas considered unsuitable for nuclear power plant siting. The purpose of the exclusionary criteria was to narrow-down the region to be considered for power plant siting and allow the study to focus on areas that have the greatest probability of containing desirable sites. The exclusionary criteria covered major factors that make licensing, permitting, or development of a nuclear power plant impractical. Exclusionary criteria included distances to highways, railroad or barge transportation, transmission, and water sources. In addition, proximity to designated lands (parks, recreational areas, natural areas, etc.) was considered, as was population density.

It should be noted that the transmission criterion eliminated areas more than 20 mi. from an existing 500 kV transmission line or substation, thus ensuring that all sites would have a primary connection point within 20 mi. As discussed in later subsections, it was expected that all sites

would require an additional transmission connection in order to address potential grid stability issues. This additional connection point was not subject to the 20-mi. exclusionary criterion because it required connection to a strong regional substation capable of providing synchronizing support to improve grid stability margin.

The application of the exclusionary criteria to the ROI is illustrated in Figures 9.3-5 through 9.3-10. As illustrated in these figures, distance from highways and rail / barge transportation did not result in the elimination of any parts of the ROI, distance from transmission and water sources eliminated relatively small parts of the ROI, but population density and designated lands eliminated significant parts of the ROI. After application of all the exclusionary criteria, seven Candidate Areas, located from northern NJ to southern NJ, remained. Figure 9.3-11 shows the locations of these seven Candidate Areas.

9.3.1.3 Identification of Potential Sites

Potential Sites were identified by examining topographic maps and aerial photographs of the Candidate Areas to find specific locations that appeared, on the basis of high-level screening criteria, to be suitable for nuclear power plant siting. A key consideration was the availability of sufficient land suitable for arrangement of the power plant and other required facilities, as well as a reasonable site boundary. Preliminary plant footprint blocks were developed and arranged on each Potential Site to confirm the adequacy of the available land. Other required conditions included site topography, as well as proximity to water, transmission, and transportation resources. Avoidance of flood areas, wetlands, residences, and other sensitive land use features were incorporated to the extent feasible.

Eleven Potential Sites were identified, including at least one site in each of the Candidate Areas. Figure 9.3-12 shows the locations of these Potential Sites in relation to the Candidate Areas.

9.3.1.4 Identification of Candidate Sites

Candidate Sites were identified by examining the Potential Sites to determine whether they had any significant environmental or other issues that would make them impractical or undesirable for licensing, permitting, or development with a nuclear power plant. Issues considered in this evaluation included the following:

- **Environmental Acceptability.** The sites were reviewed with regard to major environmental issues, such as proximity to designated lands or waters and potential encroachment on sensitive land uses.

- **Nuclear Licensing.** The sites were reviewed with regard to major nuclear licensing issues, such as proximity to capable faults, hazardous land uses, and population centers.

- **Engineering.** The sites were reviewed with regard to major engineering issues, such as the length and difficulty of required water, transmission, and rail connections, cooling water pumping head, and the ability to deliver large components to the site.

The issues evaluated during this screening were primarily environmental, combined with a qualitative assessment of the level of environmental impact and the necessary activities or considerations to mitigate or avoid the impact. While these issues often manifest themselves in

either regulatory uncertainty or cost / schedule challenges, the focus of the reviews and screening was on the environmental suitability of the Potential Sites.

Identified issues were evaluated and considered to be significant if they introduced the potential for adverse environmental impacts or schedule delays associated with environmental / regulatory permitting or nuclear licensing. Other significant issues included environmental conditions that introduced overall regulatory uncertainty by raising the possibility of unusual and restrictive licensing or permit conditions or increased project costs by requiring unusual and costly site development efforts or impact mitigation measures.

Significant issues were identified at each of the Potential Sites. In most cases, these issues did not by themselves indicate that a site would not be feasible to license, permit, or develop. Rather, the issues identified would make licensing, permitting, or development of the site more difficult, complicated, and/or costly. In general, all sites being developed for a project of the size and magnitude of a nuclear power plant are expected to have some significant issues of this kind, but the extent of such issues is important in determining the overall desirability of a site.

Based on these evaluations, five sites (Sites 4-1, 7-1, 7-2, 7-3, and 7-4) were found to have notably fewer significant negative issues than the other sites. In addition, a qualitative evaluation of the negative issues identified at these sites indicated that all of the issues were manageable and could reasonably be expected to be resolved. Each site also had other highly desirable characteristics. Therefore, the sites with significantly more negative issues were eliminated from further consideration, and the following sites were retained as Candidate Sites:

- Site 4-1 (Hunterdon County, NJ)
- Site 7-1 (Salem County, NJ)
- Site 7-2 (Salem County, NJ)
- Site 7-3 (Cumberland County, NJ)
- Site 7-4 (PSEG Site, Salem County, NJ)

Figure 9.3-13 shows the locations of these Candidate Sites.

9.3.1.5 Evaluation of Candidate Sites

The Candidate Sites were evaluated in more detail in order to provide a quantifiable basis for comparison. The primary purpose of the evaluation was to develop numerical scores that would allow the Candidate Sites to be ranked according to their overall suitability for development of a nuclear power plant. In order to support the numerical scoring, various specific aspects of the Candidate Sites were investigated and assessed, including the following:

- **Environmental and Permitting Conditions.** Factors related to environmental acceptability and permittability were evaluated in more detail than considered previously for the Potential Sites. Maps were obtained showing the property parcels on and near each Candidate Site. Information on zoning and land use planning was collected. Reviews were conducted of applicable state and local regulations concerning air quality, ambient noise,

water withdrawal, land use, and other environmental, regulatory, and permitting issues. Site-specific information on threatened and endangered species and cultural resources was obtained from appropriate state and federal government agencies.

- **Transmission Interconnection and Stability.** The feasibility of obtaining transmission interconnection for the Candidate Sites was evaluated through modeling of thermal overloads. The risk of transmission upgrades being required in order to maintain system stability was qualitatively evaluated. These evaluations allowed the sites to be scored based on potential interconnection and stability impacts.

- **Field Reconnaissance.** Field reconnaissance site visits were conducted. The field reconnaissance was intended to supplement and confirm the information collected from maps, aerial photographs, and other publicly available sources. Observations focused on issues such as the condition of wetlands and other natural habitats, recent residential developments, transportation routes, and constructability characteristics.

- **Refinement of Site Layouts**. Based on the information collected through the environmental evaluations and field reconnaissance, the preliminary site layouts developed earlier were revised to make the best use of existing property parcels and reduce impacts on environmentally sensitive areas.

The numerical scores covered 40 site characteristics related to Environmental Acceptability (15 characteristics), Nuclear Licensing (11 characteristics), and Engineering / Cost factors (14 characteristics). Many of the site characteristics categorized as Engineering / Cost factors are also relevant to environmental acceptability; for example, minimizing the length of required transmission, rail, and road connections serves to reduce environmental impacts as well as costs. The site characteristics considered in the numerical scoring are listed in Table 9.3-1. An importance weighting factor was assigned to each site characteristic.

The Candidate Sites were ranked according to the numerical scoring developed as described above. Based on total weighted scoring, Site 7-4 was the highest-ranked site, followed in order by Sites 7-3, 7-2, 7-1, and 4-1. Based on total unweighted scoring, the sites had the same ranking as the weighted scoring. Therefore, the importance weighting factors did not have a significant impact on the site evaluations.

As shown in Table 9.3-1, the site characteristics were grouped into issues related to Environmental Acceptability, Nuclear Licensing, and Engineering / Cost. To provide an additional check on the results of the site evaluations, the numerical scores were totaled within these three categories of site characteristics. Based on the scores for Environmental Acceptability issues only, Site 7-4 was the highest-ranked site, followed in order by Sites 7-2, 7-3, 7-1, and 4-1. Based on the scores for Nuclear Licensing issues only, Site 7-3 was the highest-ranked site, followed in order by Sites 7-4, 7-2, 4-1, and 7-1. Based on the scores for Engineering / Cost issues only, Site 7-1 was the highest-ranked site, followed in order by Sites 7-4, 7-3, 7-2, and 4-1.

The results summarized above indicate that Site 7-4 is the most favorable Candidate Site with regard to the issues considered in the numerical scoring. Site 7-4 was the highest-ranked site based on both weighted and unweighted overall scoring. In addition, Site 7-4 had the highest score on Environmental Acceptability issues and the second-highest scores for both Nuclear

Licensing issues and Engineering / Cost issues. No other site ranked among the top two sites in all three categories.

9.3.1.6 Selection of Proposed Site

As described in the previous subsections of this report, a standardized process was used to identify Candidate Areas, Potential Sites, and Candidate Sites. A systematic numerical scoring system was developed to provide an objective evaluation of the relative favorability of the Candidate Sites, using consistent criteria. The results of these evaluations indicate that all of the Candidate Sites are potentially licensable for a nuclear power plant, and that Site 7-4 is the most favorable Candidate Site with regard to the issues considered. The final step in the process was for PSEG to incorporate business considerations and any other relevant additional factors into the site evaluations and the selection of a Proposed Site.

In evaluating the five Candidate Sites, PSEG considered not only the Environmental Acceptability, Nuclear Licensing, and Engineering / Cost issues discussed above, but the additional technical and business considerations described below. In some cases, these considerations correlate to lower construction or operation costs. In addition, PSEG considered the synergies of colocating a new nuclear facility with the existing nuclear units at Site 7-4. These synergies are significant from environmental, financial and operational perspectives, and they include the following factors:

- Abundant existing site data, information and regulatory knowledge; familiarity with the site and environrons. This includes pre-existing knowledge and data on the following:
  - Terrestrial and aquatic ecology
  - Site characteristics including geology and seismic data; known foundation conditions and foundation design
  - Over 30 years of on-site meteorological data
  - Regional socioeconomic conditions

- Significant community and key stakeholder support in Lower Alloways Creek Township and Salem County, NJ.

- Emergency management infrastructure and support agreements with NJ and DE, and with Salem and Cumberland counties in NJ and New Castle County in DE. Existing emergency plans can be used as necessary and a consistent Emergency Planning Zone can be maintained.

- Economic and operational synergies with existing operations:
  - Common operations support facilities and training infrastructure, including off-site visitor center and emergency response facilities, eliminating the need to construct new facilities.
  - Common operations support organization, including PSEG Corporate Nuclear Headquarters and support staffing. This provides a significant benefit and flexibility in retention of staff and ability to deploy shared resources to support the needs of either the new or operating plants.

- Regional nuclear presence provides potential recruiting base for staffing and retention.

- Security considerations:
  - Opportunity for an integrated security strategy and protected area
  - Pre-existing mutual aid, support, and response agreements

- Four existing 500 kV transmission circuits allow for the output of the new plant to be more readily integrated into the regional power grid, reducing the potential need for additional transmission circuits.

In addition, development of a new nuclear facility at Site 7-4 has the following advantages:

- Jobs creation in areas of NJ currently challenged by low per-capita income and high unemployment.

- Limited risk of substantial population growth in the Low Population Zone due to surrounding land use and land cover conditions.

- Minimal community and regional disruptions associated with the new transmission lines, new pipelines, and new road and rail systems that would be necessary to develop a greenfield site. These disruptions include the following:
  - Increased costs of greenfield development due to physical and support infrastructure requirements
  - Larger environmental footprints (i.e., larger site necessary) for greenfield development

In summary, PSEG considered business and other qualitative factors in addition to the numerical evaluations in making the final site selection. Site 7-4 was selected as the Proposed Site because it was the highest-ranked site using objective numerical criteria and it has significant additional benefits in community support, emergency response, existing infrastructure, and operational synergies. The other four Candidate Sites are considered to be Alternative Sites.

9.3.2 ENVIRONMENTAL ASSESSMENT OF ALTERNATIVE SITES

The site selection process described above resulted in the selection of Site 7-4, now designated the PSEG Site, as the Proposed Site for the new plant. The environmental impacts of the PSEG Site are evaluated in detail in other sections of this Environmental Report. This section evaluates the environmental impacts of the other Candidate Sites, now designated the Alternative Sites, using the resource categories suggested in NUREG-1555. The purpose of this evaluation is to determine if any of the Alternative Sites are “environmentally preferable” to the PSEG Site and, if so, whether any of the sites are “obviously superior” to the PSEG Site.

Regulatory Guide 4.2 states: “The applicant is not expected to conduct detailed environmental studies at alternative sites; only preliminary reconnaissance-type investigations need be conducted.” The Alternative Sites are evaluated here based on publicly available information,

including field reconnaissance site visits, geographic information system (GIS) mapping, and a review of government agency websites.

In order to evaluate the environmental impacts of constructing and operating a nuclear power plant at the Alternative Sites, the general plant design described in Chapter 3 and the construction and operation practices described in Chapters 4 and 5 were consistently applied to each site. This allowed for a comprehensive and qualitatively consistent assessment of environmental impacts. The potential impact of plant construction and operation on each resource category was assigned a significance level according to the criteria 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.
>
> MODERATE - Environmental effects are sufficient to alter noticeably, but not to destabilize, any important attributes of the resource.
>
> LARGE - Environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

For some analyses, it was determined that the additional impact criteria established by the NRC in NUREG-1437, were appropriate, and those criteria were used to assign a significance level to certain impacts, as noted in specific subsections below.

The following subsections summarize the evaluation of each Alternative Site, using consistent criteria and assumptions applied to the attributes and features of each Alternate Site.

9.3.2.1 Evaluation of Site 4-1

Site 4-1 is a greenfield site in Hunterdon County, NJ. The site is located on relatively flat land approximately 5 mi. east of the Delaware River, which would be the primary water source. Elevations across the site range from 540 to 640 feet (ft.) above Mean Sea Level. Based on conceptual site boundaries identified by considering site development requirements and existing property parcels, the site has a total area of 1128 acres (ac.).

Site 4-1 would require the following off-site features in order to support a nuclear power plant:

- Road access to the site would be provided by existing public roads, but portions of those roads would have to be relocated around plant facilities or improved to allow them to carry plant-related traffic. It was assumed that all roads would be constructed on a right-of-way (ROW) 150 feet (ft.) wide. A total of 3.5 miles (mi.) of road construction was estimated to be required.
- A new rail spur would allow delivery of materials and equipment to the site. It was assumed that the rail spur would be constructed on a ROW 150 ft. wide. A conceptual route to the nearest active railroad line was identified based on existing terrain and land use features, and this route is 6.8 mi. long.
- A new makeup water pipeline would withdraw water from the Delaware River, and a new blowdown pipeline would discharge wastewater to the Delaware

River. It was assumed that the two pipelines would be constructed parallel to one another, on a single ROW 100 ft. wide. A conceptual route to the Delaware River was identified based on existing terrain and land use features, and this route is 6.6 mi. long.

- Three new 500 kV transmission lines would connect the site to the existing 500 kV transmission system. It was assumed that the three transmission lines would be constructed parallel to one another, each on a ROW 200 ft. wide. A conceptual route to the nearest existing 500 kV transmission line was identified based on existing terrain and land use features, and this route is 1.1 mi. long. It was expected that an interposing switchyard would be required at the connection point, and this switchyard was conceptually located on 25 ac. of land. In addition, it was expected that a new 500 kV transmission line from the switchyard to the Limerick Substation in PA would be required to address potential grid stability issues. The Limerick Substation is at the Limerick Generating Station, which would be capable of providing synchronizing support to Site 4-1 during grid disturbances, thus maintaining system stability. It was assumed that this transmission line would be constructed on a 200 ft. wide ROW parallel to existing transmission lines, for a total distance of 84 mi.

Subsections 9.3.2.1.1 through 9.3.2.1.8 discuss the potential environmental impacts of developing Site 4-1 and the off-site features listed above. Because the transmission corridors are significantly longer than the other off-site corridors and are not confined to the immediate site vicinity, quantitative estimates of potential impacts are presented separately for the transmission corridors.

9.3.2.1.1 Land Use

Existing land use across Site 4-1 is predominantly agricultural, with large areas planted in cultivated crops. Parts of the site are designated County Preserved Farms, a designation that would have to be addressed and mitigated for the site to be developed with a power plant. An agricultural extension research farm is located on part of the site. Soils classified as prime farmland occur across much of the site.

Residences (single family houses) are scattered across the site. There are approximately 25 houses located within the conceptual site boundaries, and most of these houses would have to be removed before the site could be developed with a power plant. Most of the site is zoned for residential use, with a zoning designation that specifies 3 ac. lots. Although the site is located 5 mi. from the nearest incorporated town, small concentrations of houses are located within 1 mi. of the site.

The off-site corridors for the access roads, rail spur, and water pipelines are largely confined to the immediate site vicinity, and the land use within these corridors is similar to the site itself, with most of the land in agricultural use and residences scattered throughout the area. It is anticipated that the corridors could be developed without removing existing houses, but some houses would be located in close proximity to the various ROW alignments.

No significant industrial land uses have been identified on the site, within the off-site corridors, or in close proximity.

Based on the conceptual plant layout developed for Site 4-1, development of the site would directly disturb (permanently and temporarily) 401 ac. of land. The remaining land within the site boundaries, which totals 727 ac., would not be directly disturbed, but access to this land would be controlled and it generally would be unavailable for non-power plant uses. In addition, development of the access road, rail spur, and water pipeline corridors would disturb 268 ac. of land. Cumulatively, 1396 ac. would be disturbed or made unavailable for non-power plant uses. The acreage of each major land use category currently found on this land was estimated based on GIS mapping data. Table 9.3-2 summarizes the acreages in the major land use categories and compares those quantities with the total acreages found in the site vicinity (within a 6 mi. radius of the site).

Table 9.3-2 shows that the acreage of each land use category potentially affected by project construction is a relatively small percentage of the total acreage of that land use available in the site vicinity. It is not expected that project construction would destabilize any important land use resources. However, construction would change the site and associated off-site corridors from predominantly rural land use with scattered housing and very little industrial development to intensive heavy industrial use. This would noticeably alter the existing land use resources. Therefore, the land use impact due to project construction would be MODERATE.

As discussed in Subsection 9.3.2.1, the potential transmission corridor to Limerick Substation is approximately 84 mi. long. This corridor, along with the transmission corridor from the site to the nearest existing 500 kV transmission line and an interposing switchyard at the connection point, includes 2136 ac. of land. Permanent land impacts associated with the transmission corridor, such as tower foundations, would be substantially less than the total acreage of the corridor.

The acreage of each major land use category currently found on this land was estimated based on GIS mapping data. Table 9.3-3 summarizes the acreages in the major land use categories and compares those quantities with the total acreages found in the 6 mi. site vicinity.

Table 9.3-3 shows that the acreage of each land use category potentially affected by transmission line construction is a relatively small percentage of the total acreage of that land use available in the site vicinity. It is not expected that transmission line construction would destabilize any important land use resources. However, transmission line construction would noticeably alter the existing land use on more than 2100 ac. of land. In addition, it is possible that some residences or other buildings would have to be removed to provide adequate clearance for the transmission lines. Therefore, the land use impact due to transmission line construction would be MODERATE.

During project operation, land use impacts would be reduced. Agricultural activities may be allowed in the transmission line and pipeline ROWs. No new land use impacts would occur beyond those described above for project construction, so land use resources that exist at the conclusion of the construction phase would not be noticeably altered. Therefore, the land use impact due to operation of the power plant, transmission lines, and other off-site features would be SMALL.

9.3.2.1.2 Air Quality

The air quality impacts of constructing and operating the new plant and off-site facilities for Site 4-1 would be similar to the impacts expected for the PSEG Site. Hunterdon County is classified as a non-attainment area for ozone, and it is considered to be in attainment with the National

Ambient Air Quality Standards (NAAQS) for all other criteria pollutants. This is the same classification as Salem County, where the PSEG Site is located.

Air quality impacts during project construction would include dust from earthmoving and material handling activities, and exhaust emissions from construction vehicles and equipment. These impacts would be similar to the impacts associated with any large construction project. To limit and mitigate the impacts, emission-specific strategies, plans and measures would be developed and implemented to ensure compliance with applicable federal and state regulations. Therefore, air quality impacts associated with construction would be SMALL.

During plant operation, the cooling towers would emit particulate matter. Auxiliary boilers and standby diesel or combustion turbine generators would emit particulate matter and gaseous pollutants such as nitrogen oxides. All emissions would be governed by a Prevention of Significant Deterioration Permit and a Title V Operating Permit, which would ensure compliance with the NAAQS and other applicable regulatory requirements. Therefore, air quality impacts associated with operation would be SMALL.

9.3.2.1.3 Hydrology, Water Use, and Water Quality

The Delaware River would be the primary source of water for a plant located at Site 4-1. The site is located 5 mi. from the river, so the only direct impact on the river during project construction would be disturbance of a relatively small section of the shoreline and river bottom for installation of a water intake structure and wastewater discharge structure. Barge access is not feasible in the Site 4-1 area, as it is north of the Delaware River Fall Line in Trenton, so a barge docking facility would not be constructed.

Water-related impacts associated with construction activities on the site itself would be similar to the impacts of any large construction project. Potential impacts include direct physical alteration of local surface water bodies; indirect alteration of nearby surface water bodies due to increased runoff volumes or diversions of runoff; degradation of downstream surface water quality as a result of erosion and sedimentation or discharges of pollutants associated with construction activities; and changes in groundwater flow patterns due to dewatering of excavations and soil retention management practices. Similar impacts would occur in the off-site corridors for construction of the rail spur, access roads, and other off-site facilities. The most significant impact would be that some existing streams on the site and within the off-site corridors would be directly disturbed, and some adjacent streams would experience a temporary increase in sediment loading due to increased runoff of disturbed soil.

Several federal, state, and local permits would govern construction activities that have the potential to impact water resources. Water-related impacts would be minimized by implementing best management practices, including erosion, grading, and sediment control measures; stormwater pollution prevention plans; spill prevention and countermeasure plans; and compliance with federal, state, and local regulations pertaining to disturbance of water bodies and pollution discharges. Withdrawal of either surface water or groundwater would be anticipated during project construction, but the quantities would be less than the quantities evaluated below for project operation. Therefore, impacts on water resources due to project construction would be SMALL.

During project operation, the new plant would withdraw make-up water from the Delaware River and discharge wastewater (primarily cooling tower blowdown) to the river. The water withdrawn

from the river would either be returned to the river as blowdown or lost to the atmosphere through operation of the cooling towers. Water returned to the river as blowdown would not be lost to downstream users or aquatic communities.

As discussed in Section 3.3, the water withdrawal rate for the new plant at the PSEG Site is 78,196 gallons per minute (gpm), and the consumptive water loss (primarily due to evaporation from the cooling towers) is 26,420 gpm. These values assume that the cooling towers operate at 1.5 cycles of concentration, which is an appropriate value for the brackish water found in the Delaware River in the PSEG Site area. However, in the Site 4-1 area, the Delaware River contains fresh water, which would allow the cooling towers to operate at 3 cycles of concentration or more. At 3 cycles of concentration, the water withdrawal rate for cooling tower makeup would be approximately half that seen at 1.5 cycles of concentration. Considering additional withdrawals for plant water uses that are not affected by the cycles of concentration, the total water withdrawal for Site 4-1 is 40,300 gpm. Consumptive water use would remain the same at 26,420 gpm.

Based on U.S. Geological Survey (USGS) data (Reference 9.3-10) for the nearest available gauging station (near Belvidere, NJ), the annual mean river flow is 3,571,789 gpm, and the 7-day 10-year low flow (7Q10) is 484,736 gpm. Based on these statistics, the withdrawal rate (40,300 gpm) would divert approximately 1.1 percent of the annual mean river flow and 8.3 percent of the 7Q10 flow. The consumptive water loss (26,420 gpm) would reduce the annual mean river flow by 0.7 percent and the 7Q10 flow by 5.5 percent.

The Belvidere gauging station is more than 30 mi. upstream of the Site 4-1 area, which indicates that the actual river flows at the site would be higher than the flows discussed above, and the impacts of water withdrawal and consumption would be correspondingly lower. It also should be noted that PSEG is a co-owner of the Merrill Creek Reservoir and has an established allocation of water that can be released from the reservoir to offset consumptive use during periods of declared drought. Water withdrawal for the new plant could be supported by re-allocation of water among the existing PSEG plants, or additional existing water allocation rights would be acquired from other Merrill Creek co-owner(s).

The withdrawal of water from the Delaware River would be regulated by the Delaware River Basin Commission (DRBC) and the New Jersey Department of Environmental Protection (NJDEP), which would ensure that the diversion and consumption of river water did not adversely affect downstream users or aquatic communities. The discharge of wastewater to the Delaware River also would be regulated, ensuring compliance with applicable water quality standards and designated uses of the river. Discharges of stormwater runoff from the operational plant site and off-site facilities would be similarly regulated by the NJDEP. Therefore, impacts on surface water resources due to project operation would be SMALL.

Groundwater withdrawal would not be mandatory at Site 4-1, because the Delaware River in the site area is capable of providing fresh water for plant uses. A detailed water study would be performed if development of Site 4-1 was anticipated. However, in order to make a consistent comparison of impacts with the PSEG Site, it was assumed that the same amount of groundwater withdrawal for the PSEG Site (210 gpm average and 953 gpm maximum, per Section 3.3) would be required at Site 4-1.

Based on data provided by the USGS (Reference 9.3-11) and the New Jersey Water Science Center (Reference 9.3-6), groundwater wells in the Site 4-1 area would withdraw water from the

Newark Group Aquifers. The aquifer materials consist of fractured rock (shale, sandstone, and some conglomerate). The aquifers are unconfined to partially-confined to a depth of approximately 200 ft., and confined at greater depths. Well depths in these aquifers typically range from 30 to 1500 ft., with groundwater yields of up to 1500 gpm.

The above information indicates that the plant groundwater requirements could be supplied by one or two wells drilled to the Newark Group Aquifers. Although some parts of these aquifers may have experienced groundwater drawdown, it is likely that properly located wells could supply the plant water needs. In addition, groundwater withdrawal would be regulated by both the DRBC and the NJDEP. Therefore, impacts on groundwater resources due to project operation would be SMALL.

9.3.2.1.4 Terrestrial Biological Resources Including Protected Species

Any large construction project impacts terrestrial ecology primarily by disturbing natural habitats and making those habitats unavailable to plants and animals. Although construction activities may result in direct mortality to some plants and animals, most animal species are able to move away to avoid direct impacts. Even those species, however, may experience disruptions due to loss of habitat. In addition, noise, lights, and dust may cause some animals to leave areas near construction activities. This is also experienced as a loss of usable habitat.

As described in the New Jersey Wildlife Action Plan (Reference 9.3-4), Site 4-1 is located in the Southern Highlands Zone of the Skylands Landscape Region. The Southern Highlands Zone is dominated by agricultural fields and pastures. Forest habitat is highly fragmented and exists primarily in small patches interspersed with agricultural land and developed areas. Wetlands are scattered throughout the zone, but many have been impacted by human activity. Terrestrial species of concern in the Southern Highlands Zone are associated primarily with wetland, forest, or grassland habitats.

Ecological conditions on Site 4-1 are generally similar to the conditions described above for the Southern Highlands Zone. Most of the land is used for agriculture. Forest is restricted to scattered woodlots and strips of trees along streams. Wetlands are found primarily in isolated low areas, and some of the wetlands are farmed. Grasslands are virtually absent. The off-site corridors for the access roads, rail spur, and water pipelines are largely confined to the immediate site vicinity, and the natural habitats within these corridors are similar to the site itself.

As discussed in Subsection 9.3.2.1.1, development of the site would directly disturb (permanently and temporarily) 401 ac. of land. The remaining land within the site boundaries, which totals 727 ac., would not be directly disturbed, but construction activities would subject much of this land to indirect disturbance (noise, dust, etc.) and impede the movement of wildlife within this area. In addition, development of the access road, rail spur, and water pipeline corridors would disturb 268 ac. of land. Cumulatively, 1396 ac. would be directly or indirectly disturbed. The acreage of forest, wetlands, and grassland habitat currently found on this land was estimated based on GIS mapping data. Table 9.3-4 summarizes the acreage of each habitat that would be potentially impacted and compares those quantities with the total acreage found in the site vicinity (within a 6 mi. radius of the site).

Table 9.3-4 shows that the acreage of each habitat potentially affected by project construction is a relatively small percentage of the total acreage of that habitat available in the site vicinity. In

addition, the specific habitat areas that would be disturbed generally are small and isolated from larger habitat areas. Therefore, the overall impacts on terrestrial ecology due to project construction would be SMALL. However, based on the acreage of wetlands that would be potentially affected (approximately 92 ac.), the wetlands impact due to project construction would be considered MODERATE.

As discussed in Subsection 9.3.2.1, the potential transmission corridor to Limerick Substation is 84 mi. long. This corridor, along with the transmission corridor from the site to the nearest existing 500 kV transmission line and an interposing switchyard at the connection point, includes 2136 ac. of land. The acreage of forest, wetlands, and grassland habitat currently found on this land was estimated based on GIS mapping data. Table 9.3-5 summarizes the acreage of each habitat that would be potentially impacted and compares those quantities with the total acreages found in the 6 mi. site vicinity.

Table 9.3-5 shows that the acreage of each habitat potentially affected by transmission line construction is a relatively small percentage of the total acreage of that habitat available in the site vicinity. It is not expected that transmission line construction would destabilize terrestrial ecological resources. However, the acreage of both wetlands and forest that would be potentially affected (36 ac. and 581 ac., respectively) is significant. It should be noted that wetlands impacts would be limited to the areas of tower construction, and final routing of the transmission line would take wetlands avoidance into consideration. Clearing of the forested areas would noticeably alter the plant and animal species found in these areas. Therefore, the impacts on terrestrial ecology due to transmission line construction would be MODERATE.

The terrestrial ecology impacts of project operation would be similar to the impacts of construction but reduced. Areas that are paved or occupied by project facilities would be permanently unavailable to plants and animals, but areas that are used for construction laydown or other temporary activities may be re-colonized by some species after construction is finished. Therefore, impacts on terrestrial ecology due to operation of the power plant, transmission lines, and other off-site features would be SMALL.

Information on protected and rare species that may occur in the Site 4-1 area was obtained from the NJDEP (Reference 9.3-3). According to this information, 13 animal species and 1 plant species have been recorded within approximately 1 mi. of the site. These species are listed in Table 9.3-6. Detailed field studies would be required to determine whether any of these species make significant use of the site or off-site corridors, and as reconnaissance level data was used for evaluation, such studies were not conducted for the alternative sites. However, based on the relatively minor impacts on natural habitats described above, it is unlikely that any of these species would be significantly affected by project construction or operation. Therefore, impacts on protected and rare terrestrial species would be expected to be SMALL.

9.3.2.1.5 Aquatic Biological Resources Including Protected Species

As discussed in Subsection 9.3.2.1.3, project construction would result in the disturbance of a section of the Delaware River shoreline and river bottom due to installation of a water intake structure and wastewater discharge structure. Some aquatic organisms that use this area might suffer direct impacts from construction activities, but most organisms would move away from the area and be affected primarily by the loss of a limited amount of habitat. In addition, some aquatic species might be affected by increased turbidity and siltation resulting from construction activities, but such effects would be temporary and localized.

Construction activities on the site and in the off-site corridors would result in direct disturbance to some existing streams, and some adjacent streams would experience a temporary increase in sediment loading due to increased runoff of disturbed soil. There is no indication that any of the streams that would be affected have any exceptional or high ecological value. Similar streams are common in the 6 mi. vicinity around Site 4-1.

Based on GIS mapping data, the total length of streams that would be directly affected by construction on the site and in the access road, rail spur, and water pipeline corridors is 2946 ft. This represents 0.1 percent of the total length of streams in the 6-mi. site vicinity (2,253, 912 ft.). In addition, the total length of streams included within the transmission corridors and interposing switchyard is 32,704 ft., which represents 1.5 percent of the stream length in the site vicinity. Most of the streams in the transmission corridors would not be directly affected; it is estimated that 95 percent of the streams could be avoided during transmission line construction.

The expected stream disturbance is a very small percentage of the total length of streams available in the site vicinity. In addition, construction impacts on streams and on the Delaware River would be regulated under federal, state, and local permits. Therefore, impacts on aquatic ecology due to construction of the power plant, transmission lines, and other off-site features would be SMALL.

During operation of the power plant, transmission lines, and other off-site features, there would be little if any additional impact on streams. The primary source of potential impacts during operation would be the withdrawal of water from the Delaware River. Some aquatic organisms would be entrained with the intake water or impinged on the intake screens. However, federal regulations (40 CFR Part 125) require cooling water intake structures to meet stringent criteria designed to protect organisms from entrainment and impingement. In addition, the amount of water withdrawn would be a relatively small percentage of the overall river flow, as discussed in Subsection 9.3.2.1.3. Therefore, impacts on aquatic ecology due to project operation would be SMALL.

Information provided by the NJDEP on protected and rare species that may occur in the site area (Reference 9.3-3) did not identify any aquatic species. Detailed field studies would be required to determine whether any protected or rare species make significant use of any streams or the part of the Delaware River that could be affected by the project, and as reconnaissance level data was used for evaluation, such studies were not conducted for the alternative sites. However, based on the relatively minor impacts on aquatic habitats described above, it is unlikely that any of aquatic species would be significantly affected by project construction or operation. Therefore, impacts on protected and rare aquatic species would be expected to be SMALL.

9.3.2.1.6 Socioeconomics

This subsection evaluates the social and economic impacts that could result from constructing and operating the new plant at Site 4-1. The evaluation includes the impacts of construction and operation activities and demands placed by the construction and operation workforces on the site and the surrounding region. It is assumed that all construction activities would occur within the site boundaries and off-site corridors described in Subsection 9.3.2.1, and physical impacts would be restricted to these construction areas and nearby properties. Other socioeconomic impacts generally occur on a regional basis, and in the following subsections they are evaluated for Hunterdon County and the region within 50 mi. of Site 4-1.

9.3.2.1.6.1 Physical Impacts

Any large construction project can cause temporary and localized physical impacts such as noise, vibration, dust, vehicle exhaust, and odors. In addition, construction materials, equipment, and workers must be transported to the construction areas, and these transportation activities also cause noise, vibration, dust, vehicle exhaust, and odors. For Site 4-1, a new rail spur would be constructed, and this rail line would be used to transport large equipment and materials to the site. Public roadways would be used to transport smaller equipment, as well as large numbers of construction workers. Appropriate measures would be taken to minimize noise, dust, and other impacts due to both construction and transportation activities. However, because residences are located throughout the area surrounding Site 4-1, it would not be possible to avoid close proximity to some residences. Based on field reconnaissance and examination of aerial photographs, it is estimated that more than 100 residences are located within 0.5 mi. of the conceptual site boundaries. Other residences are located in close proximity to the conceptual rail spur and other off-site corridors. Despite the implementation of appropriate mitigation measures, many of these residences probably would experience some impact due to construction-related noise, vibration, and dust. This would noticeably alter the existing physical conditions in the immediate site area. For this reason, the physical impact due to project construction would be MODERATE.

The physical impacts of project operation would be similar to the impacts of construction but somewhat reduced. Operating plant equipment would produce some noise, but the noise levels generally would be lower than the levels associated with construction activities. Workers and some materials and equipment would be transported to the site during project operation, but the amount of traffic and size of shipments generally would be less than during project construction. Periodic maintenance would be required for both on-site and off-site facilities, and the maintenance activities would create some noise, vibration, and dust, but these impacts would be more localized and of shorter duration than during project construction. Therefore, the physical impact due to project operation would be SMALL.

9.3.2.1.6.2 Demography

Impacts on demography would be associated with construction workers and operation workers moving into the region surrounding the project site, potentially causing changes in off-site land use and development patterns. Construction employment is inherently temporary, but construction workers sometimes move their families into the region, magnifying the population increase. However, in densely populated states such as NJ and the adjacent states, a substantial number of construction workers may commute from their existing residences and not need to move into the region.

Per NUREG-1437, demographic impacts are expected to be SMALL if project-related population growth represents less than 5 percent of the study area’s total population, MODERATE if 5 to 20 percent, and LARGE if more than 20 percent.

The analysis presented in Subsection 4.4.2.1 indicates that if the new plant were constructed at the PSEG Site, 634 of the 4100 construction workers could be expected to move into the four-county Region of Influence. The analysis conservatively assumes that all of the workers who move into the region would bring their families, resulting in a total population increase of 1712 people. For purposes of evaluating demographic impacts at Site 4-1, it was assumed that the same population increase would occur in Hunterdon County. For the purpose of this

comparison, this is considered a conservative assumption, because the same population increase for the four counties surrounding the PSEG Site is being applied to one county for Site 4-1 and the impact is not noticeable.

Based on U.S. Census Bureau (USCB) data (Reference 9.3-9), the population of Hunterdon County was 121,989 in the year 2000, and the population was estimated to have increased to 129,031 in 2008. Using the year 2000 population (121,989) and the conservative population increase discussed above (1712), project-related population growth due to the construction workforce would be approximately 1.4 percent. Therefore, the construction-related demographic impact in Hunterdon County would be SMALL.

Another conservative assumption that can be made is that the entire peak construction workforce (4100 people) would move into and bring families into the 50-mi. region surrounding the project site. Applying the average NJ household size of 2.70 people per household (Subsection 4.4.2.1), the total population increase would be 11,070. Based on USCB data (Reference 9.3-9), the population of the region within a 50- mi. radius of Site 4-1 was 10,808,154 in the year 2000. Using this population value and a population increase of 11,070, project-related population growth due to the construction workforce would be 0.1 percent. Therefore, the construction-related demographic impact in the 50 mi. region would be SMALL.

The analysis presented in Subsection 5.8.2.1 indicates that if the new plant were constructed at the PSEG Site, 496 of the 600 operation workers could be expected to move into the four-county Region of Influence. Conservatively assuming that all of these workers moved into Hunterdon County and brought families with an average of 2.70 people per household, the resulting population increase would be 1338 people. Obviously, this would be a smaller impact than the construction-related population increase discussed above. In addition, the total number of operation workers is significantly smaller than the peak construction workforce discussed above. Therefore, the operation-related demographic impact in both Hunterdon County and the 50-mi. region would be SMALL.

9.3.2.1.6.3 Economy

Impacts on the economy would be caused primarily by the jobs provided to construction and operation workers. The wages paid to workers result in additional spending, which tends to stimulate the economy, particularly in the retail and service sectors. This can provide opportunities for new businesses and new jobs. These effects are considered to be beneficial and would be expected to occur primarily in the area within which the workers reside.

Per NUREG-1437, economic impacts are considered SMALL if project-related employment represents less than 5 percent of the study area’s total employment, MODERATE if 5 to 10 percent, and LARGE if more than 10 percent.

In the previous subsection it was conservatively estimated that if the new plant were constructed at Site 4-1, 634 construction workers would move into Hunterdon County and 4100 construction workers would move into the 50-mi. region surrounding the site.

Based on USCB data for the year 2000 (Reference 9.3-9), the total number of employees in Hunterdon County was 63,448, and the total number of employees in the 50-mi. region was 5,018,984. Using the county value for total employment (63,448) and the conservative county employment increase discussed above (634), project-related employment due to the

construction workforce would be 1.0 percent. Therefore, the construction-related economic impact in Hunterdon County would be SMALL. Using the regional value for total employment (5,018,984) and the conservative regional employment increase discussed above (4100), project-related employment due to the construction workforce would be less than 0.1 percent. Therefore, the construction-related economic impact in the 50-mi. region would be SMALL.

As discussed in the previous subsection, the number of operation workers estimated to move into both Hunterdon County and the 50-mi, region is significantly smaller than the number of construction workers. Therefore, the operation-related economic impact in both Hunterdon County and the 50-mi. region would be SMALL.

9.3.2.1.6.4 Taxes

Property taxes, sales taxes, and other taxes paid during construction and operation of the new plant would benefit the state and local jurisdictions that collect the taxes. Per NUREG-1437, tax impacts are considered SMALL if project-related tax revenues represent less than 10 percent of the total tax revenues of the local taxing jurisdictions, MODERATE if 10 to 20 percent, and LARGE if more than 20 percent.

The analysis presented in Subsections 4.4.2.2.2 indicates that the taxes paid by the new plant during project construction are expected to be significantly less than 10 percent of the total tax revenues for Salem County, resulting in a SMALL tax impact. The analysis presented in Subsection 5.8.2.2.2 indicates that the taxes paid by the new plant during project operation also are expected to result in a SMALL tax impact.

Based on 2008 county budget documents (Reference 9.3-1), Salem County has total annual tax revenues of $45,672,000, while Hunterdon County has total annual tax revenues of $70,858,000. Therefore, the taxes paid by the new plant would be a smaller percentage of the total tax revenues for Hunterdon County than for Salem County, and the tax impact associated with both construction and operation would be SMALL.

9.3.2.1.6.5 Transportation

Transportation in the vicinity of the new plant could be affected by the increase in vehicle traffic associated with construction and operation workers commuting to the site and the delivery of materials and equipment to the site. The increase in vehicle traffic could cause delays on local roads. The severity of such impacts would depend primarily on the existing traffic volumes and level-of-service (LOS) on local roads compared with the expected volume of project-related traffic.

Road access to the Site 4-1 area is provided primarily by NJ Routes 513 and 579. Both are considered secondary state routes, but both are relatively wide two-lane highways. Road access to the site itself is provided primarily by Hunterdon County Road 615. This is a relatively narrow two-lane road and appears to be used mostly by local traffic.

The New Jersey Department of Transportation (NJDOT) does not publish LOS designations for roads in the state. However, NJDOT data (Reference 9.3-5) indicates that the following average daily traffic volumes (both directions) occur on the roads listed above:

- NJ Route 513 = 3284
- NJ Route 579 = 4504
- Hunterdon County Road 615 = 2005

As discussed in Subsection 4.4.1.5, maximum construction-related traffic volumes are expected to occur during shift changes (twice per day) in the peak construction workforce. During such shift changes, 2200 vehicles are expected to use local roads. Delivery of construction materials and equipment is expected to add another 50 vehicles per day over the construction period.

Considering the nature of the roads in the Site 4-1 area and the current volume of traffic on those roads, it is likely that the peak construction traffic would noticeably alter existing transportation conditions (cause noticeable delays on local roads) but not be sufficient to destabilize important transportation resources. Therefore, the transportation impact associated with project construction would be MODERATE.

As discussed in Subsection 5.8.1.2, maximum traffic volumes associated with plant operation are expected to occur when fuel-reloading is being conducted for one generating unit and another unit is operating. The peak traffic volume at such times could be 1200 vehicles. Because this number of vehicles is significantly smaller than the peak construction traffic volume, it would not be expected to noticeably alter transportation conditions. Therefore, the transportation impact associated with project operation would be SMALL.

9.3.2.1.6.6 Aesthetics

Aesthetics in the vicinity of the new plant could be affected by the visual intrusion of large industrial structures and equipment. During project construction, dust could create additional visual intrusions. During operation, water vapor plumes from the cooling towers would be readily visible at certain times. Given that the Site 4-1 area currently has predominantly rural scenery, project construction and operation would dramatically alter the existing visual conditions. However, the severity of visual impacts on the human population would depend primarily on the visibility of the plant and off-site facilities from sensitive viewing areas.

As discussed in Subsection 9.3.2.1.6.1, field reconnaissance and examination of aerial photographs indicate that more than 100 residences are located within 0.5 mi. of the conceptual site boundaries. Although trees and existing buildings may block the view of some of these residences, many would be expected to have at least a partial view of the power plant during construction and operation. In addition, some residences are located near the conceptual off-site corridors and would have at least a partial view of the transmission lines, rail spur, and other off-site facilities during construction and operation.

Other sensitive viewing areas also are located in relatively close proximity to the site and off-site corridors. The nearest boundary of the New Jersey Highlands, an area designated by the state legislature for special preservation and planning measures, is located within 1 mi. of the conceptual site boundaries. During project construction and operation, the power plant would be at least partially visible from portions of the New Jersey Highlands. In addition, the conceptual rail spur corridor passes through a portion of the New Jersey Highlands. In order to avoid the Highlands it would be necessary to connect with a different railroad line, resulting in much longer than 6.8 mi. rail spur with greater costs and environmental impacts.

St. Thomas Episcopal Church, an active church with a historic building and cemetery, is located 0.5 mi. from the conceptual site boundaries and less than 0.5 mi. from the conceptual rail spur corridor. During project construction and operation, the power plant and rail spur probably would be at least partially visible from the church grounds.

Franklin Township Elementary School is located 1.0 mi. from the conceptual site boundaries, and the school grounds may have partial views of the power plant during construction and operation.

NUREG-1437 establishes the following criteria for judging the severity of aesthetic impacts:

> SMALL - No complaints from affected public about a changed sense of place or a diminution in enjoyment of the physical environment, and no measurable impact on socioeconomic institutions and processes.
>
> MODERATE - Some complaints from affected public about a changed sense of place or a diminution in enjoyment of the physical environment, and measurable impacts that do not alter the continued functioning of socioeconomic institutions and processes.
>
> LARGE - Continuing and widely shared opposition to the project based on a perceived degradation of the area's sense of place or diminution in enjoyment of the physical environment, and measurable social impacts that perturb the continued functioning of community institutions and processes.

Considering that the power plant and off-site facilities would be visible from several sensitive viewing areas, and considering that project construction would dramatically alter the existing rural scenery, it is likely that project construction would generate public complaints related to a changed sense of place and diminished enjoyment of the physical environment. It is likely that there would be general opposition to the project, and possible that there could be measurable social impacts that perturb the continued functioning of institutions such as St. Thomas Episcopal Church. Therefore, the aesthetic impact associated with project construction would be MODERATE to LARGE.

Although project operation would not result in significant further alteration of aesthetic conditions, the power plant, cooling tower plumes, transmission lines, and rail spur traffic would continue to be visible from sensitive viewing areas. It is likely that there would be public complaints related to diminished enjoyment of the physical environment, and possible that there could be general opposition to the project and measurable social impacts that perturb the continued functioning of community institutions and processes. Therefore, the aesthetic impact associated with project operation would be MODERATE to LARGE.

9.3.2.1.6.7 Housing

Impacts on housing could be caused by construction and operation workers moving, either permanently or temporarily, into the region surrounding the project site. This influx of workers could decrease the availability of unoccupied housing units and increase the cost to buy or rent housing. The severity of such impacts would depend primarily on the existing availability of unoccupied housing units compared with the number of workers who would move into the area.

NUREG-1437 establishes the following criteria for judging the severity of housing impacts:

> 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.
>
> MODERATE - Discernible but short-lived reduction in available housing units. Rental rates and housing values rise slightly faster than the inflation rate, but prices realign quickly once new housing units became available or project-related demand diminishes.
>
> LARGE - Project-related demand for housing units results in very limited housing availability and increases in rental rates and housing values well above normal inflationary increases in the state.

In Subsection 9.3.2.1.6.2 it was conservatively estimated that if the new plant were constructed at Site 4-1, 634 construction workers would move into Hunterdon County and 4100 construction workers would move into the 50-mi. region surrounding the site.

Based on USCB data for the year 2000 (Reference 9.3-9), the total number of housing units in Hunterdon County was 45,032, and the number of vacant units was 1354. The conservative estimate of in-migrating construction workers discussed above (634) represents 46.8 percent of the unoccupied housing units in the county. Because more than half of the unoccupied housing units would remain available, it is unlikely that there would be an easily discernible change in housing availability or a significant increase in housing costs. Therefore, the construction-related housing impact in Hunterdon County would be SMALL.

Based on USCB year 2000 data, the total number of housing units in the 50-mi. region surrounding Site 4-1 was 4,227,052, and the number of vacant units was 249,272. The conservative estimate of in-migrating construction workers discussed above (4100) represents 1.6 percent of the unoccupied housing units in the region. Because a large percentage of the unoccupied housing units would remain available, it is very unlikely that there would be a discernible change in housing availability or increase in housing costs. Therefore, the construction-related housing impact in the 50-mi. region would be SMALL.

As discussed in Subsection 9.3.2.1.6.2, the number of operation workers estimated to move into both Hunterdon County and the 50-mi. region is significantly smaller than the number of construction workers. Therefore, the operation-related housing impact in both Hunterdon County and the 50-mi. region would be SMALL.

9.3.2.1.6.8 Public Services

Public services include police, fire and medical services; social services; water supply and waste water treatment facilities; and recreation facilities. Impacts on public services could be caused by construction and operation workers moving into the region surrounding the project site. This influx of workers could increase the demand for public services, potentially requiring local governments to add facilities, programs, and/or staff.

Per NUREG-1437, impacts on public services generally are considered to be SMALL if there is little or no need to add facilities, programs, and/or staff because of the influx of workers, and MODERATE or LARGE if additional facilities, programs, and/or staff are required.

As discussed in Subsection 9.3.2.1.6.2, the number of construction and operation workers estimated to move into both Hunterdon County and the 50-mi, region is insignificant compared with the existing populations. Because there would not be a noticeable increase in the population demanding public services, it is very unlikely that there would be a need to add facilities, programs, and/or staff. Therefore, the construction-related and operation-related impact on public services in both Hunterdon County and the 50-mi. region would be SMALL.

9.3.2.1.6.9 Education

Impacts on education could be caused by construction and operation workers moving into and bringing school-aged children into the region surrounding the project site. This increase in the number of school-aged children could cause crowding of local schools and potentially require school systems to add facilities and/or staff.

Per NUREG-1437, impacts on education are considered to be SMALL if the project-related increase in school enrollment represents less than 3 percent of the total school enrollment in affected school systems, MODERATE if 4 to 8 percent, and LARGE if more than 8 percent.

The analysis presented in Subsection 4.4.2.2.7 indicates that if the new plant were constructed at the PSEG Site, 315 school-aged children could be expected to move into the four-county Region of Influence. For purposes of evaluating education impacts at Site 4-1, it was assumed that the same increase in the number of school-aged children would occur in Hunterdon County. For the purpose of this comparison, this is considered a conservative assumption, because the same increase for the four counties surrounding the PSEG Site is being applied to one county for Site 4-1 and the impact is not noticeable.

Based on USCB data for the year 2000 (Reference 9.3-9), the total school enrollment (kindergarten through 12th grade) in Hunterdon County was 23,496. The conservative increase in school-aged children discussed above (315) represents 1.3 percent of the total school enrollment in the county. Therefore, the construction-related education impact in Hunterdon County would be SMALL.

In Subsection 9.3.2.1.6.2 it was conservatively estimated that the total construction-related population increase in the 50-mi. region surrounding Site 4-1 would be 11,070. As discussed in Subsection 4.4.2.2.7, school-aged children account for 14.0 to 18.4 percent of the total county populations in the four-county Region of Influence. Using the highest percentage (18.4), the construction-related population increase (11,070) would result in 2037 school-aged children moving into the 50-mi. region surrounding Site 4-1.

Based on USCB year 2000 data, the total school enrollment (kindergarten through 12th grade) in the 50-mi. region surrounding Site 4-1 was 2,038,194. The conservative increase in school-aged children discussed above (2037) represents 0.1 percent of the total school enrollment in the region. Therefore, the construction-related education impact in the 50-mi. region would be SMALL.

As discussed in Subsection 6.3.2.1.6.2, the number of operation workers estimated to move into both Hunterdon County and the 50-mi. region is significantly smaller than the number of construction workers. The number of school-aged children would be correspondingly smaller. Therefore, the operation-related education impact in both Hunterdon County and the 50-mi. region would be SMALL.

9.3.2.1.7 Historical and Archaeological Resources

Historical and archaeological resources could be directly disturbed by construction activities or indirectly disturbed by noise, dust, vehicle emissions, or visual intrusion during project construction and operation. The severity of such impacts would depend on the historic significance of the resources and the degree of disturbance.

Several properties listed on the National Register of Historic Places (NRHP) and/or the New Jersey Register of Historic Places (NJRHP) are located in the immediate vicinity of Site 4-1. In addition, one archaeological site that is not listed on either register but is reported in files maintained by the New Jersey Historic Preservation Office (NJHPO) is located within the conceptual plant footprint. This archaeological site would be directly disturbed by project construction, and it would have to be investigated before construction could proceed. If it was determined to be potentially eligible for the NRHP or NJRHP, the site would have to be excavated and any significant archaeological artifacts curated before the area was disturbed.

St. Thomas Episcopal Church, which is listed on both the NRHP and the NJRHP, is located 0.5 mi. from the conceptual site boundaries and less than 0.5 mi. from the conceptual rail spur corridor. The church would not be directly disturbed, but during project construction and operation it would be subject to noise and visual intrusion.

The Rockhill Agricultural Historic District, which is listed on both the NRHP and the NJRHP, is located less than 0.5 mi. from the conceptual rail spur corridor. The historic district would not be directly disturbed, but during construction and operation of the rail spur it would be subject to noise and visual intrusion.

The rail spur would connect to an active railroad line that runs along the Lehigh Valley Railroad Historic District, which is not listed on the NRHP but is listed on the NJRHP. Construction and operation of the rail spur would directly affect this historic district, but given that a railroad line currently operates in the historic district, it is not clear whether disturbance due to the rail spur would have a significant impact. This issue would require detailed discussion with the NJHPO.

The impacts summarized above would noticeably alter the existing historical and archaeological resources in the immediate site area during project construction. Depending on the significance of the impacts experienced by the Lehigh Valley Railroad Historic District, it is possible that construction could destabilize important attributes of this resource. Therefore, the impact on historical and archaeological resources due to project construction would be MODERATE to LARGE.

The impacts of project operation would be similar to the impacts of construction but somewhat reduced. The noise levels of operating plant equipment generally would be lower than the levels associated with construction activities. Traffic on the rail spur generally would be less frequent and involve smaller shipments than during project construction. Therefore, the impact on historical and archaeological resources due to project operation would be SMALL.

9.3.2.1.8 Environmental Justice

Environmental justice issues involve aspects of the project that could disproportionately impact minority or low income populations. The potential for disproportionate impacts depends primarily

on the location of the power plant and off-site facilities in relation to existing minority and low income populations.

USCB data for the year 2000 (Reference 9.3-8) were used to determine the percentage of minority and low-income populations within the 6-mi. site vicinity, and to identify any census block groups that contain a higher than average percentage of minority or low-income populations. The percentages for the site vicinity and each census block group were compared to the percentages for NJ.

Minorities comprise 9.1 percent of the population within 6 mi. of Site 4-1, compared with 34.0 percent for NJ. People with incomes below the poverty level comprise 3.1 percent of the population within 6 mi. of Site 4-1, compared with 8.5 percent for NJ. Of the 25 census block groups that have at least 50 percent of their area within 6 mi. of the site, only one has minority or poverty populations above the state average. Minorities comprise 37.3 percent of the population within this block group, and people with incomes below the poverty level comprise 14.2 percent. The nearest boundary of this block group is 4.9 mi. east-southeast of the conceptual site boundaries. The block group is not crossed by any of the conceptual off-site corridors and would not be expected to experience any direct impacts from construction or operation of the power plant or off-site facilities.

Based on the above information there does not appear to be a significant potential for the project to disproportionately impact minority or low income populations. Therefore, environmental justice impacts due to project construction and operation would be SMALL.

9.3.2.2 Evaluation of Site 7-1

Site 7-1 is a greenfield site in Salem County, NJ. The site is located on flat land 5 mi. east of the Delaware River, which would be the primary water source. Elevations across the site range from 15 to 35 ft. above Mean Sea Level. Based on conceptual site boundaries identified by considering site development requirements and existing property parcels, the site has a total area of 987 ac.

Site 7-1 would require the following off-site features in order to support a nuclear power plant:

- Road access to the site would be provided by existing public roads, but portions of those roads would have to be relocated around plant facilities or improved to allow them to carry plant-related traffic. It was assumed that all roads would be constructed on a ROW 150 ft. wide. A total of 3.3 mi. of road construction was estimated to be required.
- A new rail spur would allow delivery of materials and equipment to the site. It was assumed that the rail spur would be constructed on a ROW 150 ft. wide. A conceptual route to the nearest active railroad line was identified based on existing terrain and land use features, and this route is 6.9 mi. long.
- A new makeup water pipeline would withdraw water from the Delaware River, and a new blowdown pipeline would discharge wastewater to the Delaware River. It was assumed that the two pipelines would be constructed parallel to one another, on a single ROW 100 ft. wide. A conceptual route to the Delaware River

was identified based on existing terrain and land use features, and this route is 5.1 mi. long.

- Three new 500 kV transmission lines would connect the site to the existing 500 kV transmission system. It was assumed that the three transmission lines would be constructed parallel to one another, each on a ROW 200 ft. wide. A conceptual route to the nearest existing 500 kV transmission line was identified based on existing terrain and land use features, and this route is 5.4 mi. long. It was expected that an interposing switchyard would be required at the connection point, and this switchyard was conceptually located on 25 ac. of land. In addition, it was expected that a new 500 kV transmission line from the switchyard to the Indian River Substation in Delaware would be required to address potential grid stability issues. The Indian River Substation is a strong regional 500 kV substation that would be capable of providing synchronizing support to Site 7-1 during grid disturbances, thus maintaining system stability. It was assumed that this transmission line would be constructed on a 200 ft. wide ROW generally following existing transmission lines, for a total distance of 96 mi.

Subsections 9.3.2.2.1 through 9.3.2.2.8 discuss the potential environmental impacts of developing Site 7-1 and the off-site features listed above. Because the transmission corridors are significantly longer than the other off-site corridors and are not confined to the immediate site vicinity, quantitative estimates of potential impacts are presented separately for the transmission corridors.

9.3.2.2.1 Land Use

Existing land use across Site 7-1 is predominantly agricultural, with large fields planted in cultivated crops. Most of the site is zoned for agricultural use. Soils classified as prime farmland or Farmland of Statewide Importance occur across much of the site.

Residences (single family houses) are scattered across the site. There are approximately 17 houses located within the conceptual site boundaries, and most of these houses would have to be removed before the site could be developed with a power plant. The site is located less than 4 mi. from the nearest incorporated town, and small groups of houses are located within 1 mi. of the site.

An active church and cemetery are located inside the conceptual site boundaries. Based on preliminary site development plans, the church and cemetery would not be directly disturbed, and public access could be maintained during project construction. However, it is possible that emergency planning could limit public access to the church and cemetery during project operation.

The off-site corridors for the access roads, rail spur, and water pipelines are largely confined to the immediate site vicinity, and the land use within these corridors is similar to the site itself, with most of the land in agricultural use and residences scattered throughout the area. It is anticipated that the corridors could be developed without removing existing houses, but some houses would be located in close proximity to the various ROW alignments.

No significant industrial land uses have been identified on the site, within the associated off-site corridors, or in close proximity.

Based on the conceptual plant layout developed for Site 7-1, development of the site would directly disturb (permanently and temporarily) 432 ac. of land. The remaining land within the site boundaries, which totals 555 ac., would not be directly disturbed, but access to this land would be controlled and it generally would be unavailable for non-power plant uses. In addition, development of the access road, rail spur, and water pipeline corridors would disturb 246 ac. of land. Cumulatively, 1233 ac. would be disturbed or made unavailable for non-power plant uses. The acreage of each major land use category currently found on this land was estimated based on GIS mapping data. Table 9.3-7 summarizes the acreages in the major land use categories and compares those quantities with the total acreages found in the site vicinity (within a 6 mi. radius of the site).

Table 9.3-7 shows that the acreage of each land use category potentially affected by project construction is a relatively small percentage of the total acreage of that land use available in the site vicinity. Therefore, it is not expected that project construction would destabilize any important land use resources. However, construction would change the site and associated off-site corridors from predominantly rural land use with scattered housing and very little industrial development to intensive heavy industrial use. This would noticeably alter the existing land use resources. Therefore, the land use impact due to project construction would be MODERATE.

As discussed in Subsection 9.3.2.2, the potential transmission corridor to Indian River Substation is approximately 96 mi. long. This corridor, along with the transmission corridor from the site to the nearest existing 500 kV transmission line and an interposing switchyard at the connection point, includes 2857 ac. of land. Permanent land impacts associated with the transmission corridor, such as tower foundations, would be substantially less than the total acreage of the corridor.

The acreage of each major land use category currently found on this land was estimated based on GIS mapping data. Table 9.3-8 summarizes the acreages in the major land use categories and compares those quantities with the total acreages found in the 6 mi. site vicinity.

Table 9.3-8 shows that the acreage of each land use category potentially affected by transmission line construction is a relatively small percentage of the total acreage of that land use available in the site vicinity. It is not expected that transmission line construction would destabilize any important land use resources. However, transmission line construction would noticeably alter the existing land use on more than 2800 ac. of land. It is possible that some residences or other buildings would have to be removed to provide adequate clearance for the transmission lines. Therefore, the land use impact due to transmission line construction would be MODERATE.

During project operation, land use impacts generally would be reduced. Agricultural activities might be allowed in the transmission line and pipeline ROWs. Most land use resources that exist at the conclusion of the construction phase would not be noticeably altered during operation. However, as discussed above, it is possible that emergency planning for the operational power plant could limit public access to the church and cemetery located within the conceptual site boundaries. If the church and cemetery had to be closed, that aspect of the site land use would be noticeably altered. Therefore, the land use impact due to project operation would be SMALL to MODERATE.

9.3.2.2.2 Air Quality

The air quality impacts of constructing and operating the new plant and off-site facilities for Site 7-1 would be similar to the impacts expected for the PSEG Site. Salem County is classified as a non-attainment area for ozone, and it is considered to be in attainment with the NAAQS for all other criteria pollutants. The PSEG Site is located in the same county.

Air quality impacts during project construction would include dust from earthmoving and material handling activities, and exhaust emissions from construction vehicles and equipment. These impacts would be similar to the impacts associated with any large construction project. To limit and mitigate the impacts, emission-specific strategies, plans and measures would be developed and implemented to ensure compliance with applicable federal and state regulations. Therefore, air quality impacts associated with construction would be SMALL.

During plant operation, the cooling towers would emit particulate matter. Auxiliary boilers and standby diesel or combustion turbine generators would emit particulate matter and gaseous pollutants such as nitrogen oxides. All emissions would be governed by a Prevention of Significant Deterioration Permit and a Title V Certificate to Operate, which would ensure compliance with the NAAQS and other applicable regulatory requirements. Therefore, air quality impacts associated with operation would be SMALL.

9.3.2.2.3 Hydrology, Water Use, and Water Quality

The Delaware River would be the primary source of water for a plant located at Site 7-1. The site is located 5 mi. from the river, so the only direct impact on the river during project construction would be disturbance of a section of the shoreline and river bottom for installation of required facilities. At a minimum, the required facilities include a water intake structure and wastewater discharge structure, which would disturb a relatively small area of the shoreline and river bottom. Barge access is feasible on the Delaware River in the Site 7-1 area, but because any potential barge unloading area would be at least 5 mi. from the site, it is not clear whether a barge docking facility would be constructed. If constructed, a barge docking facility would result in additional disturbance of the shoreline and river bottom.

Water-related impacts associated with construction activities on the site itself would be similar to the impacts of any large construction project. Potential impacts include direct physical alteration of local surface water bodies; indirect alteration of nearby surface water bodies due to increased runoff volumes or diversions of runoff; degradation of downstream surface water quality as a result of erosion and sedimentation or discharges of pollutants associated with construction activities; and changes in groundwater flow patterns due to dewatering of excavations and soil retention management practices. Similar impacts would occur in the off-site corridors for construction of the rail spur, access roads, and other off-site facilities. The most significant impact would be that some existing streams on the site and within the off-site corridors would be directly disturbed, and some adjacent streams would experience a temporary increase in sediment loading due to increased runoff of disturbed soil.

Several federal, state, and local permits would govern construction activities that have the potential to impact water resources. Water-related impacts would be minimized by implementing BMPs, including erosion, grading, and sediment control measures; stormwater pollution prevention plans; spill prevention and countermeasure plans; and compliance with federal, state, and local regulations pertaining to disturbance of water bodies and pollution discharges.

Withdrawal of either surface water or groundwater would be anticipated during project construction, but the quantities would be less than the quantities evaluated below for project operation. Therefore, impacts on water resources due to project construction would be SMALL. During project operation, the new plant would withdraw make-up water from the Delaware River and discharge wastewater (primarily cooling tower blowdown) to the river. The water withdrawn from the river would either be returned to the river as blowdown or lost to the atmosphere through operation of the cooling towers. Water returned to the river as blowdown would not be lost to downstream users or aquatic communities.

As discussed in Section 3.3, the water withdrawal rate for the new plant at the PSEG Site is 78,196 gpm, and the consumptive water loss (primarily due to evaporation from the cooling towers) is 26,420 gpm. These values assume that the cooling towers operate at 1.5 cycles of concentration, which is appropriate for the brackish water found in the Delaware River at the PSEG Site. Site 7-1 would withdraw water from the same part of the Delaware River, so the same values can be used for Site 7-1.

Based on USGS data (Reference 9.3-10) for the nearest available gauging station (near Trenton, NJ), the annual mean river flow is 5,318,636 gpm, and the 7Q10 flow is 771,988 gpm. Based on these statistics, the withdrawal rate (78,196 gpm) would divert 1.5 percent of the annual mean river flow and 10.1 percent of the 7Q10 flow. The consumptive water loss (26,420 gpm) would reduce the annual mean river flow by 0.5 percent and the 7Q10 flow by 3.4 percent.

As stated above, Site 7-1 is located in an area where the Delaware River water is brackish. Because consumptive water use at locations with brackish water has a lesser impact on salinity intrusion than an equal consumption of fresh water, the DRBC has developed an “equivalent impact factor” (EIF) to account for the difference. As discussed in Subsection 5.2.1.2, the EIF in the PSEG Site area is 0.18. The factor applicable to Site 7-1 would nominally be the same as the value for the PSEG Site. Using this factor, the 26,420 gpm consumptive use of Delaware River water is equivalent to a freshwater consumptive use impact of a 4756 gpm. This impact represents approximately 0.1 percent of the annual average river flow and 0.6 percent of the 7Q10 flow.

It should be noted that the Trenton gauging station is more than 60 mi. upstream of the Site 7-1 area. Therefore, the actual river flows in the site area are expected to be considerably higher than the flows discussed above, and the impacts of water withdrawal and consumption would be correspondingly lower. It also should be noted that PSEG is a co-owner of the Merrill Creek Reservoir and has an established allocation of water that can be released from the reservoir to offset consumptive use during periods of declared drought. Water withdrawal for the new plant could be supported by re-allocation of water among the existing PSEG plants, or additional existing water allocation rights would be acquired from other Merrill Creek co-owner(s).

The withdrawal of water from the Delaware River would be regulated by the DRBC and NJDEP, which would ensure that the diversion and consumption of river water did not adversely affect downstream users or aquatic communities. The discharge of wastewater to the Delaware River would also be regulated, ensuring compliance with applicable water quality standards and designated uses of the river. Discharges of stormwater runoff from the operational plant site and off-site facilities would be similarly regulated by the NJDEP. Therefore, impacts on surface water resources due to project operation would be SMALL.

Because the Delaware River is brackish in the Site 7-1 area, groundwater withdrawal would be necessary to provide fresh water for plant uses. In order to make a consistent comparison of impacts with the PSEG Site, it was assumed that the same amount of groundwater withdrawal for the PSEG Site (210 gpm average, 953 gpm maximum) would be required.

Based on data provided by the USGS (Reference 9.3-11) and the New Jersey Water Science Center (Reference 9.3-6), groundwater wells in the Site 7-1 area would withdraw water from either the Kirkwood-Cohansey Coastal Plain Aquifer or the Atlantic City Sand Aquifer. Both aquifers consist of fine-to-coarse grained sand. The Kirkwood-Cohansey Aquifer is unconfined, and typical well yields range from 500 to 1000 gpm. The Atlantic City Sand Aquifer is confined, and typical well yields range from 600 to 800 gpm.

The above information indicates that the plant groundwater requirements could be supplied by one or two wells drilled to the Kirkwood-Cohansey Coastal Plain Aquifer or the Atlantic City Sand Aquifer. Although some parts of these aquifers may have experienced groundwater drawdown, it is likely that properly located wells could supply the plant water needs with no expected problems. Section 2.3 provides additional discussion of groundwater resources. In addition, groundwater withdrawal would be regulated by both the DRBC and the NJDEP. Therefore, impacts on groundwater resources due to project operation would be SMALL.

9.3.2.2.4 Terrestrial Biological Resources Including Protected Species

Any large construction project impacts terrestrial ecology primarily by disturbing natural habitats and making those habitats unavailable to plants and animals. Although construction activities may result in direct impacts to some plants and animals, most animal species are able to move away to avoid direct impacts. Even those species, however, may experience population declines due to loss of habitat. In addition, noise, lights, and dust may cause some animals to leave areas near construction activities. This is also experienced as a loss of usable habitat.

As described in the New Jersey Wildlife Action Plan (Reference 9.3-4), Site 7-1 is located in the Southern Zone of the Piedmont Plains Landscape Region. This zone is extensively farmed, but relatively large forest and wetland complexes remain in some areas. Many of the wetland areas have been farmed or otherwise disturbed by human activities. Terrestrial species of concern in the Southern Piedmont Plains Zone are associated primarily with wetland, forest, or grassland habitats.

Ecological conditions on and near Site 7-1 are typical of the extensively farmed parts of the Southern Piedmont Plains Zone. Most of the land is used for agriculture. Forest is restricted to scattered woodlots and strips of trees along streams. Wetlands are found primarily in isolated low areas, and some of the wetlands are farmed. Grasslands are virtually absent. The off-site corridors for the access roads, rail spur, and water pipelines are largely confined to the immediate site vicinity, and the natural habitats within these corridors are similar to the site itself.

As discussed in Subsection 9.3.2.2.1, development of the site would directly disturb (permanently and temporarily) 432 ac. of land. The remaining land within the site boundaries, which totals 555 ac., would not be directly disturbed, but construction activities would subject much of this land to indirect disturbance (noise, dust, etc.) and impede the movement of wildlife within this area. In addition, development of the access road, rail spur, and water pipeline corridors would disturb 246 ac. of land. Cumulatively, 1233 ac. would be directly or indirectly

disturbed. The acreage of forest, wetlands, and grassland habitat currently found on this land was estimated based on GIS mapping data. Table 9.3-9 summarizes the acreage of each habitat that would be potentially affected and compares those quantities with the total acreage found in the site vicinity (within a 6 mi. radius of the site).

Table 9.3-9 shows that the acreage of each habitat potentially affected by project construction is a relatively small percentage of the total acreage of that habitat available in the site vicinity. In addition, the specific habitat areas that would be disturbed generally are small and isolated from larger habitat areas. Therefore, the overall impacts on terrestrial ecology due to project construction would be SMALL. However, based on the acreage of wetlands that would be potentially affected (114 ac.), the wetlands impact due to project construction would be considered MODERATE.

As discussed in Subsection 9.3.2.2, the potential transmission corridor to Indian River Substation is 96 mi. long. This corridor, along with the transmission corridor from the site to the nearest existing 500 kV transmission line and an interposing switchyard at the connection point, includes 2857 ac. of land. The acreage of forest, wetlands, and grassland habitat currently found on this land was estimated based on GIS mapping data. Table 9.3-10 summarizes the acreage of each habitat that would be potentially impacted and compares those quantities with the total acreages found in the 6 mi. site vicinity.

Table 9.3-10 shows that the acreage of each habitat potentially affected by transmission line construction is a relatively small percentage of the total acreage of that habitat available in the site vicinity. It is not expected that transmission line construction would destabilize terrestrial ecological resources. However, the acreage of both wetlands and forest that would be potentially affected (963 ac. and 428 ac., respectively) is somewhat significant. It should be noted that wetlands impacts would be limited to the areas of tower construction, and final routing of the transmission line would take wetlands avoidance into consideration. Clearing of the forested areas would noticeably alter the plant and animal species found in these areas. Therefore, the impacts on terrestrial ecology due to transmission line construction would be MODERATE.

The terrestrial ecology impacts of project operation would be similar to the impacts of construction but reduced. Areas that are paved or occupied by project facilities would be permanently unavailable to plants and animals, but areas that are used for construction laydown or other temporary activities may be re-colonized by some species after construction is finished. Therefore, impacts on terrestrial ecology due to operation of the power plant, transmission lines, and other off-site features would be SMALL.

Information on protected and rare species that may occur in the Site 7-1 area was obtained from the NJDEP (Reference 9.3-3). According to this information, nine animal species and one plant species have been recorded within 1 mi. of the site. These species are listed in Table 9.3-11. Detailed field studies would be required to determine whether any of these species make significant use of the site or off-site corridors, and as reconnaissance level data was used for evaluation, such studies were not conducted for the alternative sites. However, based on the relatively minor impacts on natural habitats described above, it is unlikely that any of these species would be significantly affected by project construction or operation.

As shown in Table 9.3-11, the NJDEP also identified two Natural Heritage Priority Sites (specific habitats associated with protected and rare species) in the Site 7-1 area. Both of these Natural

Heritage Priority Sites are more than 1 mi. from the Site 7-1 boundaries, and neither is crossed by any of the off-site corridors. Therefore, it does not appear that either Natural Heritage Priority Site would be significantly affected by the project. Overall, impacts on protected and rare terrestrial species would be expected to be SMALL.

9.3.2.2.5 Aquatic Biological Resources Including Protected Species

As discussed in Subsection 9.3.2.2.3, project construction would result in the disturbance of a section of the Delaware River shoreline and river bottom due to installation of a water intake structure, wastewater discharge structure, and possibly a barge docking facility. Some aquatic organisms that use this area might suffer direct impacts from construction activities, but most organisms would move away from the area and be affected primarily by the loss of a limited amount of habitat. In addition, some aquatic species might be affected by increased turbidity and siltation resulting from construction activities, but such effects would be temporary and localized.

Construction activities on the site and in the off-site corridors would result in direct disturbance to some existing streams, and some adjacent streams would experience a temporary increase in sediment loading due to increased runoff of disturbed soil. There is no indication that any of the streams that would be affected have any exceptional or high value. Similar streams are common in the 6-mi. vicinity around Site 7-1.

Based on GIS mapping data, the total length of streams that would be directly affected by construction on the site and in the access road, rail spur, and water pipeline corridors is 8967 ft. This represents 0.3 percent of the total length of streams in the 6-mi. site vicinity (2,722,667 ft.). In addition, the total length of streams included within the transmission corridors and interposing switchyard is 100,104 ft., which represents 3.7 percent of the stream length in the site vicinity. Most of the streams in the transmission corridors would not be directly affected; it is estimated that 95 percent of the streams could be avoided during transmission line construction.

The expected stream disturbance is a very small percentage of the total length of streams available in the site vicinity. In addition, construction impacts on streams and on the Delaware River would be regulated by several federal, state, and local permits. Therefore, impacts on aquatic ecology due to construction of the power plant, transmission lines, and other off-site features would be SMALL.

During operation of the power plant, transmission lines, and other off-site features, there would be little if any additional impact on streams. The primary source of potential impacts during operation would be the withdrawal of water from the Delaware River. Some aquatic organisms would be entrained with the intake water or impinged on the intake screens. However, federal regulations (40 CFR 125) require cooling water intake structures to meet stringent criteria designed to protect organisms from entrainment and impingement. In addition, the amount of water withdrawn would be a relatively small percentage of the overall river flow, as discussed in Subsection 9.3.2.2.3. Therefore, impacts on aquatic ecology due to project operation would be SMALL.

Information provided by the NJDEP on protected and rare species that may occur in the site area (Reference 9.3-3) did not identify any aquatic species. Detailed field studies would be required to determine whether any protected or rare species make significant use of any streams or the part of the Delaware River that could be affected by the project, and as

reconnaissance level data was used for evaluation, such studies were not conducted for the alternative sites. However, based on the relatively minor impacts on aquatic habitats described above, it is unlikely that any aquatic species would be significantly affected by project construction or operation. Therefore, impacts on protected and rare aquatic species would be expected to be SMALL.

9.3.2.2.6 Socioeconomics

This subsection evaluates the social and economic impacts that could result from constructing and operating the new plant at Site 7-1. The evaluation includes the impacts of construction and operation activities and demands placed by the construction and operation workforces on the site and the surrounding region. It is assumed that all construction activities would occur within the site boundaries and off-site corridors described in Subsection 9.3.2.2, and physical impacts would be restricted to these construction areas and nearby properties. Other socioeconomic impacts generally occur on a regional basis, and in the following subsections they are evaluated for Salem County and the region within 50 mi. of Site 7-1.

9.3.2.2.6.1 Physical Impacts

Any large construction project can cause temporary and localized physical impacts such as noise, vibration, dust, vehicle exhaust, and odors. In addition, construction materials, equipment, and workers must be transported to the construction areas, and these transportation activities also cause noise, vibration, dust, vehicle exhaust, and odors. For Site 7-1, a new rail spur would be constructed, and this rail line would be used to transport large equipment and materials to the site. Public roadways would be used to transport smaller equipment, as well as large numbers of construction workers. Appropriate measures would be taken to minimize noise, dust, and other impacts due to both construction and transportation activities. However, because residences are located throughout the area surrounding Site 7-1, it would not be possible to avoid close proximity to some residences. Based on field reconnaissance and examination of aerial photographs, it is estimated that 40 residences are located within 0.5 mi. of the conceptual site boundaries. Other residences are located in close proximity to the conceptual rail spur and other off-site corridors. Despite the implementation of appropriate mitigation measures, many of these residences probably would experience some impact due to construction-related noise, vibration, and dust.

Other sensitive areas also would be subject to physical impacts during project construction. As discussed in Subsection 9.3.2.2.1, an active church and cemetery are located inside the conceptual site boundaries. Based on preliminary site development plans, the church and cemetery would not be directly disturbed by construction, but they would be exposed to significant noise, vibration, and dust. In addition, Salem River Wildlife Management Area, a state-owned property that is open to the public for hunting and fishing, is adjacent to the conceptual site boundaries and the transmission corridor, and the transmission corridor passes through 1 mi. of the Supawna Meadows National Wildlife Refuge. It would not be feasible to re-route the transmission corridor so as to completely avoid these features. During project construction, parts of the Wildlife Management Area and Wildlife Refuge would be subject to noise, vibration, and dust.

Considering the conditions summarized above, project construction would noticeably alter the existing physical conditions in the site area and might destabilize sensitive resources such as

the church, Wildlife Management Area, and/or Wildlife Refuge. For this reason, the physical impact due to project construction would be MODERATE to LARGE.

The physical impacts of project operation would be similar to the impacts of construction but somewhat reduced. Operating plant equipment would produce some noise, but the noise levels generally would be lower than the levels associated with construction activities. Workers and some materials and equipment would be transported to the site during project operation, but the amount of traffic and size of shipments generally would be less than during project construction. Periodic maintenance would be required for both on-site and off-site facilities, and the maintenance activities would create some noise, vibration, and dust, but these impacts would be more localized and of shorter duration than during project construction. Therefore, the physical impact due to project operation would be SMALL.

9.3.2.2.6.2 Demography

Impacts on demography would be associated with construction workers and operation workers moving into the region surrounding the project site. The significance of demographic impacts would be determined primarily by regional conditions, and those conditions are essentially the same for Site 7-1 as for the PSEG Site. Site 7-1 is in the same county as the PSEG Site and is located less than 15 mi. away from the PSEG Site. Therefore, regional demographic impacts would be essentially the same at both sites.

The analysis presented in Subsection 4.4.2.1 indicates that the demographic impact of constructing the new plant at the PSEG Site is expected to be SMALL. The analysis presented in Subsection 5.8.2.1 indicates that the demographic impact of plant operation at the PSEG Site also is expected to be SMALL. Therefore, the construction-related and operation-related demographic impact at Site 7-1 would be expected to be SMALL.

9.3.2.2.6.3 Economy

Impacts on the economy would be caused primarily by the jobs provided to construction and operation workers. The significance of economic impacts would be determined primarily by regional conditions, and those conditions are essentially the same for Site 7-1 as for the PSEG Site. Site 7-1 is in the same county as the PSEG Site and is located less than 15 mi. away from the PSEG Site. Therefore, regional economic impacts would be essentially the same at both sites.

The analysis presented in Subsection 4.4.2.2.1 indicates that the regional economic impact of constructing the new plant at the PSEG Site is expected to be SMALL. The analysis presented in Subsection 5.8.2.2.1 indicates that the regional economic impact of plant operation at the PSEG Site also is expected to be SMALL. Therefore, the construction-related and operation-related economic impacts at Site 7-1 would be expected to be SMALL.

9.3.2.2.6.4 Taxes

Property taxes, sales taxes, and other taxes paid during construction and operation of the new plant would benefit the state and local jurisdictions that collect the taxes. The significance of tax impacts would be determined primarily by regional conditions, and those conditions are essentially the same for Site 7-1 as for the PSEG Site. Site 7-1 is in the same county as the

PSEG Site and is located less than 15 mi. away from the PSEG Site. Therefore, regional tax impacts would be essentially the same at both sites.

The analysis presented in Subsection 4.4.2.2.2 indicates that the tax impact of constructing the new plant at the PSEG Site is expected to be SMALL. The analysis presented in Subsection 5.8.2.2.2 indicates that the tax impact of plant operation at the PSEG Site also is expected to be SMALL. Therefore, the construction-related and operation-related tax impact at Site 7-1 would be expected to be SMALL.

9.3.2.2.6.5 Transportation

Transportation in the vicinity of the new plant could be affected by the increase in vehicle traffic associated with construction and operation workers commuting to the site and the delivery of materials and equipment to the site. The increase in vehicle traffic could cause delays on local roads. The severity of such impacts would depend primarily on the existing traffic volumes and LOS on local roads compared with the expected volume of project-related traffic.

Road access to the Site 7-1 area is provided primarily by NJ Route 540. This is considered a secondary state route, but it is a relatively wide two-lane highway. Road access to the site itself is provided primarily by Salem County Road 631 and Salem County Road 646. Salem County Road 631 is a narrow two-lane road that appears to be used mostly by local traffic, but County Road 646 is a relatively wide two-lane highway.

The NJDOT does not publish LOS designations for roads in the state. However, NJDOT data (Reference 9.3-5) indicates that the average daily traffic volume (both directions) on NJ Route 540 is 5406 vehicles. NJDOT data does not include traffic volumes for Salem County Roads 631 and 646.

As discussed in Subsection 4.4.1.5, maximum construction-related traffic volumes are expected to occur during shift changes (twice per day) in the peak construction workforce. During such shift changes, 2200 vehicles are expected to use local roads. Delivery of construction materials and equipment is expected to add another 50 vehicles per day over the construction period.

Considering the nature of the roads in the Site 7-1 area and the current volume of traffic on those roads, it is likely that the peak construction traffic would noticeably alter existing transportation conditions (cause noticeable delays on local roads) but not be sufficient to destabilize important transportation resources. Therefore, the transportation impact associated with project construction would be MODERATE.

As discussed in Subsection 5.8.1.2, maximum traffic volumes associated with plant operation are expected to occur when fuel-reloading is being conducted for one generating unit and another unit is operating. The peak traffic volume at such times could be 1200 vehicles. Because this number of vehicles is significantly smaller than the peak construction traffic volume, it would not be expected to noticeably alter transportation conditions. Therefore, the transportation impact associated with project operation would be SMALL.

9.3.2.2.6.6 Aesthetics

Aesthetics in the vicinity of the new plant could be affected by the visual intrusion of large industrial structures and equipment. During project construction, dust could create additional

visual intrusions. During operation, water vapor plumes from the cooling towers would be readily visible at certain times. Given that the Site 7-1 area currently has predominantly rural scenery, project construction and operation would dramatically alter the existing visual conditions. However, the severity of visual impacts on the human population would depend primarily on the visibility of the plant and off-site facilities from sensitive viewing areas.

As discussed in Subsection 9.3.2.2.6.1, field reconnaissance and examination of aerial photographs indicate that approximately 40 residences are located within 0.5 mi. of the conceptual site boundaries. Although trees and existing buildings may block the view of some of these residences, many would be expected to have at least a partial view of the power plant during construction and operation. In addition, some residences are located near the conceptual off-site corridors and would have at least a partial view of the transmission lines, rail spur, and other off-site facilities during construction and operation.

Other sensitive viewing areas also are located in close proximity to the site and off-site corridors. As discussed in Subsection 9.3.2.2.1, an active church and cemetery are located inside the conceptual site boundaries. Based on preliminary site development plans, the church and cemetery would not be directly disturbed, but they would experience significant visual intrusion during project construction and operation.

Another active church is located 0.8 mi. from the conceptual site boundaries, and 0.2 mi. from the conceptual transmission corridor. During project construction and operation, the power plant and transmission lines probably would be at least partially visible from the church grounds. A third active church is located 0.3 mi. from the conceptual rail spur corridor and probably would have at least a partial view of the rail spur during construction and operation.

Salem River Wildlife Management Area, a state-owned property that is open to the public for hunting and fishing, is adjacent to the conceptual site boundaries and the transmission corridor. During project construction and operation, the power plant and transmission lines probably would be at least partially visible from parts of the Wildlife Management Area.

Finally, the primary transmission corridor passes through 1 mi. of the Supawna Meadows National Wildlife Refuge. It would not be feasible to re-route the transmission corridor so as to avoid the Wildlife Refuge. Parts of the Wildlife Refuge would have a clear view of the transmission lines during construction and operation.

NUREG-1437 establishes the following criteria for judging the severity of aesthetic impacts:

> SMALL - No complaints from affected public about a changed sense of place or a diminution in enjoyment of the physical environment, and no measurable impact on socioeconomic institutions and processes.
>
> MODERATE - Some complaints from affected public about a changed sense of place or a diminution in enjoyment of the physical environment, and measurable impacts that do not alter the continued functioning of socioeconomic institutions and processes.
>
> LARGE - Continuing and widely shared opposition to the project based on a perceived degradation of the area's sense of place or diminution in enjoyment of the physical environment, and measurable social impacts that perturb the continued functioning of community institutions and processes.

Considering that the power plant and off-site facilities would be visible from several sensitive viewing areas, and considering that project construction would dramatically alter the existing rural scenery, it is very likely that project construction would generate public complaints related to a changed sense of place and diminished enjoyment of the physical environment. It is likely that there would be general opposition to the project, and possible that there could be measurable social impacts that perturb the continued functioning of institutions such as the churches located in close proximity to construction areas. Therefore, the aesthetic impact associated with project construction would be MODERATE to LARGE.

Although project operation would not result in significant further alteration of aesthetic conditions, the power plant, cooling tower plumes, transmission lines, and rail spur traffic would continue to be visible from sensitive viewing areas. It is likely that there would be public complaints related to diminished enjoyment of the physical environment, and possible that there could be general opposition to the project and measurable social impacts that perturb the continued functioning of community institutions and processes. Therefore, the aesthetic impact associated with project operation would be MODERATE to LARGE.

9.3.2.2.6.7 Housing

Impacts on housing could be caused by construction and operation workers moving, either permanently or temporarily, into the region surrounding the project site. The significance of housing impacts would be determined primarily by regional conditions, and those conditions are essentially the same for Site 7-1 as for the PSEG Site. Site 7-1 is in the same county as the PSEG Site and is located less than 15 mi. away from the PSEG Site. Therefore, regional housing impacts would be essentially the same at both sites.

The analysis presented in Subsection 4.4.2.2.4 indicates that the housing impact of constructing the new plant at the PSEG Site is expected to be SMALL. The analysis presented in Subsection 5.8.2.2.4 indicates that the housing impact of plant operation at the PSEG Site also is expected to be SMALL. Therefore, the construction-related and operation-related housing impact at Site 7-1 would be expected to be SMALL.

9.3.2.2.6.8 Public Services

Public services include police, fire and medical services; social services; water supply and waste water treatment facilities; and recreation facilities. Impacts on public services could be caused by construction and operation workers moving into the region surrounding the project site. The significance of public service impacts would be determined primarily by regional conditions, and those conditions are essentially the same for Site 7-1 as for the PSEG Site. Site 7-1 is in the same county as the PSEG Site and is located less than 15 mi. away from the PSEG Site. Therefore, regional public service impacts would be essentially the same at both sites.

The analysis presented in Subsection 4.4.2.2.5 indicates that the public service impact of constructing the new plant at the PSEG Site is expected to be SMALL. The analysis presented in Subsection 5.8.2.1 indicates that the public service impact of plant operation at the PSEG Site also is expected to be SMALL. Therefore, the construction-related and operation-related public service impact at Site 7-1 would be expected to be SMALL.

9.3.2.2.6.9 Education

Impacts on education could be caused by construction and operation workers moving into and bringing school-aged children into the region surrounding the project site. The significance of education impacts would be determined primarily by regional conditions, and those conditions are essentially the same for Site 7-1 as for the PSEG Site. Site 7-1 is in the same county as the PSEG Site and is located less than 15 mi. away from the PSEG Site. Therefore, regional education impacts would be essentially the same at both sites.

The analysis presented in Subsection 4.4.2.2.7 indicates that the education impact of constructing the new plant at the PSEG Site is expected to be SMALL. The analysis presented in Subsection 5.8.2.2.7 indicates that the education impact of plant operation at the PSEG Site also is expected to be SMALL. Therefore, the construction-related and operation-related education impact at Site 7-1 would be expected to be SMALL.

9.3.2.2.7 Historical and Archaeological Resources

Historical and archaeological resources could be directly disturbed by construction activities or indirectly disturbed by noise, dust, vehicle emissions, or visual intrusion during project construction and operation. The severity of such impacts would depend on the location and historic significance of the resources.

No properties listed on the NRHP or the NJRHP have been identified in the immediate vicinity of Site 7-1. However, one archaeological site that is not listed on either register but is reported in files maintained by the NJHPO is located within the conceptual transmission corridor. This archaeological site might be directly disturbed by transmission line construction, and it probably would have to be investigated before construction could proceed. If it was determined to be potentially eligible for the NRHP or NJRHP, the site would have to be excavated and any significant archaeological artifacts curated before the area was disturbed.

In addition, two archaeological sites reported in NJHPO files are located on or near the conceptual pipeline corridor. Depending on the exact location of these archaeological sites and the final routing of the pipeline corridor, either or both of the sites might be disturbed by pipeline construction and might have to be investigated as described above.

The impacts summarized above would noticeably alter the existing archaeological resources in the site area during project construction but it is very unlikely that they would destabilize any important attributes of these resources. Therefore, the impact on historical and archaeological resources due to project construction would be MODERATE.

It does not appear that any additional disturbance of historical and archaeological resources would occur during project operation. Therefore, the impact on historical and archaeological resources due to project operation would be SMALL.

9.3.2.2.8 Environmental Justice

Environmental justice issues involve aspects of the project that could disproportionately impact minority or low income populations. The potential for disproportionate impacts depends primarily on the location of the power plant and off-site facilities in relation to existing minority and low income populations.

USCB data for the year 2000 (Reference 9.3-8) were used to determine the percentage of minority and low-income populations within the 6-mi. site vicinity, and to identify any census block groups that contain a higher than average percentage of minority or low-income populations. The percentages for the site vicinity and each census block group were compared to the percentages for NJ.

Minorities comprise 27.8 percent of the population within 6 mi. of Site 7-1, compared with 34.0 percent for NJ. People with incomes below the poverty level comprise 11.8 percent of the population within 6 mi. of Site 7-1, compared with 8.5 percent for NJ. Of the 35 census block groups that have at least 50 percent of their area within 6 mi. of the site, 15 have minority and/or poverty populations above the state average. The site is located in a census block group with poverty populations above the state average; minorities comprise 28.5 percent of the population within this block group, and people with incomes below the poverty level comprise 9.0 percent. Almost the entire length of the conceptual rail spur corridor is located within this block group. In addition, the conceptual pipeline corridor crosses part of another census block group with poverty populations above the state average (9.3 percent).

Based on the above information there appears to be a potential for the project to disproportionately impact low income populations. The severity of the impacts would depend on exactly how low income populations use the site area and the extent to which they would be exposed to the adverse impact of project construction and operation. Detailed field investigations would be performed to determine the level of impact if development of this site progresses. Based on available information, it appears that environmental justice impacts due to project construction and operation could be MODERATE to LARGE.

9.3.2.3 Evaluation of Site 7-2

Site 7-2 is a greenfield site in Salem County, NJ. The site is located on flat land 12 mi. east of the Delaware River, which would be the primary water source. Elevations across the site range from 120 to 140 ft. above Mean Sea Level. Based on conceptual site boundaries identified by considering site development requirements and existing property parcels, the site has a total area of 996 ac.

Site 7-2 would require the following off-site features in order to support a nuclear power plant:

- Road access to the site would be provided by existing public roads, but portions of those roads would have to be relocated around plant facilities or improved to allow them to carry plant-related traffic. It was assumed that all roads would be constructed on a ROW 150 ft. wide. A total of 2.2 mi. of road construction was estimated to be required.
- A new rail spur would allow delivery of materials and equipment to the site. It was assumed that the rail spur would be constructed on a ROW 150 ft. wide. A conceptual route to the nearest active railroad line was identified based on existing terrain and land use features, and this route is 5.4 mi. long.
- A new makeup water pipeline would withdraw water from the Delaware River, and a new blowdown pipeline would discharge wastewater to the Delaware River. It was assumed that the two pipelines would be constructed parallel to one another, on a

single ROW 100 ft. wide. A conceptual route to the Delaware River was identified based on existing terrain and land use features, and this route is 12.9 mi. long.

- An existing 500 kV transmission line crosses the site, and this line would provide a two-circuit connection to the 500 kV transmission system (incoming and outgoing portions of the line). A portion of the existing line would have to be re-routed to avoid plant facilities, for a total distance of 1.8 mi. A third circuit connection to the transmission system would be provided by a new transmission line from Site 7-2 to a second existing 500 kV corridor, which originates from the SGS/HCGS site. It is assumed that this new transmission line would be constructed on a ROW 200 ft. wide. A conceptual route to the existing 500 kV transmission corridor was identified based on existing terrain and land use features, and this route is 4.1 mi. long. It was expected that an interposing switchyard would be required at the connection point, and this switchyard was conceptually located on 25 ac. of land. In addition, it was expected that a new 500 kV transmission line would be required to address potential grid stability issues. A new line between the Indian River Substation in Delaware and the SGS/HCGS site (which, in turn, is electrically tied to the new interposing switchyard) would fulfill this purpose. The Indian River Substation is capable of providing synchronizing support to maintain system stability during grid disturbances. It was assumed that this transmission line would be constructed on a 200 ft. wide ROW generally following existing transmission lines, for a total distance of 107 mi.

Subsections 9.3.2.3.1 through 9.3.2.3.8 discuss the potential environmental impacts of developing Site 7-2 and the off-site features listed above. Because the transmission corridors are significantly longer than the other off-site corridors and are not confined to the immediate site vicinity, quantitative estimates of potential impacts are presented separately for the transmission corridors.

9.3.2.3.1 Land Use

Existing land use across Site 7-2 is predominantly agricultural, with large fields planted in cultivated crops. Most of the site is zoned for agricultural use. Soils classified as prime farmland or Farmland of Statewide Importance occur across much of the site.

Residences (single family houses) are scattered across the site. There are approximately 46 houses located within the conceptual site boundaries, and most of these houses would have to be removed before the site could be developed with a power plant. Although the site is located more than 6 mi. from the nearest incorporated town, and new housing developments are located within 1 mi. of the site.

A private school is located immediately outside the conceptual site boundaries. The school would not be directly disturbed, and public access could be maintained during project construction. However, it is possible that emergency planning could limit public access to the school during project operation.

The off-site corridors for the access roads, rail spur, and water pipelines are largely confined to the immediate site vicinity, and the land use within these corridors is similar to the site itself, with most of the land in agricultural use and residences scattered throughout the area. It is anticipated that the corridors could be developed without removing existing houses, but some houses would be located in close proximity to the various ROW alignments.

No significant industrial land uses have been identified on the site, within the associated off-site corridors, or in close proximity.

Based on the conceptual plant layout developed for Site 7-2, development of the site would directly disturb (permanently and temporarily) 394 ac. of land. The remaining land within the site boundaries, which totals 602 ac., would not be directly disturbed, but access to this land would be controlled and it generally would be unavailable for non-power plant uses. In addition, development of the access road, rail spur, and water pipeline corridors would disturb 294 ac. of land. Cumulatively, about 1290 ac. would be disturbed or made unavailable for non-power plant uses. The acreage of each major land use category currently found on this land was estimated based on GIS mapping data. Table 9.3-12 summarizes the acreages in the major land use categories and compares those quantities with the total acreages found in the site vicinity (within a 6 mi. radius of the site).

Table 9.3-12 shows that the acreage of each land use category potentially affected by project construction is a relatively small percentage of the total acreage of that land use available in the site vicinity. It is not expected that project construction would destabilize any important land use resources. However, construction would change the site and associated off-site corridors from predominantly rural land use with scattered housing and very little industrial development to intensive heavy industrial use. This would noticeably alter the existing land use resources. Therefore, the land use impact due to project construction would be MODERATE.

As discussed in Subsection 9.3.2.3, the potential transmission corridor to Indian River Substation is approximately 107 mi. long. This corridor, along with the transmission corridor from the site to the nearest existing 500 kV transmission corridor and an interposing switchyard at the connection point, includes 2896 ac. of land. The acreage of each major land use category currently found on this land was estimated based on GIS mapping data. Table 9.3-13 summarizes the acreages in the major land use categories and compares those quantities with the total acreages found in the 6 mi. site vicinity.

Table 9.3-13 shows that the acreage of each land use category potentially affected by transmission line construction is a relatively small percentage of the total acreage of that land use available in the site vicinity. It is not expected that transmission line construction would destabilize any important land use resources. However, transmission line construction would noticeably alter the existing land use on more than 2800 ac. of land. Permanent land impacts associated with the transmission corridor, such as tower foundations, would be substantially less than the total acreage of the corridor. It is possible that some residences or other buildings would have to be removed to provide adequate clearance for the transmission lines. Therefore, the land use impact due to transmission line construction would be MODERATE.

During project operation, land use impacts would be reduced. Agricultural activities might be allowed in the transmission line and pipeline ROWs. Most land use resources that exist at the conclusion of the construction phase would not be noticeably altered during operation. However, as discussed above, it is possible that emergency planning for the operational power plant could limit public access to the school located adjacent to the conceptual site boundaries. If the school had to be closed, that aspect of the site land use would be noticeably altered. Therefore, the land use impact due to project operation would be SMALL to MODERATE.

9.3.2.3.2 Air Quality

The air quality impacts of constructing and operating the new plant and off-site facilities for Site 7-2 would be similar to the impacts expected for the PSEG Site. Salem County is classified as a non-attainment area for ozone, and it is considered to be in attainment with the NAAQS for all other criteria pollutants. The PSEG Site is located in the same county.

Air quality impacts during project construction would include dust from earthmoving and material handling activities, and exhaust emissions from construction vehicles and equipment. These impacts would be similar to the impacts associated with any large construction project. To limit and mitigate the impacts, emission-specific strategies, plans and measures would be developed and implemented to ensure compliance with applicable federal and state regulations. Therefore, air quality impacts associated with construction would be SMALL.

During plant operation, the cooling towers would emit particulate matter. Auxiliary boilers and standby diesel generators or combustion turbines would emit particulate matter and gaseous pollutants such as nitrogen oxides. All emissions would be governed by a Prevention of Significant Deterioration Permit and a Title V Certificate to Operate, which would ensure compliance with the NAAQS and other applicable regulatory requirements. Therefore, air quality impacts associated with operation would be SMALL.

9.3.2.3.3 Hydrology, Water Use, and Water Quality

The Delaware River would be the primary source of water for a plant located at Site 7-2. The site is located approximately 12 mi. from the river, so the only direct impact on the river during project construction would be disturbance of a section of the shoreline and river bottom for installation of required facilities. At a minimum, the required facilities would include a water intake structure and wastewater discharge structure, which would disturb a relatively small area of the shoreline and river bottom. Barge access is feasible on the Delaware River in the Site 7-2 area, but because any potential barge unloading area would be at least 12 mi. from the site, it is not clear whether a barge docking facility would be constructed. If constructed, a barge docking and offloading facility would result in additional disturbance of the shoreline and river bottom.

Water-related impacts associated with construction activities on the site itself would be similar to the impacts of any large construction project. Potential impacts include direct physical alteration of local surface water bodies; indirect alteration of nearby surface water bodies due to increased runoff volumes or diversions of runoff; degradation of downstream surface water quality as a result of erosion and sedimentation or discharges of pollutants associated with construction activities; and changes in groundwater flow patterns due to dewatering of excavations and soil retention management practices. Similar impacts would occur in the off-site corridors for construction of the rail spur, access roads, and other off-site facilities. The most significant impact would be that some existing streams on the site and within the off-site corridors would be directly disturbed, and some adjacent streams would experience a temporary increase in sediment loading due to increased runoff of disturbed soil.

Several federal, state, and local permits would govern construction activities that have the potential to impact water resources. Water-related impacts would be minimized by implementing BMPs, including erosion, grading, and sediment control measures; stormwater pollution prevention plans; spill prevention and countermeasure plans; and compliance with federal, state, and local regulations pertaining to disturbance of water bodies and pollution discharges.

Withdrawal of either surface water or groundwater would be anticipated during project construction, but the quantities would be less than the quantities evaluated below for project operation. Therefore, impacts on water resources due to project construction would be SMALL.

During project operation, the new plant would withdraw make-up water from the Delaware River and discharge wastewater (primarily cooling tower blowdown) to the river. The water withdrawn from the river would either be returned to the river as blowdown or lost to the atmosphere through operation of the cooling towers. Water returned to the river as blowdown would not be lost to downstream users or aquatic communities.

As discussed in Section 3.3, the water withdrawal rate for the new plant at the PSEG Site is 78,196 gpm, and the consumptive water loss (primarily due to evaporation from the cooling towers) is 26,420 gpm. These values assume that the cooling towers operate at 1.5 cycles of concentration, which is appropriate for the brackish water found in the Delaware River at the PSEG Site. Site 7-2 would withdraw water from the same part of the Delaware River, so the same values can be used for Site 7-2.

Based on USGS data (Reference 9.3-10) for the nearest available gauging station (near Trenton, NJ), the annual mean river flow is 5,318,636 gpm, and the 7Q10 flow is 771,988 gpm. Based on these statistics, the withdrawal rate (78,196 gpm) would divert approximately 1.5 percent of the annual mean river flow and 10.1 percent of the 7Q10 flow. The consumptive water loss (26,420 gpm) would reduce the annual mean river flow by 0.5 percent and the 7Q10 flow by 3.4 percent.

As stated above, Site 7-2 is located in an area where the Delaware River water is brackish. Because consumptive water use at locations with brackish water has a lesser impact on salinity intrusion than an equal consumption of fresh water, the DRBC has developed an EIF to account for the difference. As discussed in Subsection 5.2.1.2, the EIF in the PSEG Site area is 0.18. The factor applicable to Site 7-2 would nominally be the same as the value for the PSEG Site. Using this factor, the 26,420 gpm consumptive use of Delaware River water is equivalent to a freshwater consumptive use impact of a 4756 gpm. This impact represents 0.1 percent of the annual average river flow and 0.6 percent of the 7Q10 flow.

It should be noted that the Trenton gauging station is more than 60 mi. upstream of the Site 7-2 area. Therefore, the actual river flows in the site area are expected to be considerably higher than the flows discussed above, and the impacts of water withdrawal and consumption would be correspondingly lower. It also should be noted that PSEG is a co-owner of the Merrill Creek Reservoir and has an established allocation of water that can be released from the reservoir to offset consumptive use during periods of declared drought. Water withdrawal for the new plant could be supported by re-allocation of water among the existing PSEG plants, or additional existing water allocation rights would be acquired from other Merrill Creek co-owner(s).

The withdrawal of water from the Delaware River would be regulated by the DRBC and NJDEP, which would ensure that the diversion and consumption of river water did not adversely affect downstream users or aquatic communities. The discharge of wastewater to the Delaware River also would be regulated, ensuring compliance with applicable water quality standards and designated uses of the river. Discharges of stormwater runoff from the operational plant site and off-site facilities would be similarly regulated by the NJDEP. Therefore, impacts on surface water resources due to project operation would be SMALL.

Because the Delaware River is brackish in the Site 7-2 area, groundwater withdrawal would be necessary to provide fresh water for plant uses. In order to make a consistent comparison of impacts with the PSEG Site, it was assumed that the same amount of groundwater withdrawal for the PSEG Site (210 gpm average, 953 gpm maximum) would be required.

Based on data provided by the USGS (Reference 9.3-11) and the New Jersey Water Science Center (Reference 9.3-6), groundwater wells in the Site 7-2 area would withdraw water from either the Kirkwood-Cohansey Coastal Plain Aquifer or the Atlantic City Sand Aquifer. Both aquifers consist of fine-to-coarse grained sand. The Kirkwood-Cohansey Aquifer is unconfined, and typical well yields range from 500 to 1000 gpm. The Atlantic City Sand Aquifer is confined, and typical well yields range from 600 to 800 gpm.

The above information indicates that the plant groundwater requirements could be supplied by one or two wells drilled to the Kirkwood-Cohansey Coastal Plain Aquifer or the Atlantic City Sand Aquifer. Although some parts of these aquifers may have experienced groundwater drawdown, it is likely that properly located wells could supply the plant water needs with no expected problems. See Section 2.3 for additional discussion of groundwater resources. In addition, groundwater withdrawal would be regulated by both the DRBC and the NJDEP. Therefore, impacts on groundwater resources due to project operation would be SMALL.

9.3.2.3.4 Terrestrial Biological Resources Including Protected Species

Any large construction project impacts terrestrial ecology primarily by disturbing natural habitats and making those habitats unavailable to plants and animals. Although construction activities may result in direct mortality to some plants and animals, most animal species are able to move away to avoid direct impacts. Even those species, however, may experience population declines due to loss of habitat. In addition, noise, lights, and dust may cause some animals to leave areas near construction activities. This is also experienced as a loss of usable habitat.

As described in the New Jersey Wildlife Action Plan (Reference 9.3-4), Site 7-2 is located in the Southern Zone of the Piedmont Plains Landscape Region. This zone is extensively farmed, but relatively large forest and wetland complexes remain in some areas. Many of the wetland areas have been farmed or otherwise disturbed by human activities. Terrestrial species of concern in the Southern Piedmont Plains Zone are associated primarily with wetland, forest, or grassland habitats.

Ecological conditions on and near Site 7-2 are typical of the extensively farmed parts of the Southern Piedmont Plains Zone. Most of the land is used for agriculture. Forest is restricted to scattered woodlots and strips of trees along streams. Wetland areas are very small and restricted to isolated low areas. Grasslands are virtually absent. The off-site corridors for the access roads, rail spur, and water pipelines are largely confined to the immediate site vicinity, and the natural habitats within these corridors are similar to the site itself.

As discussed in Subsection 9.3.2.3.1, development of the site would directly disturb (permanently and temporarily) 394 ac. of land. The remaining land within the site boundaries, which totals 602 ac., would not be directly disturbed, but construction activities would subject much of this land to indirect disturbance (noise, dust, etc.) and impede the movement of wildlife within this area. In addition, development of the access road, rail spur, and water pipeline corridors would disturb 294 ac. of land. Cumulatively, about 1290 ac. would be directly or indirectly disturbed. The acreage of forest, wetlands, and grassland habitat currently found on

this land was estimated based on GIS mapping data. Table 9.3-14 summarizes the acreage of each habitat that would be potentially affected and compares those quantities with the total acreage found in the site vicinity (within a 6 mi. radius of the site).

Table 9.3-14 shows that the acreage of each habitat potentially affected by project construction is a relatively small percentage of the total acreage of that habitat available in the site vicinity. In addition, the specific habitat areas that would be disturbed generally are small and isolated from larger habitat areas. Therefore, the overall impacts on terrestrial ecology due to project construction would be SMALL. However, based on the acreage of wetlands that would be potentially affected (87 ac.), the wetlands impact due to project construction is considered MODERATE.

As discussed in Subsection 9.3.2.3, the potential transmission corridor between the SGS/HCGS site and Indian River Substation is approximately 107 mi. long. This corridor, along with the transmission corridor from Site 7-2 to the nearest existing 500 kV transmission corridor and an interposing switchyard at the connection point, includes 2896 ac. of land. The acreage of forest, wetlands, and grassland habitat currently found on this land was estimated based on GIS mapping data. Table 9.3-15 summarizes the acreage of each habitat that would be potentially impacted and compares those quantities with the total acreages found in the 6 mi. site vicinity.

Table 9.3-15 shows that the acreage of each habitat potentially affected by transmission line construction is a relatively small percentage of the total acreage of that habitat available in the site vicinity. It is not expected that transmission line construction would destabilize terrestrial ecological resources. However, the acreage of both wetlands and forest that would be potentially affected (825 ac. and 464 ac., respectively) is somewhat significant. It should be noted that wetlands impacts would be limited to the areas of tower construction, and final routing of the transmission line would take wetlands avoidance into consideration. Clearing of the forested areas would noticeably alter the plant and animal species found in these areas. Therefore, the impacts on terrestrial ecology due to transmission line construction would be MODERATE.

The terrestrial ecology impacts of project operation would be similar to the impacts of construction but reduced. Areas that are paved or occupied by project facilities would be permanently unavailable to plants and animals, but areas that are used for construction laydown or other temporary activities may be re-colonized by some species after construction is finished. Therefore, impacts on terrestrial ecology due to operation of the power plant, transmission lines, and other off-site features would be SMALL.

Information on protected and rare species that may occur in the Site 7-2 area was obtained from the NJDEP (Reference 9.3-3). According to this information, eight animal species and two plant species have been recorded within 1 mi. of the site. These species are listed in Table 9.3-16. Detailed field studies would be required to determine whether any of these species make significant use of the site or off-site corridors, and as reconnaissance level data was used for evaluation, such studies were not conducted for the alternative sites. However, based on the relatively minor impacts on natural habitats described above, it is unlikely that any of these species would be significantly affected by project construction or operation.

As shown in Table 9.3-16, the NJDEP also identified two Natural Heritage Priority Sites (specific habitats associated with protected and rare species) in the Site 7-2 area. One of these Natural Heritage Priority Sites is 0.6 mi. from the Site 7-2 boundaries, and the other is 0.8 mi. from the

Site 7-2 boundaries. Neither is crossed by any of the off-site corridors. Therefore, it does not appear that either Natural Heritage Priority Site would be significantly affected by the project. Overall, impacts on protected and rare terrestrial species would be expected to be SMALL.

9.3.2.3.5 Aquatic Biological Resources Including Protected Species

As discussed in Subsection 9.3.2.3.3, project construction would result in the disturbance of a relatively small section of the Delaware River shoreline and river bottom due to installation of a water intake structure, wastewater discharge structure, and possibly a barge docking and offloading facility. Some aquatic organisms that use this area might suffer direct mortality from construction activities, but most organisms would move away from the area and be affected primarily by the loss of a limited amount of habitat. In addition, some aquatic species might be affected by increased turbidity and siltation resulting from construction activities, but such effects would be temporary and localized.

Construction activities on the site and in the off-site corridors would result in direct disturbance to some existing streams, and some adjacent streams would experience a temporary increase in sediment loading due to increased runoff of disturbed soil. There is no indication that any of the streams that would be affected have any exceptional or high value. Similar streams are common in the 6-mi. vicinity around Site 7-2.

Based on GIS mapping data, the total length of streams that would be directly affected by construction on the site and in the access road, rail spur, and water pipeline corridors is 9710 ft. This represents approximately 0.7 percent of the total length of streams in the 6-mi. site vicinity (1,384,973 ft.). In addition, the total length of streams included within the transmission corridors and interposing switchyard is 79,218 ft., which represents 5.7 percent of the stream length in the site vicinity. Most of the streams in the transmission corridors would not be directly affected; it is estimated that 95 percent of the streams could be avoided during transmission line construction.

From the numbers discussed above, it is clear that the expected stream disturbance is a very small percentage of the total length of streams available in the site vicinity. In addition, construction impacts on streams and on the Delaware River would be regulated by several federal, state, and local permits. Therefore, impacts on aquatic ecology due to construction of the power plant, transmission lines, and other off-site features would be SMALL.

During operation of the power plant, transmission lines, and other off-site features, there would be little if any additional impact on streams. The primary source of potential impacts during operation would be the withdrawal of water from the Delaware River. Some aquatic organisms would be entrained with the intake water or impinged on the intake screens. However, federal regulations (40 CFR Part 125) require cooling water intake structures to meet stringent criteria designed to protect organisms from entrainment and impingement. In addition, the amount of water withdrawn would be a relatively small percentage of the overall river flow, as discussed in Subsection 9.3.2.3.3. Therefore, impacts on aquatic ecology due to project operation would be SMALL.

Information provided by the NJDEP on protected and rare species that may occur in the site area (Reference 9.3-3) did not identify any aquatic species. Detailed field studies would be required to determine whether any protected or rare species make significant use of any streams or the part of the Delaware River that could be affected by the project, and as reconnaissance level data was used for evaluation, such studies were not conducted for the

alternative sites. However, based on the relatively minor impacts on aquatic habitats described above, it is unlikely that any aquatic species would be significantly affected by project construction or operation. Therefore, impacts on protected and rare aquatic species would be expected to be SMALL.

9.3.2.3.6 Socioeconomics

This subsection evaluates the social and economic impacts that could result from constructing and operating the new plant at Site 7-2. The evaluation includes the impacts of construction and operation activities and demands placed by the construction and operation workforces on the site and the surrounding region. It is assumed that all construction activities would occur within the site boundaries and off-site corridors described in Subsection 9.3.2.3, and physical impacts would be restricted to these construction areas and nearby properties. Other socioeconomic impacts generally occur on a regional basis, and in the following subsections they are evaluated for Salem County and the region within 50 mi. of Site 7-2.

9.3.2.3.6.1 Physical Impacts

Any large construction project can cause temporary and localized physical impacts such as noise, vibration, dust, vehicle exhaust, and odors. In addition, construction materials, equipment, and workers must be transported to the construction areas, and these transportation activities also cause noise, vibration, dust, vehicle exhaust, and odors. For Site 7-2, a new rail spur would be constructed, and this rail line would be used to transport large equipment and materials to the site. Public roadways would be used to transport smaller equipment, as well as large numbers of construction workers. Appropriate measures would be taken to minimize noise, dust, and other impacts due to both construction and transportation activities. However, because residences are located throughout the area surrounding Site 7-2, it would not be possible to avoid close proximity to some residences. Based on field reconnaissance and examination of aerial photographs, it is estimated that more than 75 residences are located within 0.5 mi. of the conceptual site boundaries. Other residences are located in close proximity to the conceptual rail spur and other off-site corridors. Despite the implementation of appropriate mitigation measures, many of these residences probably would experience some impact due to construction-related noise, vibration, and dust.

Other sensitive areas also would be subject to physical impacts during project construction. As discussed in Subsection 9.3.2.3.1, a private school is located immediately outside of the conceptual site boundaries. The school would not be directly disturbed by construction, but it would be exposed to noise, vibration, and dust. In addition, the conceptual pipeline corridor crosses parts of three Wildlife Management Areas, state-owned properties that are open to the public for hunting and fishing. It would not be feasible to re-route the pipeline corridor so as to completely avoid these areas. During installation of the pipelines, parts of the Wildlife Management Areas would be subject to noise, vibration, and dust.

Considering the conditions summarized above, project construction would noticeably alter the existing physical conditions in the site area and might destabilize sensitive resources such as the school or the Wildlife Management Areas. For this reason, the physical impact due to project construction would be MODERATE to LARGE.

The physical impacts of project operation would be similar to the impacts of construction but somewhat reduced. Operating plant equipment would produce some noise, but the noise levels

generally would be lower than the levels associated with construction activities. Workers and some materials and equipment would be transported to the site during project operation, but the amount of traffic and size of shipments generally would be less than during project construction. Periodic maintenance would be required for both on-site and off-site facilities, and the maintenance activities would create some noise, vibration, and dust, but these impacts would be more localized and of shorter duration than during project construction. Therefore, the physical impact due to project operation would be SMALL.

9.3.2.3.6.2 Demography

Impacts on demography would be associated with construction workers and operation workers moving into the region surrounding the project site. The significance of demographic impacts would be determined primarily by regional conditions, and those conditions are essentially the same for Site 7-2 as for the PSEG Site. Site 7-2 is in the same county as the PSEG Site and is located less than 15 mi. away from the PSEG Site. Therefore, regional demographic impacts would be essentially the same at both sites.

The analysis presented in Subsection 4.4.2.1 indicates that the demographic impact of constructing the new plant at the PSEG Site is expected to be SMALL. The analysis presented in Subsection 5.8.2.1 indicates that the demographic impact of plant operation at the PSEG Site also is expected to be SMALL. Therefore, the construction-related and operation-related demographic impact at Site 7-2 would be expected to be SMALL.

9.3.2.3.6.3 Economy

Impacts on the economy would be caused primarily by the jobs provided to construction and operation workers. The significance of economic impacts would be determined primarily by regional conditions, and those conditions are essentially the same for Site 7-2 as for the PSEG Site. Site 7-2 is in the same county as the PSEG Site and is located less than 15 mi. away from the PSEG Site. Therefore, regional economic impacts would be essentially the same at both sites.

The analysis presented in Subsection 4.4.2.2.1 indicates that the regional economic impact of constructing the new plant at the PSEG Site is expected to be SMALL. The analysis presented in Subsection 5.8.2.2.1 indicates that the regional economic impact of plant operation at the PSEG Site also is expected to be SMALL. Therefore, the construction-related and operation-related economic impact at Site 7-2 would be expected to be SMALL.

9.3.2.3.6.4 Taxes

Property taxes, sales taxes, and other taxes paid during construction and operation of the new plant would benefit the state and local jurisdictions that collect the taxes. The significance of tax impacts would be determined primarily by regional conditions, and those conditions are essentially the same for Site 7-2 as for the PSEG Site. Site 7-2 is in the same county as the PSEG Site and is located less than 15 mi. away from the PSEG Site. Therefore, regional tax impacts would be essentially the same at both sites.

The analysis presented in Subsection 4.4.2.2.2 indicates that the tax impact of constructing the new plant at the PSEG Site is expected to be SMALL. The analysis presented in Subsection 5.8.2.2.2 indicates that the tax impact of plant operation at the PSEG Site also is expected to be

SMALL. Therefore, the construction-related and operation-related tax impact at Site 7-2 would be expected to be SMALL.

9.3.2.3.6.5 Transportation

Transportation in the vicinity of the new plant could be affected by the increase in vehicle traffic associated with construction and operation workers commuting to the site and the delivery of materials and equipment to the site. The increase in vehicle traffic could cause delays on local roads. The severity of such impacts would depend primarily on the existing traffic volumes and LOS on local roads compared with the expected volume of project-related traffic.

Road access to the Site 7-2 area is provided primarily by NJ Route 540. This is considered a secondary state route, but it is a relatively wide two-lane highway. Road access to the site itself is provided primarily by Salem County Road 635. This is a narrow two-lane road that appears to be used mostly by local traffic.

The NJDOT does not publish LOS designations for roads in the state. However, NJDOT data (Reference 9.3-5) indicates that the average daily traffic volume (both directions) on NJ Route 540 is 5406 vehicles. NJDOT data does not include traffic volumes for Salem County Road 635.

As discussed in Subsection 4.4.1.5, maximum construction-related traffic volumes are expected to occur during shift changes (twice per day) in the peak construction workforce. During such shift changes, 2200 vehicles are expected to use local roads. Delivery of construction materials and equipment is expected to add another 50 vehicles per day over the construction period.

Considering the nature of the roads in the Site 7 -2 area and the current volume of traffic on those roads, it is likely that the peak construction traffic would noticeably alter existing transportation conditions (cause noticeable delays on local roads) but not be sufficient to destabilize important transportation resources. Therefore, the transportation impact associated with project construction would be MODERATE.

As discussed in Subsection 5.8.1.2, maximum traffic volumes associated with plant operation are expected to occur when fuel-reloading is being conducted for one generating unit and another unit is operating. The peak traffic volume at such times could be 1200 vehicles. Because this number of vehicles is significantly smaller than the peak construction traffic volume, it would not be expected to noticeably alter transportation conditions. Therefore, the transportation impact associated with project operation would be SMALL.

9.3.2.3.6.6 Aesthetics

Aesthetics in the vicinity of the new plant could be affected by the visual intrusion of large industrial structures and equipment. During project construction, dust could create additional visual intrusions. During operation, water vapor plumes from the cooling towers would be readily visible at certain times. Given that the Site 7-2 area currently has predominantly rural scenery, project construction and operation would dramatically alter the existing visual conditions. However, the severity of visual impacts on the human population would depend primarily on the visibility of the plant and off-site facilities from sensitive viewing areas.

As discussed in Subsection 9.3.2.3.6.1, field reconnaissance and examination of aerial photographs indicate that more than 75 residences are located within 0.5 mi. of the conceptual

site boundaries. Although trees and existing buildings may block the view of some of these residences, many would be expected to have at least a partial view of the power plant during construction and operation. In addition, some residences are located near the conceptual off-site corridors and would have at least a partial view of the transmission lines, rail spur, and other off-site facilities during construction and operation.

Other sensitive viewing areas also are located in relatively close proximity to the site and off-site corridors. As discussed in Subsection 9.3.2.3.1, a private school is located immediately outside of the conceptual site boundaries. The school would not be directly disturbed, but it would experience significant visual intrusion during project construction and operation.

In addition, the conceptual pipeline corridor passes through parts of three Wildlife Management Areas, state-owned properties that are open to the public for hunting and fishing. It would not be feasible to re-route the pipeline corridor so as to completely avoid these areas. Parts of the Wildlife Management Areas would have a clear view of the pipeline corridor during installation of the pipelines.

NUREG-1437 establishes the following criteria for judging the severity of aesthetic impacts:

> SMALL - No complaints from affected public about a changed sense of place or a diminution in enjoyment of the physical environment, and no measurable impact on socioeconomic institutions and processes.
>
> MODERATE - Some complaints from affected public about a changed sense of place or a diminution in enjoyment of the physical environment, and measurable impacts that do not alter the continued functioning of socioeconomic institutions and processes.
>
> LARGE - Continuing and widely shared opposition to the project based on a perceived degradation of the area's sense of place or diminution in enjoyment of the physical environment, and measurable social impacts that perturb the continued functioning of community institutions and processes.

Considering that the power plant and off-site facilities would be visible from several sensitive viewing areas, and considering that project construction would dramatically alter the existing rural scenery, it is very likely that project construction would generate public complaints related to a changed sense of place and diminished enjoyment of the physical environment. It is likely that there would be general opposition to the project, and possible that there could be measurable social impacts that perturb the continued functioning of institutions such as the private school and Wildlife Management Areas. Therefore, the aesthetic impact associated with project construction would be MODERATE to LARGE.

Although project operation would not result in significant further alteration of aesthetic conditions, the power plant, cooling tower plumes, transmission lines, and rail spur traffic would continue to be visible from sensitive viewing areas. It is likely that there would be public complaints related to diminished enjoyment of the physical environment, and possible that there could be general opposition to the project and measurable social impacts that perturb the continued functioning of community institutions and processes. Therefore, the aesthetic impact associated with project operation would be MODERATE to LARGE.

9.3.2.3.6.7 Housing

Impacts on housing could be caused by construction and operation workers moving, either permanently or temporarily, into the region surrounding the project site. The significance of housing impacts would be determined primarily by regional conditions, and those conditions are essentially the same for Site 7-2 as for the PSEG Site. Site 7-2 is in the same county as the PSEG Site and is located less than 15 mi. away from the PSEG Site. Therefore, regional housing impacts would be essentially the same at both sites.

The analysis presented in Subsection 4.4.2.2.4 indicates that the housing impact of constructing the new plant at the PSEG Site is expected to be SMALL. The analysis presented in Subsection 5.8.2.2.4 indicates that the housing impact of plant operation at the PSEG Site also is expected to be SMALL. Therefore, the construction-related and operation-related housing impact at Site 7-2 would be expected to be SMALL.

9.3.2.3.6.8 Public Services

Public services include police, fire and medical services; social services; water supply and waste water treatment facilities; and recreation facilities. Impacts on public services could be caused by construction and operation workers moving into the region surrounding the project site. The significance of public service impacts would be determined primarily by regional conditions, and those conditions are essentially the same for Site 7-2 as for the PSEG Site. Site 7-2 is in the same county as the PSEG Site and is located less than 15 mi. away from the PSEG Site. Therefore, regional public service impacts would be essentially the same at both sites.

The analysis presented in Subsection 4.4.2.2.5 indicates that the public service impact of constructing the new plant at the PSEG Site is expected to be SMALL. The analysis presented in Subsection 5.8.2.1 indicates that the public service impact of plant operation at the PSEG Site also is expected to be SMALL. Therefore, the construction-related and operation-related public service impact at Site 7-2 would be expected to be SMALL.

9.3.2.3.6.9 Education

Impacts on education could be caused by construction and operation workers moving into and bringing school-aged children into the region surrounding the project site. The significance of education impacts would be determined primarily by regional conditions, and those conditions are essentially the same for Site 7-2 as for the PSEG Site. Site 7-2 is in the same county as the PSEG Site and is located less than 15 mi. away from the PSEG Site. Therefore, regional education impacts would be essentially the same at both sites.

The analysis presented in Subsection 4.4.2.2.7 indicates that the education impact of constructing the new plant at the PSEG Site is expected to be SMALL. The analysis presented in Subsection 5.8.2.2.7 indicates that the education impact of plant operation at the PSEG Site also is expected to be SMALL. Therefore, the construction-related and operation-related education impact at Site 7-2 would be expected to be SMALL.

9.3.2.3.7 Historical and Archaeological Resources

Historical and archaeological resources could be directly disturbed by construction activities or indirectly disturbed by noise, dust, vehicle emissions, or visual intrusion during project

construction and operation. The severity of such impacts would depend on the historic significance of the resources and the degree of disturbance.

Several properties listed on the NRHP and/or the NJRHP are located in the immediate vicinity of Site 7-2 and the off-site corridors. The Philip Fries House, which is listed on both the NRHP and the NJRHP, is located 0.3 mi. from the conceptual site boundaries. The house would not be directly disturbed, but it would be subject to noise and visual intrusion during project construction and operation.

Deerfield Presbyterian Church, which is listed on both the NRHP and the NJRHP, is located 0.3 mi. from the conceptual rail spur corridor. The church would not be directly disturbed, but it would be subject to noise and visual intrusion during construction and operation of the rail spur.

In addition, three historical sites and one archaeological site are located on or near the conceptual pipeline corridor. It would be feasible to route the pipeline corridor so as to avoid direct disturbance to these sites, but they probably would be subject to noise and visual intrusion during construction of the pipelines.

The impacts summarized above would noticeably alter the existing historical and archaeological resources in the site area during project construction, but it is very unlikely that they would destabilize any important attributes of these resources. Therefore, the impact on historical and archaeological resources due to project construction would be MODERATE.

It does not appear that any additional disturbance of historical and archaeological resources would occur during project operation. Therefore, the impact on historical and archaeological resources due to project operation would be SMALL.

9.3.2.3.8 Environmental Justice

Environmental justice issues involve aspects of the project that could disproportionately impact minority or low income populations. The potential for disproportionate impacts depends primarily on the location of the power plant and off-site facilities in relation to existing minority and low income populations.

USCB data for the year 2000 (Reference 9.3-8) were used to determine the percentage of minority and low-income populations within the 6-mi. site vicinity, and to identify any census block groups within 6 mi. that contain a higher than average percentage of minority or low-income populations. The percentages for the site vicinity and each census block group were compared to the percentages for NJ.

Minorities comprise 20.9 percent of the population within 6 mi. of Site 7-2, compared with 34.0 percent for NJ. People with incomes below the poverty level comprise 11.5 percent of the population within 6 mi. of Site 7-2, compared with 8.5 percent for NJ. Of the 16 census block groups that have at least 50 percent of their area within 6 mi. of the site, 6 have minority and/or poverty populations above the state average. A census block group with poverty populations above the state average is located 0.5 mi. from the conceptual site boundaries; minorities comprise 22.6 percent of the population within this block group, and people with incomes below the poverty level comprise 9.4 percent. The conceptual pipeline corridor crosses part of this same block group. In addition, the conceptual rail spur corridor crosses part of a block group with both minority and poverty populations above the state average; minorities comprise 70.2

percent of the population within this block group, and people with incomes below the poverty level comprise 16.2 percent.

Based on the above information there appears to be a potential for the project to disproportionately impact minority and low income populations. The severity of the impacts would depend on exactly how minority and low income populations use the site area and the extent to which they would be exposed to the adverse impacts of project construction and operation. Detailed field investigations would be performed to determine the level of impact if development of this site progresses. Based on available information, it appears that environmental justice impacts due to project construction and operation could be MODERATE to LARGE.

9.3.2.4 Evaluation of Site 7-3

Site 7-3 is a greenfield site in Cumberland County, NJ. The site is located on flat land less than 1 mi. east of the Delaware River, which would be the primary water source. Elevations across the site range from 0 to 20 ft. above Mean Sea Level. Based on conceptual site boundaries identified by considering site development requirements and existing property parcels, the site has a total area of 886 ac.

Site 7-3 would require the following off-site features in order to support a nuclear power plant:

- Road access to the site would be provided by existing public roads, but portions of those roads would have to be relocated around plant facilities or improved to allow them to carry plant-related traffic. It was assumed that all roads would be constructed on a ROW 150 ft. wide. A total of 4.2 mi. of road construction was estimated to be required.
- A new makeup water pipeline would withdraw water from the Delaware River, and a new blowdown pipeline would discharge wastewater to the Delaware River. It was assumed that the two pipelines would be constructed parallel to one another, on a single ROW 100 ft. wide. A conceptual route to the Delaware River was identified based on existing terrain and land use features, and this route is 0.7 mi. long
- Three new 500 kV transmission lines would connect the site to the existing 500 kV transmission system. It was assumed that the three transmission lines would be constructed parallel to one another, each on a ROW 200 ft. wide. A conceptual route to the nearest existing 500 kV transmission line (which originates from the SGS/HCGS site) was identified based on existing terrain and land use features, and this route is 6.8 mi. long. It was expected that an interposing switchyard would be required at the connection point, and this switchyard was conceptually located on 25 ac. of land. In addition, it was expected that a new 500 kV transmission line would be required to address potential grid stability issues. A new line between the Indian River Substation in Delaware and the SGS/HCGS site (which, in turn, is electrically tied to the new interposing switchyard) would fulfill this purpose. The Indian River Substation is capable of providing synchronizing support to maintain system stability during grid disturbances. It was assumed that this transmission line would be

constructed on a 200 ft. wide ROW generally following existing transmission lines, for a total distance of approximately 107 mi.

Because Site 7-3 is located less than 1 mi. from the Delaware River and the intervening land is suitable for delivery of materials and large equipment off-loaded from a barge, a rail spur would not be required for delivery of materials and equipment to the site. However, the impact assessment includes a new road between the potential barge unloading area and the conceptual plant footprint. It was assumed that this road would be constructed parallel to the makeup and blowdown pipelines, on a ROW 150 ft. wide.

Subsections 9.3.2.4.1 through 9.3.2.4.8 discuss the potential environmental impacts of developing Site 7-3 and the off-site features listed above. Because the transmission corridors are significantly longer than the other off-site corridors and are not confined to the immediate site vicinity, quantitative estimates of potential impacts are presented separately for the transmission corridors.

9.3.2.4.1 Land Use

Existing land use across Site 7-3 is predominantly agricultural, with large fields planted in cultivated crops. Soils classified as prime farmland occur across much of the site. In addition, portions of the site are covered by a Deed of Conservation Restriction filed by PSEG. This restriction would have to be removed and mitigated in order to develop the site for a power plant.

Residences (single family houses) are scattered across the site. There are nine houses located within the conceptual site boundaries, and most of these houses would have to be removed before the site could be developed with a power plant. Most the site is zoned for Rural Residential use. Although the site is located more than 6 mi. from the nearest incorporated town, small concentrations of houses are located within 2 mi. of the site.

The off-site corridors for the access roads and water pipelines are largely confined to the immediate site vicinity, and the land use within these corridors is similar to the site itself, with most of the land in agricultural use. It is anticipated that the corridors could be developed without removing existing houses, but some houses would be located in close proximity to the various ROW alignments.

No significant industrial land uses have been identified on the site, within the associated off-site corridors, or in close proximity.

Based on the conceptual plant layout developed for Site 7-3, development of the site would directly disturb (permanently and temporarily) 395 ac. of land. The remaining land within the site boundaries, which totals 491 ac., would not be directly disturbed, but access to this land would be controlled and it generally would be unavailable for non-power plant uses. In addition, development of the access road and water pipeline corridors would disturb 84 ac. of land. Cumulatively, 970 ac. would be disturbed or made unavailable for non-power plant uses. The acreage of each major land use category currently found on this land was estimated based on GIS mapping data. Table 9.3-17 summarizes the acreages in the major land use categories and compares those quantities with the total acreages found in the site vicinity (within a 6 mi. radius of the site).

Table 9.3-17 shows that the acreage of each land use category potentially affected by project construction is a relatively small percentage of the total acreage of that land use available in the site vicinity. It is not expected that project construction would destabilize any important land use resources. However, construction would change the site and associated off-site corridors from predominantly rural land use with scattered housing and very little industrial development to intensive heavy industrial use. This would noticeably alter the existing land use resources. Therefore, the land use impact due to project construction would be MODERATE.

As discussed in Subsection 9.3.2.4, the potential transmission corridor from the SGS/HCGS site to the Indian River Substation is approximately 107 mi. long. This corridor, along with the transmission corridor from Site 7-3 to the nearest existing 500 kV transmission line and an interposing switchyard at the connection point, includes 3238 ac. of land. The acreage of each major land use category currently found on this land was estimated based on GIS mapping data. Table 9.3-18 summarizes the acreages in the major land use categories and compares those quantities with the total acreages found in the 6 mi. site vicinity.

Table 9.3-18 shows that the acreage of each land use category potentially affected by transmission line construction is a relatively small percentage of the total acreage of that land use available in the site vicinity. It is not expected that transmission line construction would destabilize any important land use resources. However, transmission line construction would noticeably alter the existing land use on more than 3200 ac. of land. Permanent land impacts associated with the transmission corridor, such as tower foundations, would be substantially less than the total acreage of the corridor. It is possible that some residences or other buildings would have to be removed to provide adequate clearance for the transmission lines. Therefore, the land use impact due to transmission line construction would be MODERATE.

During project operation, land use impacts would be reduced. Agricultural activities may be allowed in the transmission line and pipeline ROWs. No new land use impacts would occur beyond those described above for project construction, so land use resources that exist at the conclusion of the construction phase would not be noticeably altered. Therefore, the land use impact due to project operation would be SMALL.

9.3.2.4.2 Air Quality

The air quality impacts of constructing and operating the new plant and off-site facilities for Site 7-3 would be similar to the impacts expected for the PSEG Site. Cumberland County is classified as a non-attainment area for ozone, and it is considered to be in attainment with the NAAQS for all other criteria pollutants. This is the same classification as Salem County, where the PSEG Site is located.

Air quality impacts during project construction would include dust from earthmoving and material handling activities, and exhaust emissions from construction vehicles and equipment. These impacts would be similar to the impacts associated with any large construction project. To limit and mitigate the impacts, emission-specific strategies, plans and measures would be developed and implemented to ensure compliance with applicable federal and state regulations. Therefore, air quality impacts associated with construction would be SMALL.

During plant operation, the cooling towers would emit particulate matter. Auxiliary boilers and standby diesel generators or combustion turbines would emit particulate matter and gaseous pollutants such as nitrogen oxides. All emissions would be governed by a Prevention of

Significant Deterioration Permit and a Title V Certificate to Operate, which would ensure compliance with the NAAQS and other applicable regulatory requirements. Therefore, air quality impacts associated with operation would be SMALL.

9.3.2.4.3 Hydrology, Water Use, and Water Quality

The Delaware River would be the primary source of water for a plant located at Site 7-3. The site is located 5 mi. from the river, so the only direct impact on the river during project construction would be disturbance of a relatively small section of the shoreline and river bottom for installation of a water intake structure, wastewater discharge structure, and barge docking and offloading facility.

Water-related impacts associated with construction activities on the site itself would be similar to the impacts of any large construction project. Potential impacts include direct physical alteration of local surface water bodies; indirect alteration of nearby surface water bodies due to increased runoff volumes or diversions of runoff; degradation of downstream surface water quality as a result of erosion and sedimentation or discharges of pollutants associated with construction activities; and changes in groundwater flow patterns due to dewatering of excavations and soil retention management practices. Similar impacts would occur in the off-site corridors for construction of the rail spur, access roads, and other off-site facilities. The most significant impact would be that some existing streams on the site and within the off-site corridors would be directly disturbed, and some adjacent streams would experience a temporary increase in sediment loading due to increased runoff of disturbed soil.

Several federal, state, and local permits would govern construction activities that have the potential to impact water resources. Water-related impacts would be minimized by implementing BMPs, including erosion, grading, and sediment control measures; stormwater pollution prevention plans; spill prevention and countermeasure plans; and compliance with federal, state, and local regulations pertaining to disturbance of water bodies and pollution discharges. Withdrawal of either surface water or groundwater would be anticipated during project construction, but the quantities would be less than the quantities evaluated below for project operation. Therefore, impacts on water resources due to project construction would be SMALL.

During project operation, the new plant would withdraw make-up water from the Delaware River and discharge wastewater (primarily cooling tower blowdown) to the river. The water withdrawn from the river would either be returned to the river as blowdown or lost to the atmosphere through operation of the cooling towers. Water returned to the river as blowdown would not be lost to downstream users or aquatic communities.

As discussed in Section 3.3, the water withdrawal rate for the new plant at the PSEG Site is 78,196 gpm, and the consumptive water loss (primarily due to evaporation from the cooling towers) is 26,420 gpm. These values assume that the cooling towers operate at 1.5 cycles of concentration, which is appropriate for the brackish water found in the Delaware River at the PSEG Site. Site 7-3 would withdraw water from the same part of the Delaware River, so the same values can be used for Site 7-3.

Based on USGS data (Reference 9.3-10) for the nearest available gauging station (near Trenton, NJ), the annual mean river flow is 5,318,636 gpm, and the 7Q10 flow is 771,988 gpm. Based on these statistics, the withdrawal rate (78,196 gpm) would divert approximately 1.5 percent of the annual mean river flow and 10.1 percent of the 7Q10 flow. The consumptive

water loss (26,420 gpm) would reduce the annual mean river flow by 0.5 percent and the 7Q10 flow by 3.4 percent.

As stated above, Site 7-3 is located in an area where the Delaware River water is brackish. Because consumptive water use at locations with brackish water has a lesser impact on salinity intrusion than an equal consumption of fresh water, the DRBC has developed an EIF to account for the difference. As discussed in Subsection 5.2.1.2, the EIF in the PSEG Site area is 0.18. The factor applicable to Site 7-3 would nominally be the same as the value for the PSEG Site. Using this factor, the 26,420 gpm consumptive use of Delaware River water is equivalent to a freshwater consumptive use impact of a 4756 gpm. This impact represents approximately 0.1 percent of the annual average river flow and 0.6 percent of the 7Q10 flow.

It should be noted that the Trenton gauging station is more than 60 mi. upstream of the Site 7-3 area. Therefore, the actual river flows in the site area are expected to be considerably higher than the flows discussed above, and the impacts of water withdrawal and consumption would be correspondingly lower. It also should be noted that PSEG is a co-owner of the Merrill Creek Reservoir and has an established allocation of water that can be released from the reservoir to offset consumptive use during periods of declared drought. Water withdrawal for the new plant could be supported by re-allocation of water among the existing PSEG plants, or additional existing water allocation rights would be acquired from other Merrill Creek co-owner(s).

The withdrawal of water from the Delaware River would be regulated by the DRBC and NJDEP, which would ensure that the diversion and consumption of river water did not adversely affect downstream users or aquatic communities. The discharge of wastewater to the Delaware River also would be regulated, ensuring compliance with applicable water quality standards and designated uses of the river. Discharges of stormwater runoff from the operational plant site and off-site facilities would be similarly regulated by the NJDEP. Therefore, impacts on surface water resources due to project operation would be SMALL.

Because the Delaware River is brackish in the Site 7-3 area, groundwater withdrawal would be necessary to provide fresh water for plant uses. In order to make a consistent comparison of impacts with the PSEG Site, it was assumed that the same amount of groundwater withdrawal for the PSEG Site (210 gpm average, 953 gpm maximum) would be required.

Based on data provided by the USGS (Reference 9.3-11) and the New Jersey Water Science Center (Reference 9.3-6), groundwater wells in the Site 7-3 area would withdraw water from either the Kirkwood-Cohansey Coastal Plain Aquifer or the Atlantic City Sand Aquifer. Both aquifers consist of fine-to-coarse grained sand. The Kirkwood-Cohansey Aquifer is unconfined, and typical well yields range from 500 to 1000 gpm. The Atlantic City Sand Aquifer is confined, and typical well yields range from 600 to 800 gpm.

The above information indicates that the plant groundwater requirements could be supplied by one or two wells drilled to the Kirkwood-Cohansey Coastal Plain Aquifer or the Atlantic City Sand Aquifer. Although some parts of these aquifers may have experienced groundwater drawdown, it is likely that properly located wells could supply the plant water needs with no expected problems. Section 2.3 provides additional discussion of groundwater resources. In addition, groundwater withdrawal would be regulated by both the DRBC and the NJDEP. Therefore, impacts on groundwater resources due to project operation would be SMALL.

9.3.2.4.4 Terrestrial Biological Resources Including Protected Species

Any large construction project impacts terrestrial ecology primarily by disturbing natural habitats and making those habitats unavailable to plants and animals. Although construction activities may result in direct mortality to some plants and animals, most animal species are able to move away to avoid direct impacts. Even those species, however, may experience population declines due to loss of habitat. In addition, noise, lights, and dust may cause some animals to leave areas near construction activities. This is also experienced as a loss of usable habitat.

As described in the New Jersey Wildlife Action Plan (Reference 9.3-4), Site 7-3 is located in the Shoreline Zone of the Delaware Bay Landscape Region. Critical habitats in this zone include beaches, dunes, and tidal and freshwater. Rich farmlands are found inland from the Delaware Bay shoreline.

Ecological conditions on Site 7-3 are typical of the farmlands found in the Shoreline Zone. Most of the land is used for agriculture. Forest is restricted to scattered woodlots and strips of trees along streams. Wetlands, both tidal and freshwater, are found primarily in isolated low areas, and some of the wetlands are farmed. Grasslands are virtually absent. The off-site corridors for the access roads and water pipelines are largely confined to the immediate site vicinity, and the natural habitats within these corridors are similar to the site itself.

As discussed in Subsection 9.3.2.4.1, development of the site would directly disturb (permanently and temporarily) 395 ac. of land. The remaining land within the site boundaries, which totals 491 ac., would not be directly disturbed, but construction activities would subject much of this land to indirect disturbance (noise, dust, etc.) and impede the movement of wildlife within this area. In addition, development of the access road and water pipeline corridors would disturb 84 ac. of land. Cumulatively, 970 ac. would be directly or indirectly disturbed. The acreage of forest, wetlands, and grassland habitat currently found on this land was estimated based on GIS mapping data. Table 9.3-19 summarizes the acreage of each habitat that would be potentially affected and compares those quantities with the total acreage found in the site vicinity (within a 6 mi. radius of the site).

Table 9.3-19 shows that the acreage of each habitat potentially affected by project construction is a relatively small percentage of the total acreage of that habitat available in the site vicinity. In addition, the specific habitat areas that would be disturbed generally are small and isolated from larger habitat areas. Therefore, the overall impacts on terrestrial ecology due to project construction would be SMALL. However, based on the acreage of wetlands that would be potentially affected (173 ac.), the wetlands impact due to project construction would be considered MODERATE.

As discussed in Subsection 9.3.2.4, the potential transmission corridor from the SGS/HCGS site to Indian River Substation is approximately 107 mi. long. This corridor, along with the transmission corridor from Site 7-3 to the nearest existing 500 kV transmission line and an interposing switchyard at the connection point, includes 3238 ac. of land. The acreage of forest, wetlands, and grassland habitat currently found on this land was estimated based on GIS mapping data. Table 9.3-20 summarizes the acreage of each habitat that would be potentially impacted and compares those quantities with the total acreages found in the 6 mi. site vicinity.

Table 9.3-20 shows that the acreage of each habitat potentially affected by transmission line construction is a relatively small percentage of the total acreage of that habitat available in the

site vicinity. It is not expected that transmission line construction would destabilize terrestrial ecological resources. However, the acreage of both wetlands and forest that would be potentially affected (936 ac. and 632 ac., respectively) is somewhat significant. It should be noted that wetlands impacts would be limited to the areas of tower construction, and final routing of the transmission line would take wetlands avoidance into consideration. Clearing of the forested areas would noticeably alter the plant and animal species found in these areas. Therefore, the impacts on terrestrial ecology due to transmission line construction would be MODERATE.

The terrestrial ecology impacts of project operation would be similar to the impacts of construction but somewhat reduced. Areas that are paved or occupied by project facilities would be permanently unavailable to plants and animals, but areas that are used for construction laydown or other temporary activities may be re-colonized by some species after construction is finished. Therefore, impacts on terrestrial ecology due to operation of the power plant, transmission lines, and other off-site features would be SMALL.

Information on protected and rare species that may occur in the Site 7-3 area was obtained from the NJDEP (Reference 9.3-3). According to this information, 13 animal species have been recorded within approximately 1 mi. of the site. These species are listed in Table 9.3-21. Detailed field studies would be required to determine whether any of these species make significant use of the site or off-site corridors, and as reconnaissance level data was used for evaluation, such studies were not conducted for the alternative sites. However, based on the relatively minor impacts on natural habitats described above, it is unlikely that any of these species would be significantly affected by project construction or operation. Therefore, impacts on protected and rare terrestrial species would be expected to be SMALL.

9.3.2.4.5 Aquatic Biological Resources Including Protected Species

As discussed in Subsection 9.3.2.4.3, project construction would result in the disturbance of a relatively small section of the Delaware River shoreline and river bottom due to installation of a water intake structure, wastewater discharge structure, and barge docking facility. Some aquatic organisms that use this area might suffer direct mortality from construction activities, but most organisms would move away from the area and be affected primarily by the loss of a limited amount of habitat. In addition, some aquatic species might be affected by increased turbidity and siltation resulting from construction activities, but such effects would be temporary and localized.

Construction activities on the site and in the off-site corridors would result in direct disturbance to some existing streams, and some adjacent streams would experience a temporary increase in sediment loading due to increased runoff of disturbed soil. There is no indication that any of the streams that would be affected have any exceptional or high value. Similar streams are common in the 6-mi. vicinity around Site 7-3.

Based on GIS mapping data, the total length of streams that would be directly affected by construction on the site and in the access road, rail spur, and water pipeline corridors is 3747 ft. This represents less than 0.1 percent of the total length of streams in the 6-mi. site vicinity (4,121,978 ft.). In addition, the total length of streams included within the transmission corridors and interposing switchyard is 86,596 ft., which represents approximately 2.1 percent of the stream length in the site vicinity. Most of the streams in the transmission corridors would not be

directly affected; it is estimated that 95 percent of the streams could be avoided during transmission line construction.

From the numbers discussed above, it is clear that the expected stream disturbance is a very small percentage of the total length of streams available in the site vicinity. In addition, construction impacts on streams and on the Delaware River would be regulated by several federal, state, and local permits. Therefore, impacts on aquatic ecology due to construction of the power plant, transmission lines, and other off-site features would be SMALL.

During operation of the power plant, transmission lines, and other off-site features, there would be little if any additional impact on streams. The primary source of potential impacts during operation would be the withdrawal of water from the Delaware River. Some aquatic organisms would be entrained with the intake water or impinged on the intake screens. However, federal regulations (40 CFR Part 125) require cooling water intake structures to meet stringent criteria designed to protect organisms from entrainment and impingement. In addition, the amount of water withdrawn would be a relatively small percentage of the overall river flow, as discussed in Subsection 9.3.2.4.3. Therefore, impacts on aquatic ecology due to project operation would be SMALL.

Information provided by the NJDEP on protected and rare species that may occur in the site area (Reference 9.3-3) identified one aquatic species, the Shortnose Sturgeon. This species is known to occur throughout the lower reaches of the Delaware River. Detailed field studies would be required to determine whether the Shortnose Sturgeon or any other protected or rare aquatic species make significant use of the part of the Delaware River or any streams that could be affected by the project, and as reconnaissance level data was used for evaluation, such studies were not conducted for the alternative sites. However, based on the relatively minor impacts on aquatic habitats described above, it is unlikely that any aquatic species would be significantly affected by project construction or operation. Therefore, impacts on protected and rare aquatic species would be expected to be SMALL.

9.3.2.4.6 Socioeconomics

This subsection evaluates the social and economic impacts that could result from constructing and operating the new plant at Site 7-3. The evaluation includes the impacts of construction and operation activities and demands placed by the construction and operation workforces on the site and the surrounding region. It is assumed that all construction activities would occur within the site boundaries and off-site corridors described in Subsection 9.3.2.4, and physical impacts would be restricted to these construction areas and nearby properties. Other socioeconomic impacts generally occur on a regional basis, and in the following subsections they are evaluated for Cumberland County and the region within 50 mi. of Site 7-3.

9.3.2.4.6.1 Physical Impacts

Any large construction project can cause temporary and localized physical impacts such as noise, vibration, dust, vehicle exhaust, and odors. In addition, construction materials, equipment, and workers must be transported to the construction areas, and these transportation activities also cause noise, vibration, dust, vehicle exhaust, and odors. For Site 7-3, public roadways would be used to transport equipment and materials that were not delivered by barge. Large numbers of construction workers also would use public roadways to reach the site. Appropriate measures would be taken to minimize noise, dust, and other impacts due to both

construction and transportation activities. However, because residences are located throughout the area surrounding Site 7-3, it would not be possible to avoid close proximity to some residences. Based on field reconnaissance and examination of aerial photographs, approximately 17 residences are located within 0.5 mi. of the conceptual site boundaries. Other residences are located in close proximity to the conceptual transmission corridor. Despite the implementation of appropriate mitigation measures, some of these residences probably would experience some impact due to construction-related noise, vibration, and dust. This would noticeably alter the existing physical conditions in the immediate site area. For this reason, the physical impact due to project construction would be MODERATE.

The physical impacts of project operation would be similar to the impacts of construction but somewhat reduced. Operating plant equipment would produce some noise, but the noise levels generally would be lower than the levels associated with construction activities. Workers and some materials and equipment would be transported to the site during project operation, but the amount of traffic and size of shipments generally would be less than during project construction. Periodic maintenance would be required for both on-site and off-site facilities, and the maintenance activities would create some noise, vibration, and dust, but these impacts would be more localized and of shorter duration than during project construction. Therefore, the physical impact due to project operation would be SMALL.

9.3.2.4.6.2 Demography

Impacts on demography would be associated with construction workers and operation workers moving into the region surrounding the project site, potentially causing changes in off-site land use and development patterns. Construction employment is inherently temporary, but construction workers sometimes move their families into the region, magnifying the population increase. However, in densely populated states such as NJ and the adjacent states, a substantial number of construction workers may commute from their existing residences and not need to move into the region.

Per NUREG-1437, demographic impacts are expected to be SMALL if project-related population growth represents less than 5 percent of the study area’s total population, MODERATE if 5 to 20 percent, and LARGE if more than 20 percent.

The analysis presented in Subsection 4.4.2.1 indicates that if the new plant were constructed at the PSEG Site, 634 of the 4100 construction workers could be expected to move into the four-county Region of Influence. The analysis conservatively assumes that all of the workers who move into the region would bring their families, resulting in a total population increase of 1712 people. For purposes of evaluating demographic impacts at Site 7-3, it was assumed that the same population increase would occur in Cumberland County. For the purpose of this comparison, this is considered a conservative assumption, because the same population increase for the four counties surrounding the PSEG Site is being applied to one county for Site 7-3 and the impact is not noticeable.

Based on USCB data (Reference 9.3-9), the population of Cumberland County was 146,438 in the year 2000, and the population was estimated to have increased to 156,830 in 2008. Using the year 2000 population (146,438) and the conservative population increase discussed above (1712), project-related population growth due to the construction workforce would be approximately 1.2 percent. Therefore, the construction-related demographic impact in Cumberland County would be SMALL.

Another conservative assumption that can be made is that the entire peak construction workforce (4100 people) would move into and bring families into the 50-mi. region surrounding the project site. Applying the average NJ household size of 2.70 people per household (Subsection 4.4.2.1), the total population increase would be 11,070. Based on USCB data (Reference 9.3-9), the population of the region within a 50-mi. radius of Site 7-3 was 5,047,429 in the year 2000. Using this population value and a population increase of 11,070, project-related population growth due to the construction workforce would be 0.2 percent. Therefore, the construction-related demographic impact in the 50-mi. region would be SMALL.

The analysis presented in Subsection 5.8.2.1 indicates that if the new plant were constructed at the PSEG Site, 496 of the 600 operation workers could be expected to move into the four-county Region of Influence. Conservatively assuming that all of these workers moved into Cumberland County and brought families with an average of 2.70 people per household, the resulting population increase would be 1338 people. Obviously, this would be a smaller impact than the construction-related population increase discussed above. In addition, the total number of operation workers is significantly smaller than the peak construction workforce discussed above. Therefore, the operation-related demographic impact in both Cumberland County and the 50-mi. region would be SMALL.

9.3.2.4.6.3 Economy

Impacts on the economy would be caused primarily by the jobs provided to construction and operation workers. The wages paid to workers result in additional spending, which tends to stimulate the economy, particularly in the retail and service sectors. This can provide opportunities for new businesses and new jobs. These effects are considered to be beneficial and would be expected to occur primarily in the area within which the workers reside.

Per NUREG-1437, economic impacts are considered SMALL if project-related employment represents less than 5 percent of the study area’s total employment, MODERATE if 5 to 10 percent, and LARGE if more than 10 percent.

In the previous subsection it was conservatively estimated that if the new plant were constructed at Site 7-3, 634 construction workers would move into Cumberland County and 4100 construction workers would move into the 50-mi. region surrounding the site.

Based on USCB data for the year 2000 (Reference 9.3-9), the total number of employees in Cumberland County was 59,129, and the total number of employees in the 50-mi. region was 2,283,341. Using the county value for total employment (59,129) and the conservative county employment increase discussed above (634), project-related employment due to the construction workforce would be 1.1 percent. Therefore, the construction-related economic impact in Cumberland County would be SMALL. Using the regional value for total employment (2,283,341) and the conservative regional employment increase discussed above (4100), project-related employment due to the construction workforce would be less than 0.2 percent. Therefore, the construction-related economic impact in the 50-mi. region would be SMALL.

As discussed in the previous subsection, the number of operation workers estimated to move into both Cumberland County and the 50-mi. region is significantly smaller than the number of construction workers. Therefore, the operation-related economic impact in both Cumberland County and the 50-mi. region would be SMALL.

9.3.2.4.6.4 Taxes

Property taxes, sales taxes, and other taxes paid during construction and operation of the new plant would benefit the state and local jurisdictions that collect the taxes. Per NUREG-1437, tax impacts are considered SMALL if project-related tax revenues represent less than 10 percent of the total tax revenues of the local taxing jurisdictions, MODERATE if 10 to 20 percent, and LARGE if more than 20 percent.

The analysis presented in Subsections 4.4.2.2.2 indicates that the taxes paid by the new plant during project construction are expected to be significantly less than 10 percent of the total tax revenues for Salem County, resulting in a SMALL tax impact. The analysis presented in Subsection 5.8.2.2.2 indicates that the taxes paid by the new plant during project operation also are expected to result in a SMALL tax impact.

Based on 2008 county budget documents (Reference 9.3-1), Salem County has total annual tax revenues of $50,139,854, while Cumberland County has total annual tax revenues of $76,100,000. Therefore, the taxes paid by the new plant would be a smaller percentage of the total tax revenues for Cumberland County than for Salem County, and the tax impact associated with both construction and operation would be SMALL.

9.3.2.4.6.5 Transportation

Transportation in the vicinity of the new plant could be affected by the increase in vehicle traffic associated with construction and operation workers commuting to the site and the delivery of materials and equipment to the site. The increase in vehicle traffic could cause delays on local roads. The severity of such impacts would depend primarily on the existing traffic volumes and LOS on local roads compared with the expected volume of project-related traffic.

Road access to the Site 7-3 area is provided primarily by Cumberland County Roads 623 and 639. Access to the site itself is provided by Cumberland County Road 642. All of these are relatively narrow two-lane roads that appear to be used mostly by local traffic.

The NJDOT does not publish LOS designations for roads in the state. However, NJDOT data (Reference 9.3-5) indicates that the average daily traffic volume (both directions) on Cumberland County Road 642 is 230 vehicles. NJDOT data does not include traffic volumes for Cumberland County Roads 623 and 639.

As discussed in Subsection 4.4.1.5, maximum construction-related traffic volumes are expected to occur during shift changes (twice per day) in the peak construction workforce. During such shift changes, 2200 vehicles are expected to use local roads. Delivery of construction materials and equipment is expected to add another 50 vehicles per day over the construction period.

Considering that the only roads that currently provide access to the Site 7-3 area are narrow, two-lane, local roads with very low traffic volumes, it is likely that the peak construction traffic would cause significant delays on those roads and might be sufficient to destabilize local transportation resources. Therefore, the transportation impact associated with project construction would be MODERATE to LARGE.

As discussed in Subsection 5.8.1.2, maximum traffic volumes associated with plant operation are expected to occur when fuel-reloading is being conducted for one generating unit and

another unit is operating. The peak traffic volume at such times could be 1200 vehicles. Because this number of vehicles is significantly smaller than the peak construction traffic volume, it would not be expected to noticeably alter transportation conditions. Therefore, the transportation impact associated with project operation would be SMALL.

9.3.2.4.6.6 Aesthetics

Aesthetics in the vicinity of the new plant could be affected by the visual intrusion of large industrial structures and equipment. During project construction, dust could create additional visual intrusions. During operation, water vapor plumes from the cooling towers would be readily visible at certain times. Given that the Site 7-3 area currently has predominantly rural scenery, project construction and operation would dramatically alter the existing visual conditions. However, the severity of visual impacts on the human population would depend primarily on the visibility of the plant and off-site facilities from sensitive viewing areas.

As discussed in Subsection 9.3.2.4.6.1, field reconnaissance and examination of aerial photographs indicate that approximately 17 residences are located within 0.5 mi. of the conceptual site boundaries. Although trees and existing buildings may block the view of some of these residences, some would be expected to have at least a partial view of the power plant during construction and operation. In addition, some residences are located near the conceptual off-site corridors and would have at least a partial view of the transmission lines or access road during construction and operation.

The only other sensitive viewing area identified in close proximity to the site or off-site corridors is Stow Creek Wildlife Management Area, a state-owned property that is open to the public for hunting and fishing. The nearest boundary of this area is 1.3 mi. away from the conceptual site boundaries; at that distance, the power plant might be partially visible from parts of the Wildlife Management Area during construction and operation. In addition, part of the Wildlife Management Area is adjacent to a section of the conceptual transmission corridor. The transmission lines would be partially visible from that part of the Wildlife Management Area during construction and operation.

NUREG-1437 establishes the following criteria for judging the severity of aesthetic impacts:

> SMALL - No complaints from affected public about a changed sense of place or a diminution in enjoyment of the physical environment, and no measurable impact on socioeconomic institutions and processes.
>
> MODERATE - Some complaints from affected public about a changed sense of place or a diminution in enjoyment of the physical environment, and measurable impacts that do not alter the continued functioning of socioeconomic institutions and processes.
>
> LARGE - Continuing and widely shared opposition to the project based on a perceived degradation of the area's sense of place or diminution in enjoyment of the physical environment, and measurable social impacts that perturb the continued functioning of community institutions and processes.

Considering that the power plant and off-site facilities would be visible from some sensitive viewing areas, and considering that project construction would dramatically alter the existing rural scenery, it is very likely that construction would generate public complaints related to a

changed sense of place and diminished enjoyment of the physical environment. It is possible that there could be general opposition to the project, but it is unlikely that there would be measurable social impacts that perturb the continued functioning community institutions and processes. Therefore, the aesthetic impact associated with project construction would be MODERATE.

Although project operation would not result in significant further alteration of aesthetic conditions, the power plant, cooling tower plumes, and transmission lines would continue to be visible from sensitive viewing areas. It is likely that there would be public complaints related to diminished enjoyment of the physical environment, be but it is unlikely that there would general opposition to the project or measurable social impacts that perturb the continued functioning of community institutions and processes. Therefore, the aesthetic impact associated with project operation would be MODERATE.

9.3.2.4.6.7 Housing

Impacts on housing could be caused by construction and operation workers moving, either permanently or temporarily, into the region surrounding the project site. This influx of workers could decrease the availability of unoccupied housing units and increase the cost to buy or rent housing. The severity of such impacts would depend primarily on the existing availability of unoccupied housing units compared with the number of workers who would move into the area.

NUREG-1437 establishes the following criteria for judging the severity of housing impacts:

> 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.
>
> MODERATE - Discernible but short-lived reduction in available housing units. Rental rates and housing values rise slightly faster than the inflation rate, but prices realign quickly once new housing units became available or project-related demand diminishes.
>
> LARGE - Project-related demand for housing units results in very limited housing availability and increases in rental rates and housing values well above normal inflationary increases in the state.

In Subsection 9.3.2.4.6.2 it was conservatively estimated that if the new plant were constructed at Site 7-3, 634 construction workers would move into Cumberland County and 4100 construction workers would move into the 50-mi. region surrounding the site.

Based on USCB data for the year 2000 (Reference 9.3-9), the total number of housing units in Cumberland County was 52,863, and the number of vacant units was 3720. The conservative estimate of in-migrating construction workers discussed above (634) represents 17.0 percent of the unoccupied housing units in the county. Because a large percentage of the unoccupied housing units would remain available, it is unlikely that there would be an easily discernible change in housing availability or a significant increase in housing costs. Therefore, the construction-related housing impact in Cumberland County would be SMALL.

Based on USCB year 2000 data, the total number of housing units in the 50-mi. region surrounding Site 7-3 was 2,112,404, and the number of vacant units was 211,511. The conservative estimate of in-migrating construction workers discussed above (4100) represents

1.9 percent of the unoccupied housing units in the region. Because a large percentage of the unoccupied housing units would remain available, it is very unlikely that there would be a discernible change in housing availability or increase in housing costs. Therefore, the construction-related housing impact in the 50-mi. region would be SMALL.

As discussed in Subsection 9.3.2.4.6.2, the number of operation workers estimated to move into both Cumberland County and the 50-mi. region is significantly smaller than the estimated number of construction workers. Therefore, the operation-related housing impact in both Cumberland County and the 50-mi. region would be SMALL.

9.3.2.4.6.8 Public Services

Public services include police, fire and medical services; social services; water supply and waste water treatment facilities; and recreation facilities. Impacts on public services could be caused by construction and operation workers moving into the region surrounding the project site. This influx of workers could increase the demand for public services, potentially requiring local governments to add facilities, programs, and/or staff.

Per NUREG-1437, impacts on public services generally are considered to be SMALL if there is little or no need to add facilities, programs, and/or staff because of the influx of workers, and MODERATE or LARGE if additional facilities, programs, and/or staff are required.

As discussed in Subsection 9.3.2.4.6.2, the number of construction and operation workers estimated to move into both Cumberland County and the 50-mi, region is insignificant compared with the existing populations. Because there would not be a noticeable increase in the population demanding public services, it is very unlikely that there would be a need to add facilities, programs, and/or staff. Therefore, the construction-related and operation-related impact on public services in both Cumberland County and the 50-mi. region would be SMALL.

9.3.2.4.6.9 Education

Impacts on education could be caused by construction and operation workers moving into and bringing school-aged children into the region surrounding the project site. This increase in the number of school-aged children could cause crowding of local schools and potentially require school systems to add facilities and/or staff.

Per NUREG-1437, impacts on education are considered to be SMALL if the project-related increase in school enrollment represents less than 3 percent of the total school enrollment in affected school systems, MODERATE if 4 to 8 percent, and LARGE if more than 8 percent.

The analysis presented in Subsection 4.4.2.2.7 indicates that if the new plant were constructed at the PSEG Site, 315 school-aged children could be expected to move into the four-county Region of Influence. For purposes of evaluating education impacts at Site 7-3, it was assumed that the same increase in the number of school-aged children would occur in Cumberland County. For the purpose of this comparison, this is considered a conservative assumption, because the same increase for the four counties surrounding the PSEG Site is being applied to one county for Site 7-3 and the impact is not noticeable.

Based on USCB data for the year 2000 (Reference 9.3-9), the total school enrollment (kindergarten through 12th grade) in Cumberland County was 29,889. The conservative increase

in school-aged children discussed above (315) represents 1.1 percent of the total school enrollment in the county. Therefore, the construction-related education impact in Cumberland County would be SMALL.

In Subsection 9.3.2.4.6.2 it was conservatively estimated that the total construction-related population increase in the 50-mi. region surrounding Site 7-3 would be 11,070. As discussed in Subsection 4.4.2.2.7, school-aged children account for 14.0 to 18.4 percent of the total county populations in the four-county Region of Influence. Using the highest percentage (18.4), the construction-related population increase (11,070) would result in 2037 school-aged children moving into the 50-mi. region surrounding Site 7-3.

Based on USCB year 2000 data, the total school enrollment (kindergarten through 12th grade) in the 50-mi. region surrounding Site 7-3 was 982,273. The conservative increase in school-aged children discussed above (2037) represents 0.2 percent of the total school enrollment in the region. Therefore, the construction-related education impact in the 50-mi. region would be SMALL.

As discussed in Subsection 6.3.2.1.6.2, the number of operation workers estimated to move into both Cumberland County and the 50-mi. region is significantly smaller than the estimated number of construction workers. The number of school-aged children would be correspondingly smaller. Therefore, the operation-related education impact in both Cumberland County and the 50-mi. region would be SMALL.

9.3.2.4.7 Historical and Archaeological Resources

Historical and archaeological resources could be directly disturbed by construction activities or indirectly disturbed by noise, dust, vehicle emissions, or visual intrusion during project construction and operation. The severity of such impacts would depend on the historic significance of the resources and the degree of disturbance.

Two properties listed on the NRHP and the NJRHP are located in the immediate vicinity of Site 7-3. The Thomas Maskel House, which is listed on both the NRHP and the NJRHP, is located 0.3 mi. from the conceptual site boundaries. The house would not be directly disturbed, but it would be subject to noise and visual intrusion during project construction and operation.

The Greenwich Historic District, which is listed on both the NRHP and the NJRHP, is located 1.2 mi. from the conceptual site boundaries, and might experience some visual intrusion during project construction and operation. More importantly, a small section of the Greenwich Historic District is crossed by a public road that would have to be widened and improved to provide access to the site. Impacts on the Historic District would be mitigated somewhat by the fact that a road is already present, but the Historic District would be subject to some direct disturbance as well as noise, dust, and visual intrusion during project construction.

In addition, two archaeological sites that are not listed on either register but are reported in NJHPO files are located along the conceptual transmission corridor. These archaeological sites might be directly disturbed by project construction, and if so they would have to be investigated before construction could proceed. If they were determined to be potentially eligible for the NRHP or NJRHP, the site would have to be excavated and any significant archaeological artifacts curated before the area was disturbed.

The impacts summarized above would noticeably alter the existing historical and archaeological resources in the immediate site area during project construction. However, it is unlikely that the impacts would destabilize important attributes of these resources. Therefore, the impact on historical and archaeological resources due to project construction would be MODERATE.

The impacts of project operation would be similar to the impacts of construction but somewhat reduced. The noise levels of operating plant equipment generally would be lower than the levels associated with construction activities. No new disturbance of historical and archaeological resources would be expected to occur during project operation. Therefore, the impact on historical and archaeological resources due to project operation would be SMALL.

9.3.2.4.8 Environmental Justice

Environmental justice issues involve aspects of the project that could disproportionately impact minority or low income populations. The potential for disproportionate impacts depends primarily on the location of the power plant and off-site facilities in relation to existing minority and low income populations.

USCB data for the year 2000 (Reference 9.3-8) were used to determine the percentage of minority and low-income populations within the 6-mi. site vicinity, and to identify any census block groups that contain a higher than average percentage of minority or low-income populations. The percentages for the site vicinity and each census block group were compared to the percentages for NJ.

Minorities comprise 26.6 percent of the population within 6 mi. of Site 7-3, compared with 34.0 percent for NJ. People with incomes below the poverty level comprise approximately 7.7 percent of the population within 6 mi. of Site 7-3, compared with 8.5 percent for NJ. Of the six census block groups that have at least 50 percent of their area within 6 mi. of the site, three have minority or poverty populations above the state average. The nearest boundary of the nearest block group with minority or poverty populations above the state average is more than 1 mi. away from the conceptual site boundaries. None of the block groups with minority or poverty populations above the state average are crossed by any of the conceptual off-site corridors, and none would be expected to experience any direct impacts from construction or operation of the power plant or off-site facilities.

Based on the above information there does not appear to be a significant potential for the project to disproportionately impact minority or low income populations. Therefore, environmental justice impacts due to project construction and operation would be SMALL.

9.3.2.5 Summary of the Environmental Assessment

This subsection compares the environmental impacts discussed above for the Alternative Sites with the impacts expected at the PSEG Site, and evaluates whether any of the Alternative Sites can be considered “environmentally preferable” to the PSEG Site. As noted in NUREG-1555, an “environmentally preferable” Alternative Site is a site for which the environmental impacts are sufficiently less than for the Proposed Site such that environmental preference can be established.

Table 9.3-22 summarizes the expected environmental impacts of project construction at each of the alternative sites and at the PSEG Site. Construction impacts at the PSEG Site are SMALL

for every resource category except Land Use associated with transmission facilities, Historical / Archaeological Resources, and Transportation. The impacts in these three categories are MODERATE. All of the Alternative Sites have at least a MODERATE impact in these same categories, and Site 4-1 has a MODERATE to LARGE impact in Historical / Archaeological Resources, while Site 7-3 has a MODERATE to LARGE impact in Transportation. In addition, each of the Alternative Sites has a MODERATE or MODERATE to LARGE impact in at least three categories where the PSEG Site has a SMALL impact. These differences in the impact ratings reflect real differences in site characteristics that would be expected to result in more severe construction-related impacts at the Alternative Sites.

Table 9.3-23 summarizes the expected environmental impacts of project operation at each of the alternative sites and at the PSEG Site. It can be seen that operation impacts at the PSEG Site are SMALL for every resource category, whereas each of the Alternative Sites has a MODERATE or MODERATE to LARGE impact in at least one category. Again, these differences in the impact ratings reflect real differences in site characteristics that would be expected to result in more severe operation-related impacts at the Alternative Sites.

Potential impacts related to human health (due to both radiological and non-radiological releases) are not explicitly evaluated for the Alternative Sites, because they are not site selection factors that would likely impact the siting decision. However, the site selection study performed by PSEG in 2008 and 2009 included the numerical evaluation of several site characteristics that influence the significance of both radiological and non-radiological health impacts at the Proposed Site and Alternative Sites. The relevant site characteristics are listed below along with the type of health impacts they influence:

- Population Density (radiological and non-radiological)
- River Flow (radiological and non-radiological)
- Potential to Impact Water Quality (radiological and non-radiological)
- Proximity to Population Centers (radiological only)
- Exclusion Area Feasibility (radiological only)
- Emergency Planning Zone Feasibility (radiological only)
- Hazardous Material Contamination (non-radiological only)
- Length of New Transmission Lines (non-radiological only)
- Noise Impacts (non-radiological only)

All of these characteristics are fully considered in the numerical evaluation that resulted in the selection of the PSEG Site as the Proposed Site. The PSEG Site has significant advantages with regard to many of these characteristics. There is no indication that any of the Alternative Sites are preferable to the PSEG Site with regard to radiological or non-radiological health impacts.

A detailed evaluation of radiological health impacts requires site-specific information (e.g. meteorological data) that is not available to PSEG. None of the Alternative Sites currently have operating nuclear facilities, therefore, potential radiological exposures due to existing facilities would be lower at the Alternative Sites compared to the PSEG Site. However, since human health impacts are dependent on population density near the proposed facility, the low population density near the PSEG Site should lessen potential health effects. Subsections 9.3.2.1.6.1, 9.3.2.2.6.1, 9.3.2.3.6.1, and 9.3.2.4.6.1, show that each of the Alternative Sites has a significant number of existing residences within 0.5 mi. of the site boundaries. As discussed in

Subsection 2.1.2, the PSEG Site has no residences closer than 2.8 mi. from the site. Therefore, with regard to nearby residences, the PSEG Site has a distinct advantage compared with the Alternative Sites.

Based on the information summarized above, none of the Alternative Sites are environmentally preferable to the PSEG Site.

9.3.3 CONCLUSIONS

The PSEG Site was selected as the Proposed Site on the basis of a comprehensive site selection study. The site selection study included computerized GIS screening of a large and diverse Region of Interest, identification of seven Candidate Areas and eleven Potential Sites, evaluation of the Potential Sites to select five Candidate Sites, and numerical scoring of the Candidate Sites. The numerical scores and other objective evaluations indicate that Site 7-4, now known as the PSEG Site, is the most favorable site for the new plant. Site 7-4 had the highest total score for all evaluation factors together and the highest score for those evaluation factors specifically related to environmental acceptability.

The environmental impacts for all of the Alternative Sites were evaluated to determine that none of the Alternative Sites are environmentally preferable to the PSEG Site, and therefore none are obviously superior to the PSEG Site.

9.3.4 REFERENCES

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9.3-3 New Jersey Department of Environmental Protection Correspondence:

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9.3-6 New Jersey Water Science Center, Aquifer and Well Characteristics in New Jersey, http://nj.usgs.gov/infodata/aquifers/table_1.html, accessed December 10, 2009.

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9.3-9 U.S. Census Bureau, Census 2000, SF3, Census Tract Geography, Tables P1, P36, P43, AND H6.

9.3-10 U.S. Geological Survey, National Water Summary – New Jersey, Principal Aquifers in New Jersey, http://nj.usgs.gov/infodata/images/im_scan1_72.gif, accessed December 10, 2009.

9.3-11 U.S. Geological Survey, Water Resources Data, New Jersey, *Water Year 2005*, Volume 1, Water Data Report NJ-05-1.

9.3-12 New Jersey Department of Environmental Protection, website, http://www.state.nj.us/dep/gis/imapnj_geolsplash.htm#, accessed December 10, 2009.

Table 9.3-1 (Sheet 1 of 2)
Site Characteristics Considered in the Numerical Evaluation of Candidate Sites

Environmental Acceptability Issues
Wetlands
Other Natural Habitats
Threatened and Endangered Species
Designated Natural Areas
Existing Land Use On-Site
Existing Land Use within 1 Mile
Zoning/Land Use Planning
Prime Farmland
Proximity to Airports
Proximity to Federal Airways
Socioeconomic Impact Potential
Cultural Resources Impact Potential
Aesthetic and Noise Impact Potential
Community Acceptance
Potential for Hazardous Material Contamination

Nuclear Licensing Issues
Proximity to Population Centers
Low Population Zone Feasibility
Exclusion Area Feasibility
Emergency Planning Zone Feasibility
Proximity to Capable Faults
Safe Shutdown Earthquake Maximum Acceleration
Liquefaction Potential
Proximity to Off-Site Hazards
Protection Against Malevolent Watercraft or Vehicles
Response Time for Local Law Enforcement
Suitable Terrain for Protected Area Fence and Surveillance

Table 9.3-1 (Sheet 2 of 2)
Site Characteristics Considered in the Numerical Evaluation of Candidate Sites

Engineering and Cost Issues
Site Topography
Flood Potential
Foundation, Earthwork, and Pipe Installation Conditions
Constructability
Distance from Highway Access
Distance from Railroad Access
Distance from Barge Access
Distance from Transmission Access
Transmission Upgrade Requirements
Transmission System Stability
Distance from Adequate Water Source
Adequacy of Water Source
Water Source Static Head
Potential to Impact Water Quality

Table 9.3-2
Site 4-1 Potential Land Use Impacts - Non-Transmission

Land Use Category (acres)	Plant Footprint Area	Remaining Area within Site Boundary	Total Site Impact	Off-Site Corridors (Non-Transmission)	Grand Total Impact	6-Mile Vicinity	Percentage of Vicinity Impacted
Total Area	401.3	726.8	1128.1	267.8	1395.9	93,750.4	1.5%
Total Planted/Cultivated Land	323.0	435.8	758.8	168.0	926.8	43,670.9	2.1%
Pasture/Hay	144.9	240.2	385.1	60.1	445.2	14,328.0	3.1%
Cultivated Crops	178.1	195.6	373.7	107.9	481.7	29,342.9	1.6%
Developed Land	6.9	5.1	12.0	4.7	16.7	6535.4	0.3%
Barren Land	46.7	113.3	159.9	18.7	178.6	4759.0	3.8%
Prime Farmland	323.4	369.4	692.7	150.4	843.2	24,503.3	3.4%
Farmland of Statewide Importance	77.8	329.6	407.4	100.0	507.4	46,122.9	1.1%
100-Year Floodplain	0.0	0.0	0.0	1.3	1.3	6101.0	<0.1%

Table 9.3-3
Site 4-1 Potential Land Use Impacts - Transmission

Land Use Category (acres)	Primary Transmission Corridor and Interposing Switchyard	Additional Transmission Corridor Area	Grand Total Impact	6-Mile Vicinity	Percentage of Vicinity Impacted
Total Area	100.0	2035.6	2135.6	93,750.4	2.3%
Total Planted/Cultivated Land	79.1	1195.8	1274.9	43,670.9	2.9%
Pasture/Hay	27.3	301.1	328.3	14,328.0	2.3%
Cultivated Crops	51.8	894.8	946.6	29,342.9	3.2%
Developed Land	0.2	171.0	171.2	6535.4	2.6%
Barren Land	2.6	58.9	61.5	4759.0	1.3%
Prime Farmland	66.1	529.2	595.3	24,503.3	2.4%
Farmland of Statewide Importance	24.4	798.0	822.4	46,122.9	1.8%
100-Year Floodplain	0.0	102.8	102.8	6101.0	1.7%

Table 9.3-4
Site 4-1 Potential Natural Habitat Impacts - Non-Transmission

Resource Category (acres)	Plant Footprint Area	Remaining Area within Site Boundary	Total Site Impact	Off-Site Corridors (Non-Transmission)	Grand Total Impact	6-Mile Vicinity	Percentage of Vicinity Impacted
Total Area	401.3	726.8	1128.1	267.8	1395.9	93,750.4	1.5%
Forest	11.8	138.9	150.7	69.1	219.8	35,232.2	0.6%
Grassland	0.0	0.0	0.0	0.0	0.0	0.0	0.0%
Total Wetlands (acres)	1.8	72.6	74.4	17.3	91.6	7167.3	1.3%
Estuarine and Marine Deepwater	0.0	0.0	0.0	0.0	0.0	0.0	0.0%
Estuarine and Marine Wetland	0.0	0.0	0.0	0.0	0.0	0.0	0.0%
Freshwater Emergent Wetland	0.0	9.6	9.6	0.1	9.6	635.9	1.5%
Freshwater Forested/Shrub Wetland	1.8	58.1	59.9	15.2	75.1	5174.8	1.5%
Other Wetland	0.0	4.9	4.9	2.0	6.9	1356.7	0.5%

Table 9.3-5
Site 4-1 Potential Natural Habitat Impacts - Transmission

Resource Category (acres)	Primary Transmission Corridor and Interposing Switchyard	Additional Transmission Corridor	Grand Total Impact	6-Mile Vicinity	Percentage of Vicinity Impacted
Total Area	100.0	2035.6	2135.6	93,750.4	2.3%
Forest	16.4	564.8	581.2	35,232.2	1.6%
Grassland	0.0	0.0	0.0	0.0	0.0%
Total Wetlands	0.4	35.6	36.1	7167.3	0.5%
Estuarine and Marine Deepwater	0.0	0.0	0.0	0.0	0.0%
Estuarine and Marine Wetland	0.0	0.0	0.0	0.0	0.0%
Freshwater Emergent Wetland	0.0	15.8	15.8	635.9	2.5%
Freshwater Forested/Shrub Wetland	0.0	10.0	10.0	5174.8	0.2%
Other Wetland	0.4	9.9	10.3	1356.7	0.8%

Table 9.3-6
State and Federal Threatened, Endangered, and Rare Species Recorded in the Site 4-1 Area [(a)]

Common Name	Scientific Name / Description	State or Regional Status – Rank	Federal Status
Plants			
Bush's Sedge	*Carex bushii*	E, LP, HL – S1	
Birds			
Bobolink	*Dolichonyx oryzivorus*	T/SC – S2B, S3N	
Eastern Meadowlark	*Sturnella magna*	SC/SC – S3B, S3N	
Great Blue Heron	*Ardea herodias*	SC/S – S3B, S4N	
Red-Shouldered Hawk	*Buteo lineatus*	E/T – S1B, S2N	
Savannah Sparrow	*Passerculus sandwichensis*	T/T – S2B, S4N	
Veery	*Catharus fuscescens*	S/S – S3B	
Vesper Sparrow	*Pooecetes gramineus*	E – S1B, S2N	
Wood Thrush	*Hylocichla mustelina*	SC/S – S3B	
Amphibians			
Longtail Salamander	*Eurycea longicauda longicauda*	T – S2	
Northern Spring Salamander	*Gyrinophilus p. porphyriticus*	D – S3	
Reptiles			
Eastern Box Turtle	*Terrapene carolina carolina*	SC – S3	
Wood Turtle	*Glyptemys insculpta*	T – S2	
Mammals			
Bobcat	*Lynx rufus*	E – S1	

a) S1 = Critically Imperiled (typically 5 or fewer occurrences)
S2 = Imperiled (typically 6 to 20 occurrences)
S3 = Vulnerable (typically 21 to 100 occurrences)
S4 = Apparently Secure (typically more than 100 occurrences)
S5 = Secure
S#S# = Rank Range to indicate the range of uncertainty about exact status
x/x = Dual status: State breeding population/State migratory or winter population
B = Breeding population
N = Nonbreeding population
S = Stable species
D = Declining species
E = Endangered species
LP = Listed by Pinelands Commission as endangered or threatened within their jurisdiction
HL = Protected by Highlands Water Protection and Planning Act within Highlands Preservation Area
T = Threatened species
SC = Special Concern

Table 9.3-7
Site 7-1 Potential Land Use Impacts - Non-Transmission

Resource Category (acres)	Plant Footprint Area	Remaining Area within Site Boundary	Total Site Impact	Off-Site Corridors (Non-Transmission) Area	Grand Total Impact	6-Mile Vicinity	Percentage of Vicinity Impacted
Total Area	432.3	555.0	987.3	246.0	1233.2	93,243.0	1.3%
Total Planted/Cultivated Land	365.4	430.0	795.4	175.8	971.2	41,354.2	2.3%
Pasture/Hay	133.8	176.6	310.3	37.5	347.8	13,172.6	2.6%
Cultivated Crops	231.6	253.5	485.1	138.3	623.4	28,181.6	2.2%
Developed Land	1.5	2.7	4.2	9.2	13.5	9827.7	<0.1%
Barren Land	18.1	22.0	40.0	6.4	46.4	2260.6	2.1%
Prime Farmland	27.4	80.3	107.7	94.8	202.5	30,145.2	0.7%
Farmland of Statewide Importance	271.7	275.7	547.4	60.5	608.0	16,090.9	3.8%
100-Year Floodplain	4.8	48.9	53.7	27.7	81.4	24,608.0	0.3%

Table 9.3-8
Site 7-1 Potential Land Use Impacts - Transmission

Resource Category (acres)	Primary Transmission Corridor and Interposing Switchyard	Additional Transmission Corridor	Grand Total Impact	6-Mile Vicinity	Percentage of Vicinity Impacted
Total Area	412.1	2445.0	2857.1	93,243.0	3.1%
Total Planted/Cultivated Land	140.6	1217.0	1357.6	41,354.2	3.3%
Pasture/Hay	55.4	275.0	330.4	13,172.6	2.5%
Cultivated Crops	85.2	942.0	1027.2	28,181.6	3.6%
Developed Land	4.6	130.0	134.6	9827.7	1.4%
Barren Land	8.9	28.0	36.9	2260.6	1.6%
Prime Farmland	93.1	750.0	843.1	30,145.2	2.8%
Farmland of Statewide Importance	101.0	576.0	677.0	16,090.9	4.2%
100-Year Floodplain	252.0	920.0	1172.0	24,608.0	4.8%

Table 9.3-9
Site 7-1 Potential Natural Habitat Impacts - Non-Transmission

Resource Category (acres)	Plant Footprint Area	Remaining Area within Site Boundary	Total Site Impact	Off-Site Corridors (Non-Transmission) Area	Grand Total Impact	6-Mile Vicinity	Percentage of Vicinity Impacted
Total Area	432.3	555.0	987.3	246.0	1233.2	93,243.0	1.3%
Forest	36.5	41.5	78.0	38.1	116.0	13,014.5	0.9%
Grassland	0.0	0.0	0.0	0.0	0.0	0.0	0.0%
Total Wetlands	17.6	62.8	80.4	33.2	113.5	33,621.4	0.3%
Estuarine and Marine Deepwater	0.0	0.0	0.0	1.3	1.3	10,170.3	<0.1%
Estuarine and Marine Wetland	0.0	0.0	0.0	0.0	0.0	5196.7	0.0%
Freshwater Emergent Wetland	0.0	2.9	2.9	5.1	8.0	2261.7	0.4%
Freshwater Forested/Shrub Wetland	17.6	44.2	61.8	24.0	85.8	12,610.3	0.7%
Other Wetland	0.0	15.7	15.7	2.8	18.5	3382.3	0.5%

Table 9.3-10
Site 7-1 Potential Natural Habitat Impacts - Transmission

Resource Category (acres)	Primary Transmission Corridor and Interposing Switchyard	Additional Transmission Corridor	Grand Total Impact	6-Mile Vicinity	Percentage of Vicinity Impacted
Total Area	412.1	2445.0	2857.1	93,243.0	3.1%
Forest	63.2	365.0	428.2	13,014.5	3.3%
Grassland	0.0	0.0	0.0	0.0	0.0%
Total Wetlands	233.4	730.0	963.4	33,621.3	2.9%
Estuarine and Marine Deepwater	59.2	97.0	156.2	10,170.3	1.5%
Estuarine and Marine Wetland	69.7	381.0	450.7	5196.7	8.7%
Freshwater Emergent Wetland	5.6	42.0	47.6	2261.7	2.1%
Freshwater Forested/Shrub Wetland	89.8	189.0	278.8	12,610.3	2.2%
Other Wetland	9.2	21.0	30.2	3382.3	0.9%

Table 9.3-11
State and Federal Threatened, Endangered, and Rare Species Recorded in the Site 7-1 Area [(a)]

Common Name	Scientific Name / Description	State or Regional Status – Rank	Federal Status
Plants			
Leatherwood	*Dirca palustris*	HL – S2	
Birds			
Bald Eagle	*Haliaeetus leucocephalus*	E – S1B,S1N	
Bobolink	*Dolichonyx oryzivorus*	T/SC – S2B, S3N	
Cooper's Hawk	*Accipiter cooperii*	T/S – S2B, S4N	
Great Blue Heron	*Ardea herodias*	SC/S – S3B, S4N	
Osprey	*Pandion haliaetus*	T/T – S2B	
Upland Sandpiper	*Bartramia longicauda*	E – S1B, S1N	
Vesper Sparrow	*Pooecetes gramineus*	E – S1B, S2N	
Reptiles			
Bog Turtle	*Glyptemys muhlenbergii*	E – S1	LT
Eastern Box Turtle	*Terrapene carolina carolina*	SC – S3	
Natural Heritage Priority Sites			
Culliers Run	*Floodplain in rich wooded ravine*	B4	
Mannington Marsh	*Freshwater intertidal marsh*	B4	

a) S1 = Critically Imperiled (typically 5 or fewer occurrences)
S2 = Imperiled (typically 6 to 20 occurrences)
S3 = Vulnerable (typically 21 to 100 occurrences)
S4 = Apparently Secure (typically more than 100 occurrences)
S5 = Secure
S#S# = Rank Range to indicate the range of uncertainty about exact status
x/x = Dual status: State breeding population/State migratory or winter population
B = Breeding population
N = Nonbreeding population
S = Stable species
HL = Protected by Highlands Water Protection and Planning Act within Highlands Preservation Area
E = Endangered species
T = Threatened species
SC = Special Concern
LT = Formally listed as Threatened
B4 = Moderate significance on global level

Table 9.3-12
Site 7-2 Potential Land Use Impacts - Non-Transmission

Resource Category (acres)	Plant Footprint Area	Remaining Area within Site Boundary	Total Site Impact	Off-Site Corridors (Non-Transmission) Area	Grand Total Impact	6-Mile Vicinity	Percentage of Vicinity Impacted
Total Area	393.8	601.8	995.7	293.6	1289.2	92,912.0	1.4%
Total Planted/Cultivated Land	381.1	548.4	929.5	173.0	1102.4	53,694.0	2.1%
Pasture/Hay	219.4	337.0	556.4	59.2	615.5	20,782.7	3.0%
Cultivated Crops	161.7	211.4	373.1	113.8	486.9	32,911.3	1.5%
Developed Land	0.4	3.1	3.4	7.3	10.7	3783.3	0.3%
Barren Land	6.0	18.5	24.5	4.7	29.2	1869.0	1.6%
Prime Farmland	349.5	503.8	853.3	159.0	1012.3	56,000.1	1.8%
Farmland of Statewide Importance	26.5	57.5	84.0	60.9	144.9	21,528.0	0.7%
100-Year Floodplain	0.0	0.0	0.0	57.5	57.5	5760.0	1.0%

Table 9.3-13
Site 7-2 Potential Land Use Impacts - Transmission

Resource Category (acres)	Primary Transmission Corridor and Interposing Switchyard	Additional Transmission Corridor	Grand Total Impact	6-Mile Vicinity	Percentage of Vicinity Impacted
Total Area	167.6	2728.0	2895.6	92,912.0	3.1%
Total Planted/Cultivated Land	105.3	1358.0	1463.3	53,694.0	2.7%
Pasture/Hay	26.6	307.0	333.6	20,782.7	1.6%
Cultivated Crops	78.7	1051.0	1129.7	32,911.3	3.4%
Developed Land	2.6	146.0	148.6	3783.3	3.9%
Barren Land	1.2	31.0	32.2	1869.0	1.7%
Prime Farmland	84.3	837.0	921.3	56,000.1	1.6%
Farmland of Statewide Importance	15.8	642.0	657.8	21,528.0	3.1%
100-Year Floodplain	0.0	1026.0	1026.0	5760.0	17.8%

Table 9.3-14
Site 7-2 Potential Natural Habitat Impacts - Non-Transmission

Resource Category (acres)	Plant Footprint Area	Remaining Area within Site Boundary	Total Site Impact	Off-Site Corridors (Non-Transmission) Area	Grand Total Impact	6-Mile Vicinity	Percentage of Vicinity Impacted
Total Area	393.8	601.8	995.7	293.6	1289.2	92,912.0	1.4%
Forest	5.3	30.5	35.8	59.4	95.1	28,082.9	0.3%
Grassland	0.0	0.0	0.0	0.0	0.0	0.0	0.0%
Total Wetlands	3.4	9.0	12.4	74.5	86.9	13,087.3	0.7%
Estuarine and Marine Deepwater	0.0	0.0	0.0	6.8	6.8	137.6	5.0%
Estuarine and Marine Wetland	0.0	0.0	0.0	32.8	32.8	291.2	11.3%
Freshwater Emergent Wetland	2.6	0.0	2.6	2.0	4.6	767.6	0.6%
Freshwater Forested/Shrub Wetland	0.0	5.6	5.6	31.3	36.9	10,839.2	0.3%
Other Wetland	0.8	3.4	4.2	1.5	5.7	1051.7	0.5%

Table 9.3-15
Site 7-2 Potential Natural Habitat Impacts - Transmission

Resource Category (acres)	Primary Transmission Corridor and Interposing Switchyard	Additional Transmission Corridor	Grand Total Impact	6-Mile Vicinity	Percentage of Vicinity Impacted
Total Area	167.6	2728.0	2895.6	92,912.0	3.1%
Forest	56.4	408.0	464.4	28,082.9	1.7%
Grassland	0.0	0.0	0.0	0.0	0.0%
Total Wetlands	11.1	814.0	825.1	13,087.3	6.3%
Estuarine and Marine Deepwater	0.0	109.0	109.0	137.6	79.2%
Estuarine and Marine Wetland	0.0	425.0	425.0	291.2	145.9%
Freshwater Emergent Wetland	0.0	47.0	47.0	767.6	6.1%
Freshwater Forested/Shrub Wetland	10.9	210.0	220.9	10,839.2	2.0%
Other Wetland	0.2	23.0	23.2	1051.7	2.2%

Table 9.3-16
State and Federal Threatened, Endangered, and Rare Species Recorded in the Site 7-2 Area [(a)]

Common Name	Scientific Name / Description	State or Regional Status – Rank	Federal Status
Plants			
Chinquapin	*Castanea pumila*	E, LP, HL – S1	
Swamp-pink	*Helonias bullata*	E, LP, HL – S3	LT
Birds			
American Kestrel	*Falco sparverius*	SC – S3B, S3N	
Bald Eagle	*Haliaeetus leucocephalus*	E – S1B,S1N	
Cooper's Hawk	*Accipiter cooperii*	T/S – S2B, S4N	
Great Blue Heron	*Ardea herodias*	SC/S – S3B, S4N	
Red-Headed Woodpecker	*Melanerpes erythrocephalus*	T/T – S2B, S2N	
Wood Thrush	*Hylocichla mustelina*	SC/S – S3B	
Amphibians			
Fowler's Toad	*Bufo woodhousii fowleri*	SC – S3	
Reptiles			
Eastern Box Turtle	*Terrapene carolina carolina*	SC – S3	
Natural Heritage Priority Sites			
Franks Cabin Site	*Narrow headwater stream corridor*	B3	
Pecks Corner	*Hardwood-evergreen swamp*	B5	

a) S1 = Critically Imperiled (typically 5 or fewer occurrences)
S2 = Imperiled (typically 6 to 20 occurrences)
S3 = Vulnerable (typically 21 to 100 occurrences)
S4 = Apparently Secure (typically more than 100 occurrences)
S5 = Secure
S#S# = Rank Range to indicate the range of uncertainty about exact status
x/x = Dual status: State breeding population/State migratory or winter population
B = Breeding population
N = Nonbreeding population
S = Stable species
E = Endangered species
LP = Listed by Pinelands Commission as endangered or threatened within their jurisdiction
HL = Protected by Highlands Water Protection and Planning Act within Highlands Preservation Area
T = Threatened species
SC = Special Concern
LT = Formally listed as Threatened
B3 = High significance on global level
B5 = General biodiversity interest on global level

Table 9.3-17
Site 7-3 Potential Land Use Impacts - Non-Transmission

Resource Category (acres)	Plant Footprint Area	Remaining Area within Site Boundary	Total Site Impact	Off-Site Corridors (Non-Transmission) Area	Grand Total Impact	6-Mile Vicinity	Percentage of Vicinity Impacted
Total Area	395.4	490.9	886.3	83.8	970.1	91,276.7	1.1%
Total Planted/Cultivated Land	306.3	216.4	522.8	52.4	575.1	19,393.0	3.0%
Pasture/Hay	172.5	94.5	267.0	16.8	283.8	5810.2	4.9%
Cultivated Crops	133.8	121.9	255.8	35.5	291.3	13,582.8	2.1%
Developed Land	1.9	0.0	1.9	1.1	3.0	640.2	0.5%
Barren Land	35.0	79.1	114.1	0.7	114.8	1192.1	9.6%
Prime Farmland	382.3	348.9	731.2	46.1	777.3	18,290.6	4.2%
Farmland of Statewide Importance	2.3	63.7	66.0	15.2	81.2	11,449.6	0.7%
100-Year Floodplain	44.9	159.8	204.7	15.4	220.0	26,894.6	0.8%

Table 9.3-18
Site 7-3 Potential Land Use Impacts - Transmission

Resource Category (acres)	Primary Transmission Corridor and Interposing Switchyard	Additional Transmission Corridor	Grand Total Impact	6-Mile Vicinity	Percentage of Vicinity Impacted
Total Area	510.4	2728.0	3238.4	91,276.7	3.5%
Total Planted/Cultivated Land	209.2	1358.0	1567.2	19,393.0	8.1%
Pasture/Hay	76.2	307.0	383.2	5810.2	6.6%
Cultivated Crops	133.0	1051.0	1184.0	13,582.8	8.7%
Developed Land	0.3	146.0	146.3	640.2	22.9%
Barren Land	19.1	31.0	50.1	1192.1	4.2%
Prime Farmland	211.5	837.0	1048.5	18,290.6	5.7%
Farmland of Statewide Importance	137.0	642.0	779.0	11,449.6	6.8%
100-Year Floodplain	39.4	1026.0	1065.4	26,894.6	4.0%

Table 9.3-19
Site 7-3 Potential Natural Habitat Impacts - Non-Transmission

Resource Category (acres)	Plant Footprint Area	Remaining Area within Site Boundary	Total Site Impact	Off-Site Corridors (Non-Transmission) Area	Grand Total Impact	6-Mile Vicinity	Percentage of Vicinity Impacted
Total Area	395.4	490.9	886.3	83.8	970.1	91,276.7	1.1%
Forest	29.9	81.2	111.1	11.2	122.3	9704.2	1.3%
Grassland	0.0	0.0	0.0	0.0	0.0	0.0	0.0%
Total Wetlands	13.0	135.6	148.6	24.0	172.6	63,459.0	0.3%
Estuarine and Marine Deepwater	0.1	3.2	3.2	3.4	6.7	37,691.0	<0.1%
Estuarine and Marine Wetland	7.4	76.0	83.4	13.8	97.2	19,684.4	0.5%
Freshwater Emergent Wetland	1.4	5.2	6.6	0.0	6.6	810.9	0.8%
Freshwater Forested/Shrub Wetland	4.2	51.1	55.3	5.8	61.2	4743.6	1.3%
Other Wetland	0.0	0.0	0.0	0.9	0.9	529.0	0.2%

Table 9.3-20
Site 7-3 Potential Natural Habitat Impacts - Transmission

Resource Category (acres)	Primary Transmission Corridor and Interposing Switchyard	Additional Transmission Corridor	Grand Total Impact	6-Mile Vicinity	Percentage of Vicinity Impacted
Total Area	510.4	2728.0	3238.4	91,276.7	3.5%
Forest	224.5	408.0	632.5	9704.2	6.5%
Grassland	0.0	0.0	0.0	0.0	0.0%
Total Wetlands	121.9	814.0	935.9	63,459.0	1.5%
Estuarine and Marine Deepwater	2.1	109.0	111.1	37,691.0	0.3%
Estuarine and Marine Wetland	23.5	425.0	448.5	19,684.4	2.3%
Freshwater Emergent Wetland	0.3	47.0	47.3	810.9	5.8%
Freshwater Forested/Shrub Wetland	95.6	210.0	305.6	4743.6	6.4%
Other Wetland	0.4	23.0	23.4	529.0	4.4%

Table 9.3-21
State and Federal Threatened, Endangered, and Rare Species Recorded in the Site 7-3 Area [(a)]

Common Name	Scientific Name / Description	State or Regional Status – Rank	Federal Status
Insects			
Bronze Copper	*Lycaena hyllus*	E – S1	
Fish			
Shortnose Sturgeon	*Acipenser brevirostrum*	E – S1	LE
Birds			
Bald Eagle	*Haliaeetus leucocephalus*	E – S1B,S1N	
Black Rail	*Laterallus jamaicensis*	T/T – S2B, S2N	
Great Blue Heron	*Ardea herodias*	SC/S – S3B, S4N	
Northern Harrier	*Circus cyaneus*	E/U – S1B, S3N	
Osprey	*Pandion haliaetus*	T/T – S2B	
Red-Shouldered Hawk	*Buteo lineatus*	E/T – S1B, S2N	
Wood Thrush	*Hylocichla mustelina*	SC/S – S3B	
Amphibians			
Fowler’s Toad	*Bufo woodhousii fowleri*	SC – S3	
Reptiles			
Eastern Box Turtle	*Terrapene carolina carolina*	SC – S3	
Eastern King Snake	*Lampropeltis g. getula*	U – S3	
Northern Diamondback Terrapin	*Malaclemys terrapin terrapin*	SC – S3	

a) S1 = Critically Imperiled (typically 5 or fewer occurrences)
S2 = Imperiled (typically 6 to 20 occurrences)
S3 = Vulnerable (typically 21 to 100 occurrences)
S4 = Apparently Secure (typically more than 100 occurrences)
S5 = Secure
S#S# = Rank Range to indicate the range of uncertainty about exact status
x/x = Dual status: State breeding population/State migratory or winter population
B = Breeding population
N = Nonbreeding population
S = Stable species
E = Endangered species
T = Threatened species
U = Undetermined species (not enough information available)
SC = Special Concern
LE = Formally listed as Endangered

Table 9.3-22
Characterization of Construction Impacts at the PSEG Site and Alternative Sites

Category	Site 4-1	Site 7-1	Site 7-2	Site 7-3	Site 7-4 (PSEG Site)
Land Use Impacts					
The Site and Vicinity [a]	MODERATE	MODERATE	MODERATE	MODERATE	SMALL
Transmission Facilities [b]	MODERATE	MODERATE	MODERATE	MODERATE	MODERATE
Air Quality Impacts	SMALL	SMALL	SMALL	SMALL	SMALL
Water Related Impacts					
Water Use	SMALL	SMALL	SMALL	SMALL	SMALL
Water Quality	SMALL	SMALL	SMALL	SMALL	SMALL
Ecological Impacts					
Terrestrial Ecosystems [c, d]	SMALL	SMALL	SMALL	SMALL	SMALL
Aquatic Ecosystems	SMALL	SMALL	SMALL	SMALL	SMALL
Protected Species	SMALL	SMALL	SMALL	SMALL	SMALL
Socioeconomic Impacts					
Physical Impacts	MODERATE	MODERATE to LARGE	MODERATE to LARGE	MODERATE	SMALL
Demography	SMALL	SMALL	SMALL	SMALL	SMALL
Economy	SMALL	SMALL	SMALL	SMALL	SMALL
Taxes	SMALL	SMALL	SMALL	SMALL	SMALL
Transportation	MODERATE	MODERATE	MODERATE	MODERATE to LARGE	MODERATE
Aesthetics	MODERATE to LARGE	MODERATE to LARGE	MODERATE to LARGE	MODERATE	SMALL
Housing	SMALL	SMALL	SMALL	SMALL	SMALL
Public Services	SMALL	SMALL	SMALL	SMALL	SMALL
Education	SMALL	SMALL	SMALL	SMALL	SMALL
Historical and Archaeological Impacts	MODERATE to LARGE	MODERATE	MODERATE	MODERATE	MODERATE
Environmental Justice Impacts	SMALL	MODERATE to LARGE	MODERATE to LARGE	SMALL	SMALL

a) The evaluation of site impacts includes the off-site corridors expected to be required for access roads, rail spur, and water pipelines.

b) The evaluation of transmission impacts includes off-site transmission corridors and an interposing switchyard as required for each site.

c) Impacts on wetlands due to construction of the power plant and access road, rail spur, and water pipeline corridors are expected to be MODERATE for all sites.

d) Impacts on terrestrial ecosystems due to construction of the transmission facilities are expected to be MODERATE for all sites.

Table 9.3-23
Characterization of Operation Impacts at the PSEG Site and Alternative Sites

Category	Site 4-1	Site 7-1	Site 7-2	Site 7-3	Site 7-4 (PSEG Site)
Land Use Impacts					
The Site and Vicinity [a]	SMALL	SMALL to MODERATE	SMALL to MODERATE	SMALL	SMALL
Transmission Facilities [b]	SMALL	SMALL	SMALL	SMALL	SMALL
Air Quality Impacts	SMALL	SMALL	SMALL	SMALL	SMALL
Water Related Impacts					
Water Use	SMALL	SMALL	SMALL	SMALL	SMALL
Water Quality	SMALL	SMALL	SMALL	SMALL	SMALL
Ecological Impacts					
Terrestrial Ecosystems	SMALL	SMALL	SMALL	SMALL	SMALL
Aquatic Ecosystems	SMALL	SMALL	SMALL	SMALL	SMALL
Protected Species	SMALL	SMALL	SMALL	SMALL	SMALL
Socioeconomic Impacts					
Physical Impacts	SMALL	SMALL	SMALL	SMALL	SMALL
Demography	SMALL	SMALL	SMALL	SMALL	SMALL
Economy	SMALL	SMALL	SMALL	SMALL	SMALL
Taxes	SMALL	SMALL	SMALL	SMALL	SMALL
Transportation	SMALL	SMALL	SMALL	SMALL	SMALL
Aesthetics	MODERATE to LARGE	MODERATE to LARGE	MODERATE to LARGE	MODERATE	SMALL
Housing	SMALL	SMALL	SMALL	SMALL	SMALL
Public Services	SMALL	SMALL	SMALL	SMALL	SMALL
Education	SMALL	SMALL	SMALL	SMALL	SMALL
Historical and Archaeological Impacts	SMALL	SMALL	SMALL	SMALL	SMALL
Environmental Justice Impacts	SMALL	MODERATE to LARGE	MODERATE to LARGE	SMALL	SMALL

a) The evaluation of site impacts includes the off-site corridors expected to be required for access roads, rail spur, and water pipelines.

b) The evaluation of transmission impacts includes off-site transmission corridors and an interposing switchyard as required for each site.

9.4 ALTERNATIVE PLANT AND TRANSMISSION SYSTEMS

This section describes the evaluation of the alternative heat dissipation, circulating water, and power transmission systems for the new plant at the PSEG Site. Because PSEG has not yet finalized a reactor selection, a Plant Parameter Envelope approach to defining the various plant systems is utilized. Chapter 3 presents the proposed heat dissipation, circulating water, and power transmission systems for the new plant.

As discussed in Chapters 4 and 5, potential SMALL adverse impacts were noted for the construction and operation of the proposed heat dissipation system and circulating water system. Impacts associated with the placement of any new transmission lines that may be required will be minimized by routing the lines on or adjacent to existing corridors to the extent possible. The discussion of alternative systems in the following subsections provides the bases for these conclusions.

9.4.1 HEAT DISSIPATION SYSTEMS

This subsection discusses alternatives to the proposed heat dissipation system presented in Section 3.4. This subsection utilizes the methodology and format presented in NUREG-1555 to first perform an initial screening of the alternatives to eliminate any technologies that are obviously unsuitable for the PSEG Site. Following the initial screening any remaining alternatives are reviewed to determine if they are environmentally preferable, equivalent or inferior to the proposed heat dissipation system.

NUREG-1555 recommends considering the following classes of heat dissipation systems:

- Once-through systems
- Closed cycle systems
    - Mechanical draft wet cooling towers
    - Natural draft cooling towers
    - Dry cooling towers
    - Wet-dry cooling towers
    - Cooling ponds
    - Spray ponds

Of the alternatives recommended by NUREG-1555, the mechanical draft wet cooling towers and natural draft cooling towers, along with fan-assisted natural draft cooling towers, comprise the proposed heat dissipation system options for the new plant at the PSEG Site.

9.4.1.1 Proposed Heat Dissipation System

The purpose of a heat dissipation system is to dissipate waste heat to the environment. The condenser creates the low pressure required to draw steam through and increase the efficiency of the turbines. The lower the pressure of the exhaust steam leaving the low-pressure turbine, the more efficiency is gained. The limiting factor is the temperature of the cooling water supplied to the main turbine condenser.

For the PSEG Site, the preferred method for dissipating the waste heat is a closed-cycle cooling system that consists of either natural draft, mechanical draft or fan assisted natural draft cooling

towers, which draw makeup water via a new intake structure on the Delaware River. At this phase in the licensing effort, specific cooling tower configurations have not been established, because the range of possible heat rejection requirements varies with the potential reactor technology selections.

9.4.1.2 Screening of Alternatives to the Proposed Heat Dissipation System

This subsection presents the initial screening of the alternative heat dissipation systems against criteria specified in NUREG-1555 to eliminate those systems that are obviously unsuitable for use at the PSEG Site. Factors considered in this initial screening include land use, water use, and legislative or regulatory restrictions.

Heat dissipation systems differ in how the energy transfer takes place, and therefore, have different environmental impacts. There are generally two types of heat dissipation systems: once-through cooling and closed-cycle cooling.

Once-through cooling systems involve the use of a large quantity of cooling water, withdrawn from and returned to a large water source after its circulation through the main condenser. Normal system losses are due to evaporation of the heated water as it is returned to the water source.

Closed-cycle cooling systems involve substantially less water usage because the water performing the cooling is recirculated through the main condenser, and only makeup water for normal system losses is required. Normal system losses include evaporation, blowdown, and drift. Evaporation occurs as part of the cooling process in wet systems. Blowdown is the discharge of a portion of the circulating water in order to control dissolved solids concentrations in the water and to help protect surfaces from scaling or corrosion. Drift is water that escapes from the heat dissipation system in the form of unevaporated droplets during operation. Closed-cycle systems include cooling towers (wet, dry and wet-dry hybrid) and cooling ponds or spray ponds. The relevant characteristics of these systems, as well as once-through cooling, are discussed in the following subsections.

9.4.1.2.1 Once-Through Cooling System

In a once-through cooling system, water is withdrawn from the Delaware River, routed through the main condenser, and discharged back to the Delaware River at an elevated temperature. The water requirements for a once-through system are on the order of 1.7 to 2.1 million gpm for a 2200 MWe plant. Once-through cooling systems have practical advantages of providing the condenser cooler water to lower turbine backpressure and thus increase plant efficiency. While once-through systems consume less water through evaporation, utilize less land and have minimal visual impacts, U.S. Environmental Protection Agency (EPA) regulations (40 CFR 125) governing cooling water intake structures under Section 316(b) of the Clean Water Act effectively prohibit newly constructed steam electric generating plants from using once-through cooling systems. As such, once-through cooling was eliminated from further consideration.

9.4.1.2.2 Dry Cooling Towers

Dry cooling is an alternative cooling method in which heat is dissipated directly to the atmosphere using a tower. This tower transfers the heat to the air by conduction and convection rather than by evaporation. Heat transfer is therefore based on the temperature of the ambient

air and the thermal transport properties of the piping material. A natural-draft or mechanical-draft configuration is used to move the air.

While a wet tower uses the processes of evaporation, convection and conduction to reject heat, a dry tower is dependent on conduction and convection only. As a result, heat rejection is limited by the dry bulb temperature of the ambient air at the site. The higher the ambient temperature, the higher the steam saturation pressure, resulting in higher turbine backpressure.

In a 2001 study of cooling technologies, the EPA rejected dry cooling as the best available technology because dry cooling carries high capital, operating and maintenance costs that are sufficient to pose a barrier to entry into the marketplace for some projected new facilities (Reference 9.4-6). In addition, dry cooling has a detrimental effect on electricity production by reducing the efficiency of steam turbines. Mechanical draft dry cooling requires a power plant to use more energy to produce the same amount of electricity than is required with wet cooling towers. This energy penalty is most significant in the summer months when the demand for electricity is at its peak. The energy penalty results in an increase in environmental impacts, because replacement generating capacity is needed to offset the loss in efficiency from dry cooling. EPA concluded that dry cooling may be appropriate in areas with limited water available for cooling or where the source of cooling water is associated with extremely sensitive biological resources (e.g., endangered species, specially protected areas) (Reference 9.4-6). The conditions at the PSEG Site do not warrant use of dry cooling based on either of these exceptions.

Despite the problems summarized above, dry cooling has some advantages in that cooling water makeup requirements are reduced or eliminated, and potential issues with cooling tower blowdown, circulating water chemical treatment, and fogging / icing are reduced or eliminated. Therefore, the following subsections discuss available dry cooling technologies in more detail. The two available technologies are the air-cooled condenser and the indirect dry cooling tower.

9.4.1.2.2.1 Air Cooled Condenser

The most common form of dry cooling tower technology is the air-cooled condenser (ACC). In this design, steam from the turbine exhaust is piped through large ducts to a separate air-cooled condenser located next to the turbine building. Fans draw air through cooling coils to reject heat from the exhaust steam. As the steam loses its heat, it condenses to water and is returned as steam generator feedwater.

Available information on ACC technologies indicates that they require condenser and turbine designs that differ significantly from the standardized designs provided by reactor vendor manufacturers in the designs currently being reviewed under the 10 CFR 52 Design Certification process. Therefore, incorporation of ACC technology would require large-scale changes to the standardized designs being considered by PSEG. ACC technology would require extensive revisions to fundamental design elements of the main steam, feedwater and heater drains systems. Essential elements of the turbine building foundation, structure, and turbine missile evaluation also would require revision.

ACC technologies also have significant disadvantages related to land requirements, plant efficiency, and plant stability. These disadvantages are summarized below.

The cooling units for an ACC must be located in immediate proximity to the turbine building, and the size of the units requires extensive land use. An ACC tower requires much larger heat transfer surfaces and is much larger in size than a comparable wet cooling tower. An ACC tower generally requires approximately three to four times the land use of a wet cooling tower for a comparable cooling capacity (Reference 9.4-5). Extensive changes to the turbine building footprint and standardized plant layouts are required to accommodate this land requirement.

Because of the larger volume of air required for heat rejection, fan horsepower requirements for an ACC are typically 3 to 4 times higher than for a fan-assisted wet cooling tower. This significantly decreases the net electrical output of a power plant. In addition, an ACC is not as thermally efficient as a wet cooling tower system, which has a negative impact on plant performance. An ACC is unable to maintain design plant thermal performance during the hottest months of the year. Depending on weather conditions and the design heat rate, a plant can experience capacity reductions of up to 10 percent on the steam side alone, because of increased turbine backpressure (Reference 9.4-6). For the new plant at the PSEG Site, these increased losses in net plant generation would result in importing additional power from fossil-fueled power sources in the PJM region.

In addition to plant generation reductions due to thermal efficiency, turbine generator reliability is also of concern. The main turbine low pressure stage designs in the standardized designs being reviewed for certification require operation at a condenser backpressure of 2.5 to 3 inches of mercury (in. Hg) absolute to produce the rated electrical output, with turbine backpressure alarm and trip setpoints approximately 3 in. Hg higher. State-of-the-art ACC designs can not operate within these parameters during the summer temperature conditions expected at the PSEG Site. This increases the probability of forced power reductions and turbine trips due to encroachment on turbine backpressure limits.

In summary, use of ACC technology at the PSEG Site would: require extensive revisions to the standardized plant designs being reviewed under the 10 CFR 52 Design Certification process, significantly increase the amount of land used for the heat dissipation system on the site, reduce the thermal efficiency of the new plant resulting in the need to import more power, and greatly increase the probability of forced power reductions and turbine trips during summer operation when electricity demand is highest. Therefore, an ACC based dry cooling system is not preferable to the proposed wet tower system for the PSEG Site.

9.4.1.2.2.2 Indirect Dry Tower

The second type of dry cooling tower technology is the indirect dry tower. In this design, the proposed wet tower is replaced with a large air-water heat exchanger. Circulating water from the condenser is piped through metal-finned tubes, and fans force air over the tubes to reject heat to the air and atmosphere.

As with ACC technology, the indirect dry cooling towers currently in use are combined with turbines specially designed to operate at higher backpressures than the turbines associated with the standardized designs being reviewed under the 10 CFR 52 Design Certification process. Therefore, using an indirect dry cooling tower system would require large-scale changes to the standardized designs being considered by PSEG.

The other disadvantages of indirect dry cooling towers are similar to the disadvantages of ACC technology. However, indirect dry cooling is much less efficient than ACC because heat

rejection is dependent on two thermal exchanges (steam to circulating water and circulating water to air), rather than the single interface used in the ACC technology (steam to air). This makes some of the disadvantages of indirect dry cooling towers more severe.

The most significant disadvantage of indirect dry cooling towers are their increased land use requirements. Based on relative efficiencies of the processes, an indirect dry cooling tower requires 30 percent more space than an ACC tower and would be up to five times the footprint of a wet cooling tower proposed for the PSEG Site (Reference 9.4-3).

An indirect dry cooling tower requires an even larger volume of air for heat rejection than an ACC tower because of the loss of efficiency. Therefore, fan horsepower requirements increase beyond the ACC design, which is itself 3 to 4 times greater than a fan-assisted wet cooling tower. In addition, the turbine backpressure limitations discussed with regard to ACC technology are applicable to the indirect dry cooling technology (Reference 9.4-3). These limitations lead to both decreased plant output and increased probability of forced power reductions and turbine trips during summer operation. As a result, indirect dry cooling decreases the plant net electrical output even more than ACC, further increasing the need to import power into the PJM region.

In summary, using indirect dry cooling technology at the PSEG Site would require extensive revisions to the standardized plant designs being reviewed under the 10 CFR 52 Design Certification process, significantly increase the amount of land used for the heat dissipation system on the site, reduce the thermal efficiency of the new plant resulting in the need to import more power, and greatly increase the probability of forced power reductions and turbine trips during summer operation when electricity demand is highest. Therefore, an indirect dry cooling system is not preferable to the proposed wet tower system for the PSEG Site.

9.4.1.2.3 Wet-Dry Cooling Towers

Hybrid wet-dry cooling towers employ both a wet section and a dry section. Consumptive water use for the hybrid wet-dry cooling alternative is bounded by the water use of the wet section. Compared to full wet cooling towers, less evaporation, make-up water, and blowdown are involved in the hybrid wet-dry process, therefore reducing water-related impacts. In addition, the visible water vapor plumes associated with wet cooling towers are reduced or eliminated. However, the disadvantages of dry cooling still apply to the dry cooling portion of this heat dissipation process. The dry cooling process is not as efficient as the wet cooling process because it requires the movement of a large amount of air through the heat exchanger to achieve the necessary cooling. This results in a net loss of approximately 22 MW of electrical power for distribution. Consequently, there would be an increase in environmental impacts as replacement generating capacity would be needed to offset the loss in efficiency from hybrid wet-dry cooling. In addition, the hybrid wet-dry cooling towers occupy more land than a wet cooling tower system due to the decreased thermal efficiency, affecting site land use and increasing terrestrial impacts. Therefore, a hybrid wet-dry cooling system is not preferable to the proposed wet tower system for the PSEG Site.

9.4.1.2.4 Cooling Ponds

Power plants that use cooling ponds compose a unique subset of closed-cycle systems. Such facilities operate as once-through power plants (i.e., large condenser flow rates) that withdraw from and discharge to relatively small bodies of water created for the plant. Cooling ponds reduce the heat load to natural bodies of water from power plant operations without the

construction and operational expenses of cooling towers. The natural body of water is not relied on for heat dissipation but is used as a source of makeup water to replace that lost to evaporation and as a receiving stream for blowdown from the cooling pond. (Reference 9.4-7)

Plant output as a function of land use at commercial nuclear power plants utilizing cooling ponds ranges from approximately 0.5 to 2.1 megawatt thermal (MWt) per acre due to many factors including local meteorology and land costs. Utilizing the high end of the land use range and the smallest nuclear facility under consideration equates to over 1800 acres of land required. This requirement exceeds the entire amount of land available on the PSEG Site including the already developed areas. Therefore, cooling ponds are not considered a viable alternative for heat dissipation at the PSEG Site.

9.4.1.2.5 Spray Ponds

Spray ponds offer significant advantages over conventional cooling ponds by requiring significantly less land use to dissipate the same amount of heat. Spray ponds consist of a series of spray nozzles located in a relatively long and narrow pond. Water from the condenser is sprayed into the air, cooled by evaporation, and finally falls back to the pond where it is drawn into the intake structure to be pumped back to the condenser.

Due to the evaporation, water is lost through this process, requiring makeup from a natural body of water. Water quality in the pond would also require monitoring and discharge to the Delaware River to control solids. In this regard the spray pond system is similar to the proposed heat dissipation system and does not offer an environmental advantage.

The evaporative heat transfer due to the nozzles spraying the water into the air is inherently less efficient when compared to a cooling tower which utilizes either forced or natural draft effects to increase airflow over a sprayed water pattern. The relatively lesser airflows associated with a spray pond equates to a decrease in efficiency of the heat transfer and an increase in the amount of land area required for the spray pond to dissipate an equivalent amount of heat when compared with a wet cooling tower. Plant output as a function of land use at power plants utilizing spray ponds is approximately 1 acre per 15 MWe. Utilizing the smallest nuclear facility under consideration equates to approximately 90 acres of land required.

A spray pond requires increased land use, negatively affecting terrestrial and wetland ecosystems, and does not offer a significant improvement over the proposed system when considering impacts to water availability, water quality, or aquatic resources. Therefore, a spray pond heat dissipation system is not preferable to the proposed wet tower system for the PSEG Site.

9.4.1.2.6 Conclusions

As discussed in the above subsections, none of the alternative heat dissipation systems represent an environmentally preferable alternative for the PSEG Site. The options among the proposed wet cooling towers (natural draft, mechanical or fan assisted natural draft) for the PSEG Site will be evaluated after reactor technology selection as part of a CWS optimization study prior to detailed design.

9.4.2 CIRCULATING WATER SYSTEMS

In accordance with the NUREG-1555, this subsection presents a discussion of alternatives to the following components of the circulating water system: intake systems, discharge systems, water supply and water treatment processes. This review only considers those alternatives that are applicable to the PSEG Site and compatible with the proposed heat dissipation system presented in Section 3.4.

As applicable, the following factors were considered in the initial environmental screening of the alternative CWS components considered viable alternatives on the PSEG Site:

- Plant water requirements
- Site terrain and relationships to water bodies
- Water body geometry
- Other water use
- Ecological considerations
- Legislative or regulatory requirements

9.4.2.1 Alternatives to the Proposed Circulating Water System

This subsection summarizes the CWS components proposed for the new plant, as presented in Chapter 3, and identifies whether alternatives applicable to the PSEG Site are appropriate for further evaluation.

9.4.2.1.1 Intake System

The intake structure is designed to meet the bounding makeup requirements of the heat dissipation system by drawing water directly from the Delaware River to supply makeup to the closed cycle wet cooling tower. Makeup water flow rates drawn into the intake structure are discussed Section 3.3. The intake structure is located along the east shoreline of the Delaware River, west of the plant site. The design of the intake structure consists of a bar rack at the inlet that prevents debris in the river from entering the intake bays. Debris on the bar rack is cleared by the trash rake which can traverse across the track installed above the forebay along the intake structure’s inlet. To minimize impingement and entrainment, the intake water passes through traveling water screens. The intake structure bay sizes and intake screens will be designed such that the average intake flow velocity through the screens is less than 0.5 feet per second (fps), as required by Clean Water Act, Section 316(b) Phase I requirements specified in 40 CFR 125.84. Debris and aquatic biota from the traveling water screens are returned to the Delaware River per the requirements of the New Jersey Pollutant Discharge Elimination System (NJPDES) permit for the new plant.

While the impacts due to the construction and operation of the proposed intake system are considered SMALL as discussed in Section 5.3, alternative intake systems and design modifications were considered and are presented below. Alternative intake system designs and locations were evaluated to determine if any are environmentally preferable to the proposed system. The below options were considered as alternatives to the proposed system. Options such as an intake canal were not considered as they do not fit into the site terrain and the site’s relationship to the Delaware River.

9.4.2.1.1.1 Collector Well System and other Filtration Based Alternatives

A radial collector well system can be used to develop a filtered water supply by projecting well screens laterally adjacent to and underneath the water source from a central caisson. The central shaft or caisson serves as the collection point for the water that enters the system through the network of well screens. The wells would be primarily recharged from the Delaware River, combining the desirable features of higher well yields with induced seabed filtration of suspended particulates. This improves the raw water quality, simplifies the treatment process and minimizes impingement and entrainment concerns.

Due to the soil conditions near the shoreline of the PSEG Site, expected well production capacity would be on the order of 5 MGD (approximately 3500 gpm). In order to support the required makeup conditions at least 22 wells would be required. Spacing between collector wells is typically 1500 ft. or more to minimize impact on the surrounding aquifer and adjacent wells (Reference 9.4-1). This equates to a shoreline requirement of over six miles. The PSEG Site has less than half of the required shoreline, even when including the developed areas. Thus, collector wells are not a technically feasible alternative for the PSEG Site.

Other options, such as artificial filter beds and porous dikes, are intake options which minimize or eliminate impingement and entrainment. However, artificial filter beds and porous dikes are only feasible on water bodies with low concentrations of suspended solids and where the potential for biofouling is low. The water quality characteristics of the Delaware River in the vicinity of the PSEG Site do not meet either of these conditions.

Due to these limitations, collector wells and other filtration based intake alternatives were determined to not be feasible at the PSEG Site. No further evaluation of this option was considered.

9.4.2.1.1.2 Intake Pipe

An intake pipe feeding the forebay of a traditional shoreline intake structure allows the entrance of the intake to be located a significant distance offshore, in areas of the river with deeper bottom and potentially less productive biological habitat.

An intake pipe or tunnel is typically made up of reinforced concrete pipe. The area along the alignment of the piping is dredged, crushed stone bedding provided along the bottom, the pipe backfilled with crushed stone, sand or gravel, and protected with riprap or armor stone. The intake pipe is typically sized based on flow velocities with consideration given to both higher flow velocities to minimize sediment deposition in the pipe and lower flow velocities to minimize impact to aquatic life. Intake pipes are fitted with a velocity cap to draw in water horizontally and to minimize vortexing and in some cases, subsequent entrainment of aquatic biota and detritus. The intake pipe system would be designed in such a manner to keep velocity cap entrance velocities less than 0.5 fps, as required by Clean Water Act, Section 316(b) Phase I requirements specified in 40 CFR 125.84. The utilization of a velocity cap would be the preferred choice for a multi-directional flow (flood and ebb tides), and brackish water environment, as this type of intake pipe cap has been successfully used at coastal locations.

Construction of an intake pipe into the Delaware River would increase the disruption of the Delaware River aquatic habitat over the proposed intake design. The intake pipe is not likely to have any significant difference in impact to aquatic ecology in the Delaware River. As discussed

in Section 5.3, the impacts on the aquatic ecology of the Delaware River due to the proposed intake are SMALL. An intake pipe would also represent an increase in capital and maintenance costs over the proposed intake design.

Due to these limitations, an intake pipe based alternative is not environmentally preferable to the proposed intake at the PSEG Site. No further evaluation of this option was considered.

9.4.2.1.1.3 Hope Creek SWIS

Modifications to the existing HCGS service water intake structure (SWIS) were considered. The existing HCGS SWIS was reviewed to determine if it would be feasible to utilize the empty intake bays from the cancelled HCGS Unit 2. The HCGS service water system provides river water to cool the safety auxiliary cooling system heat exchangers and the reactor auxiliary cooling system heat exchangers during normal and emergency conditions and supplies the filling and makeup requirements for the circulating water system. The HCGS SWIS houses four pumps capable of supplying rated flow of 16,500 gpm per pump and two 36-in. diameter headers, one redundant.

The HCGS SWIS has two empty bays that were originally designed for the cancelled HCGS Unit 2. These bays could be used to provide intake water for the new plant on the PSEG Site; however, the new plant requires up to approximately 80,000 gpm of intake water. This flow rate, when combined with the open area of the HCGS SWIS intake bays, leads to exceeding the through screen velocity limitations of 0.5 fps, as required by Clean Water Act, Section 316(b) Phase I requirements specified in 40 CFR 125.84. Expansion of the intake structure and routing new intake piping from the existing HCGS SWIS to the new plant location would present various interferences with existing buried commodities, including potential impacts to station service water, fire protection piping, fuel oil piping and cooling tower blowdown line, on the PSEG Site.

In addition to the physical limitations, consideration must be given to the differences in design bases and licensing of the two distinct nuclear power plants. The HCGS SWIS is a safety-related structure as defined in its licensing documentation. The intake structure associated with the new plant is required to meet the site characteristics associated with this licensing effort and specific design requirements specified by the reactor vendors in the Design Control Document, which will likely differ from those associated with the HCGS. Additionally, HCGS is currently licensed to operate until 2026, but is seeking license renewal potentially extending its operating license until 2046. However, the new plant on the PSEG Site has a design operating life extending until 2081, beyond that currently planned for HCGS.

Due to these limitations, utilization of the existing HCGS SWIS is not feasible for the new plant on the PSEG Site. No further evaluation of this option was considered.

9.4.2.1.2 Discharge System

The proposed plant discharge consists of cooling tower blowdown and other site wastewater streams, including the domestic water treatment and service water treatment systems. The volume and concentration of each constituent discharged to the environment will meet requirements established in the NJPDES permit. As described in Section 3.4, the proposed discharge outfall from the new plant is a single 48 in. pipe located approximately 100 ft. from the shoreline. The discharge pipe is similar to that utilized at the adjacent HCGS, but extends further into the Delaware River to improve mixing as discussed in Section 5.2.

Dilution and dissipation of the discharge heat as well as other effluent constituents are affected by both the design of the discharge structure and the flow characteristics of the receiving water. Section 5.3 concludes that the impacts of the discharge system to aquatic ecosystems from thermal, chemical and physical impacts are SMALL.

Alternative systems and design modifications such as multi-port diffusers, modified discharge velocity, or discharges into deeper waters are options to the proposed system. During evaluation of the proposed system, as discussed in Section 5.2 and 5.3, consideration was given to selecting a more complex diffuser design if the impacts due to the proposed system were to cause unreasonable physical, thermal, or aquatic impacts to the environment. As discussed in Section 5.2 and 5.3, the impacts associated with the discharge system are SMALL and do not warrant further evaluation of system or design alternatives.

Alternative discharge system locations were considered to determine if an environmentally preferable configuration could be used. Shore locations along the PSEG Site were investigated to determine the feasibility of routing a discharge pipeline. The shoreline immediately south of the proposed location for the discharge is developed and used for facilities associated with the SGS and HCGS. However, east of the SGS circulating water intake structure is an undeveloped portion of shoreline at the southern boundary of the PSEG Site. This location was identified as a potential alternate location for discharge. Additionally, north of PSEG Site along the tip of Artificial Island in the vicinity of Alloways Creek was considered potentially feasible for a discharge location.

Both of these locations increase land usage to route the piping to these locations during construction, adversely impacting additional terrestrial ecology habitats. At both the south shore location and Alloways Creek location, the Delaware River depths are less than 5 ft. below mean lower low water. At these depths, discharge effluent does not mix as efficiently and could cause river bottom scour. To meet the appropriate mixing requirements, the discharge pipe would need to be extended much further off shore than the proposed system, increasing impacts to aquatic biota during construction.

Due to these increased environmental impacts of these alternative locations when compared with the proposed system and minimal environmental impact of the proposed system, utilization of an alternate discharge location was determined to not provide an environmentally preferable option for the new plant on the PSEG Site. No further evaluation of an alternative discharge location option was considered.

9.4.2.1.3 Water Supply

The selected water supply for makeup to the heat dissipation system at the PSEG Site is the Delaware River. No alternative sources of water supply are available. As described in Section 3.3, the maximum amount of water introduced into the system from the Delaware River is 78,196 gpm for the new plant. The annual mean flow of the Delaware River at Trenton, NJ is 7110 cfs (3,200,000 gpm) and tidal flow past the PSEG Site ranges between 400,000 and 472,000 cfs (180,000,000 to 212,000,000 gpm). Based on the anticipated maximum intake flow of 78,196 gpm for the new plant, the intake withdraws less than one percent of the tidal flows which dominate the river in the area of the PSEG Site.

Groundwater was evaluated and not considered a viable alternative water source because the local groundwater aquifers are not able to support the continuous cooling makeup water

requirement of 78,196 gpm for the new plant. Groundwater is used for miscellaneous plant water makeup needs such as fire protection, potable and sanitary, and demineralizer makeup. The environmental impact of using the Delaware River water supply for CWS is SMALL as discussed in Section 5.3. No environmentally feasible alternative water supply source for makeup to the CWS is identified. Environmental impacts are SMALL.

9.4.2.1.4 Water Treatment

Evaporation of water from closed cycle cooling systems leads to an increase in chemical and solids concentrations in the circulating water, which in turn increases the scaling tendencies of the water. The new plant will be operated so that the concentration of total dissolved solids in the cooling tower blowdown is monitored to meet the requirements of the NJPDES permit for the site. The selected water treatment system is described in Subsection 3.3.2.

Sulfuric acid will be used to control calcite scale as required, and acid addition will maintain a slightly alkaline pH level. The combination of low cycles of concentration and acid addition will be used so that other scale inhibitors are not required. Chlorination will control microbial growth in the piping and condenser to prevent biofouling and microbiological deposits. Sodium hypochlorite solution will be injected as required at the intake structure and the cooling tower basin.

Alternate anti-scaling chemicals include sodium hydroxide. Alternative biocides include hydrogen peroxide or ozone. The final choice of chemicals or combination of chemicals is dictated by makeup water conditions, technical feasibility, economics, and discharge permit requirements. The discharges from the CWS are subject to NJPDES permit limitations that consider aquatic impacts and all water treatment chemicals used in the system will be reviewed by NJDEP to assure that they are environmentally equivalent.

The new plant is required to obtain an NJPDES permit to discharge effluents. The NJPDES permitting process and periodic renewals allow for changes and modifications to be appropriately reviewed and approved by NJDEP.

The environmental impact due to the proposed water treatment system is SMALL as discussed in Section 5.3. No environmentally equivalent or superior alternative water treatment option is identified because any system selected for use will meet the NJDPES requirements for discharge into the Delaware River. The discharge will meet regulatory standards and therefore environmental impacts are SMALL.

9.4.3 TRANSMISSION SYSTEMS

The four existing 500 kV transmission lines that leave the PSEG Site provide adequate thermal capacity for the new plant. However, there may be a need for additional off-site transmission to address potential transient grid stability limitations. Future needs for off-site transmission for the new plant are dependent on the reactor technology selected by PSEG and external factors not under PSEG control (e.g., PJM’s regional transmission planning process). Any required transmission upgrades will be determined by PJM based on formal transmission impact studies performed as part of the interconnection queue process. A limited GIS study of two potential transmission macro-corridors was performed to provide a preliminary evaluation of the transmission routing alternatives that may be considered when the need for additional off-site transmission has been established.

9.4.3.1 Macro-Corridor Study

The purpose of this study was to provide an approximation of the magnitude of potential environmental impacts associated with two conceptual 500 kV transmission macro-corridors. The termination points were selected to link the new plant to a strong regional 500 kV substation that could provide synchronizing support to improve grid stability margin. Because a transmission routing study has not been completed and precise transmission line routes have not been established, each macro-corridor was evaluated as a 5 mi. wide band generally following existing transmission line corridors. The following macro-corridors were evaluated:

- The South Macro-Corridor runs north from the PSEG Site, turns west to cross the Delaware River, and then runs south to the Indian River Substation in Delaware. The South Macro-Corridor generally follows existing transmission line corridors, and it has a total length of approximately 94 mi. This routing was preliminarily identified as the final segment of the Mid-Atlantic Power Project (MAPP) transmission line, but the segment has not been approved by PJM and is not in the current Regional Transmission Expansion Plan (RTEP). Although this segment of the MAPP line has been deferred by PJM for future study, it provided a logical conceptual route for the macro-corridor.

- The West Macro-Corridor runs north from the PSEG Site, turns west to cross the Delaware River, and then continues west to the Peach Bottom Substation in PA. The West Macro-Corridor generally follows existing transmission line corridors, and it has a total length of approximately 55 mi.

Each of these macro-corridors was developed with a common segment. From the PSEG Site the common segment extends north and then west across the Delaware River to the Red Lion Substation in DE, following the existing Hope Creek to Red Lion right-of-way. From this location, the macro-corridors diverge, extending to the west (Peach Bottom Substation) or south (Indian River Substation). When a specific route is selected, this segment may pursue a more direct path (e.g., crossing the river closer to the PSEG Site); however, crossing the Delaware River in the same area as existing transmission lines was selected for the purposes of defining the bounding conceptual macro-corridors.

As stated above, each macro-corridor was evaluated as a 5 mi. wide band that generally followed existing transmission line corridors between the end points. These 5 mi. wide bands were simplified so as not to follow the detailed alignments of the existing corridors. This approach allowed a general characterization of environmental resources within the existing corridors as well as those adjacent lands that might be subject to new transmission routing. When detailed routing studies are performed, it is anticipated that existing transmission line ROWs or alignments adjacent to existing ROWs will be used as much as possible.

The two macro-corridors described above were developed outside of formal PJM processes associated with transmission system improvements. Following PSEG's ESP application, PJM, independent of new nuclear generation, determined that transmission system improvements are desirable in the region of Artificial Island to address system voltage and stability constraints. Although this transmission upgrade is currently in the proposal stage, the project can be considered independent and reasonably foreseeable. Of the two macro-corridors described above, the West Macro-Corridor to Peach Bottom substation has the technical attributes that best resolve these constraints and is considered representative of the project being pursued by

PJM. Therefore, the West Macro-Corridor is evaluated as a cumulative impact in Section 10.5. The analytical approach of the macro-corridor study for both alternative routes and their associated impacts are presented below with only the potential West Macro-Corridor discussed in Section 10.5.

Table 9.4-1 identifies the counties potentially crossed by the South and West Macro-Corridors. Figures 9.4-1 and 9.4-2 illustrate the counties potentially crossed by each macro-corridor.

The land along the South Macro-Corridor is characterized by low elevations and low topographic relief that is typical of the Coastal Lowlands subregion of the Mid-Atlantic Coastal Plain. This subregion is characterized by poor drainage, shallow water tables, abundant wetlands, and tidal streams and rivers (Reference 9.4-2). The land along the West Macro-Corridor is also characterized by low elevations along the eastern half of the macro-corridor, but as the macro-corridor travels further west, it passes into more upland areas that are characteristic of the Northeastern Highland physiographic province.

The following subsection describes the methods used to evaluate the potential environmental impacts of these macro-corridors.

9.4.3.1.1 Methods

In the context of this study, environmental features were considered to be the factors important in environmental impact assessment and transmission corridor development. The environmental features considered included the following:

- U.S. Geological Survey (USGS) Land Use/Land Cover (LULC)
- Wetlands
- Hydrography (streams, rivers)
- Infrastructure
- Parklands
- Nature Preserves/Natural Areas
- Wildlife Refuges
- Forest Preserve Lands
- Historic Properties
- Prime and unique farmland
- Natural Heritage Data
- Floodplains

Available GIS coverages for the above listed environmental features were obtained from a variety of available public sources for each corridor including:

- **Land Use/Land Cover** – USGS Land Cover Institute. Multi-Resolution Land Characteristics Consortium, National Land Cover Database. Available at: http://www.mrlc.gov/nlcd.php

- **Wetlands** – U.S. Fish and Wildlife Service National Wetlands Inventory (NWI). Available at: http://www.fws.gov/wetlands/Data/DataDownloadState.html
- **Hydrography** – USGS National Hydrography Dataset (High Resolution-24k). Available at: http://nhd.usgs.gov/index.html
- **Prime Farmland** – Natural Resources Conservation Service (NRCS) SSURGO Soil Database. Available at: http://soildatamart.nrcs.usda.gov/State.aspx
- **Pennsylvania State Parks and Forested Areas** – Pennsylvania Spatial Data Access (Penn State University). Available at: http://www.pasda.psu.edu/
- **New Jersey State Parks** – New Jersey Department of Environmental Protection GIS. Available at: http://www.state.nj.us/dep/gis/
- **Maryland Public, Protected, Heritage Lands, Sensitive Areas** – Maryland Department of Natural Resources. Available at: http://dnrweb.dnr.state.md.us/gis/data/data.asp
- **Historic Properties** – National Register of Historic Places (NRHP). Available at: http://nrhp.focus.nps.gov/natreg/docs/Download.html
- **Natural Heritage Data –** New Jersey Natural Heritage Program (NJNHP). Available at: http://www.nj.gov/dep/parksandforests/natural/heritage/
- **Roads/Highways** – Tele Atlas North America, Inc., Geographic Data Technology, Inc., Environmental Systems Research Institute, Inc. (ESRI; 2005)
- **Railroads** – Federal Railroad Administration (FRA), Bureau of Transportation Statistics, ESRI (2005)
- **Terrain** – United States Geological Survey (USGS). Available at: http://ned.usgs.gov/
- **Floodplains** – National Flood Hazard Database and Q3 Digital Flood Data. Available at: http://msc.fema.gov/

After compilation of the GIS coverages, each macro-corridor was analyzed to provide a summary of the number and type of each resource within the 5 mi. wide band. The data was summarized into tables and expressed in terms of area, length, or number of occurrences, depending on the resource. These measurements were compiled separately for the portion of each macro-corridor within a 6 mi. radius and within a 50 mi. radius of the PSEG Site. Most resource coverages were then scaled from the total macro-corridor values to a “projected” impact value for a hypothetical 200 ft. wide (typical 500 kV width) ROW potentially located within each macro-corridor. An adjustment factor was applied to the projected value for the hypothetical 200 ft. wide ROW to account for the actual transmission line length along existing ROWs relative to the simplified conceptual route. For example, the length of the simplified conceptual route for the West Macro-Corridor is approximately 55 mi., but the actual length along the existing ROWs is approximately 59 mi. Therefore, the estimated value for each resource within the West Macro-Corridor hypothetical ROW was increased by 7 percent (the percentage increase from 55 mi. to 59 mi.) to derive values for an adjusted hypothetical ROW. Similarly, the length of the simplified conceptual route for the South Macro-Corridor is approximately 94 mi., but the actual length along the existing ROWs is approximately 107 mi. Therefore, the estimated value for each resource within the South Macro-Corridor hypothetical ROW was increased by 14 percent (the percentage increase from 94 mi. to 107 mi.) to derive values for an adjusted hypothetical ROW.

The following subsections describe the results of the GIS evaluations in each major resource area.

9.4.3.1.2 Results

9.4.3.1.2.1 Land Use and Land Cover

The existing land use and land cover areas crossed by the 5 mi. wide macro-corridors and the 200 ft. wide hypothetical ROWs are summarized in Table 9.4-2. Cultivated cropland is the largest land use/land cover type crossed by the South Macro-Corridor, representing 39 percent of the macro-corridor area. Based on this percentage, the adjusted hypothetical ROW is estimated to cross 1051 ac. of cultivated cropland. Other major land uses within the South Macro-Corridor include wetlands, pasture hay, and deciduous forest (Table 9.4-2).

Pasture hay (lands that are either pastured or periodically cut and baled for domestic livestock forage) is the largest land use/land cover type crossed by the West Macro-Corridor, representing 24 percent of the macro-corridor area. Based on this percentage, the adjusted hypothetical ROW is estimated to cross 374 ac. of pasture hay land. Other major land uses within the West Macro-Corridor include cultivated cropland, deciduous forest, wetlands, and open water (Table 9.4-2).

9.4.3.1.2.2 Streams

The Delaware River is tidal in the study area, with flow rates and water levels dominated by tidal cycles. There are numerous other streams and channels along both macro-corridors. These streams are essentially all interconnected to some degree as tidal waterways. Table 9.4-3 presents the length of the streams within each macro-corridor and hypothetical ROW. There are a total of 1697 mi. of streams within the South Macro-Corridor and 970 mi. of streams within the West Macro-Corridor. Based on the adjusted hypothetical ROWs, the South Macro-Corridor ROW crosses 14.6 mi. of streams and the West Macro-Corridor ROW crosses 7.9 mi. of streams.

It is expected that approximately 95 percent of stream channels could be avoided in the location of transmission towers. Crossing of major rivers (Delaware River, Susquehanna River) would require the placement of in-stream structures. Structures placed near the navigation channel would be expected to also require the placement of dikes, bulkheading, rip rap, or other protective structures to guard against collisions with marine vessels.

9.4.3.1.2.3 Wetlands

Wetlands are a subset of waters of the United States defined as "...areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions" (33 CFR 328.3(b)).

As is shown in Table 9.4-2, Land Use Land Cover (LULC) data on wetlands includes two major classifications. The NWI wetlands coverage contains several classifications, including:

- Estuarine and marine deepwater
- Estuarine and marine wetland

- Freshwater emergent wetland
- Freshwater Forested/Shrub wetland
- Freshwater pond
- Lake
- Riverine
- Other (farmed, excavated, etc.)

NWI data is presumed to be a better indicator of potential wetland impacts than LULC data, as the NWI database has been developed with a particular focus on wetland resources. NWI mapping will be augmented with field delineation of jurisdictional wetlands as part of the permitting process if an actual transmission ROW is proposed.
Table 9.4-4 summarizes the wetland areas within each macro-corridor and hypothetical ROW based on NWI data. There are a total of 94,413 ac. of wetlands within the South Macro-Corridor and 35,516 ac. within the West Macro-Corridor. The adjusted hypothetical ROWs are estimated to cross 814 ac. along the South Macro-Corridor and 289 ac. along the West Macro-Corridor.

In general, the wetlands within a transmission ROW would not be directly impacted except in the limited footprints of transmission towers and any necessary access points. It is expected that 85 percent of wetlands could be avoided in the location of transmission towers.

9.4.3.1.2.4 Prime Farmland and Farmland of Special Status

The National Soils Survey Handbook (Reference 9.4-4) defines prime farmland as soils that have the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops, and are available for these uses. Farmland of statewide or unique importance is also considered a valuable agricultural resource and is tabulated here along with prime farmland. Prime farmland within the study area was quantified using soil types and slopes specified as prime by the NRCS. In contrast, farmlands of unique importance correspond to lands within the coastal wetlands and likely correspond to the use of these areas for salt hay farming.

The prime farmland and farmlands of special status within each macro-corridor and hypothetical ROW are summarized in Table 9.4-5. Soils data was not available in GIS format for New Castle County, DE; consequently, the USGS LULC cultivated crops data for New Castle County was used as a surrogate for this analysis. Within the South and West Macro-Corridors there are, respectively, 231,992 ac. and 146,827 ac. of prime and special status farmland. The adjusted hypothetical ROWs cross 2000 ac. along the South Macro-Corridor and 992 ac. along the West Macro-Corridor.

Most farmland would be unaffected by a transmission line except in the limited footprints of transmission towers and any necessary access points.

9.4.3.1.2.5 Sensitive Resources

Sensitive resources identified within the macro-corridors are summarized in Table 9.4-6. This information was obtained through several public sources, and the manner and level of detail in which each particular agency describes these sensitive resources varies. The sensitive resources that are described in Table 9.4-6 include parks, public lands, refuges, natural heritage resources (rare, threatened or endangered species or habitats of unusual natural quality), and

state/federal lands. Many of these lands are available for such recreational uses as hunting, fishing, bird watching, and other low intensity uses. The natural heritage GIS data was quite limited and subject to the public domain availability of such data within each state. Resource agencies typically do not make precise sensitive species locations readily available in order to guard against potential human interference with the resource. This data was generally not available for DE, MD, and PA. Within NJ, data is represented by USGS quadrangles that have historically had an occurrence of an endangered or sensitive plant species. Any available qualitative information is provided descriptively in Table 9.4-6.

Some of the resources shown in Table 9.4-6 are expected to be sensitive and would be actively avoided during route development (e.g., listed threatened or endangered species, state parks, historic sites, etc.). In contrast, other features (e.g., state wildlife management areas) may be considered sensitive but represent a manageable issue during routing studies. Unidentified natural heritage features are available only on a USGS quadrangle basis, therefore, any attempt at quantification of this potential constraint would be an exaggeration. Further, the quality of the available natural heritage data is considered low. Accordingly, no scaling or adjustment of these features to hypothetical ROWs was performed.

9.4.3.1.2.6 Historical Places

The number of historic places (based on NRHP data) identified within each macro-corridor by county is summarized in Table 9.4-7. Within the South and West Macro-Corridors there are 147 and 52 historic places, respectively. Within the adjusted hypothetical ROWs there are estimated to be two historic places for the South Macro-Corridor and none for the West Macro-Corridor.

It is expected that most historic and cultural resources could be avoided during the detailed design of transmission facilities.

9.4.3.1.2.7 Infrastructure

Infrastructure (roads and railroads) are summarized in Table 9.4-8. There are 325 mi. of roads and railroads within the South Macro-Corridor and 282 mi. within the West Macro-Corridor. The adjusted hypothetical ROWs crosses 2.8 mi. of these features along the South Macro-Corridor and 2.3 mi. along the West Macro-Corridor.

9.4.3.1.2.8 Floodplains

The acreage of 100-year floodplains within each macro-corridor and hypothetical ROW is summarized in Table 9.4-9. There are a total of 119,065 ac. of floodplains within the South Macro-Corridor and 60,496 ac. within the West Macro-Corridor. The adjusted hypothetical ROWs cross 1026 ac. along the South Macro-Corridor and 492 ac. along the Macro-West Corridor. Most floodplains would be unaffected except in the limited footprints of transmission towers and any necessary access points.

9.4.3.1.3 Summary

An analysis of potential future off-site transmission corridors that may be needed to support system stability was performed using publicly available GIS data. Because precise routes have not yet been developed, this analysis utilized a macro-corridor approach to characterize potential impacts. The macro-corridor approach entailed the use of simplified 5 mi. wide bands

along two primary routing alternatives chosen to support potential transmission stability needs. One alternative (the South Macro-Corridor) extends from the PSEG Site to the Indian River Substation in DE. The second alternative (the West Macro-Corridor) extends from the PSEG Site to the Peach Bottom Substation in PA.

The results of this analysis demonstrate that the South Macro-Corridor, by virtue of its greater length, represents a bounding condition that, for most resource categories examined, exceeds the impacts of the West Macro-Corridor. The total area potentially included within the 200 ft. wide adjusted hypothetical ROW for the South Macro-Corridor is 2728 ac., as compared to 1557 ac. for the West Macro-Corridor.

Both macro-corridors have similarities in the dominant land uses crossed. Agricultural lands (cultivated crops and pasture hay), forested lands, and wetlands are the dominant land cover types crossed by each macro-corridor. Wetland and stream resources are also similarly represented within each macro-corridor. Perennial streams are slightly more abundant (by percentage) within the West Macro-Corridor relative to the South Macro-Corridor. In contrast, wetlands are represented by a greater percentage within the South Macro-Corridor as compared to the West Macro-Corridor. Prime and unique farmland is more abundant (by percentage) within the West Macro-Corridor, and floodplains are more abundant within the South Macro-Corridor.

Sensitive resources including parkland, refuges, and publicly owned wildlife management areas were also evaluated. Notably, the West Macro-Corridor contained a greater number of potentially sensitive features as compared to the South Macro-Corridor. Natural Heritage features were difficult to characterize due to the unavailability of site-specific data in publicly available GIS databases. Historic properties were demonstrated to be low in number within each macro-corridor and are likely avoidable.

The resources characterized as part of this analysis are a general indicator of potential impacts associated with off-site transmission corridor development. Additionally, these data serve as a baseline from which to initiate detailed studies as part of future route selection activities. In many cases, detailed studies will allow the avoidance of resources characterized by this macro-corridor analysis, thereby reducing potential impacts, particularly to sensitive features such as wetlands, streams, and historic properties.

Although the purpose of this analysis was not to select a transmission corridor for development, the values for the 200 ft. wide adjusted hypothetical ROW for the South Macro-Corridor are considered useful as bounding estimates for the potential environmental impacts that could result from any off-site transmission that may be required for the new plant. Accordingly, environmental impact evaluations in other parts of this Environmental Report are based on the South Macro-Corridor adjusted ROW. Additional analysis during specific transmission line routing studies will allow a detailed determination of environmental impacts. The potential impacts indicated by the South Macro-Corridor adjusted ROW likely over-estimate actual environmental impacts.

9.4.3.2 Design Considerations

Detailed design parameters will not be determined until the need for off-site transmission has been established. However, any new off-site transmission line will be 500 kV and will be

expected to have characteristics similar to existing PSEG 500 kV transmission lines. Characteristics relevant to the macro-corridors under consideration include the following:

- Typical tower spacing of five spans per mi.
- Delaware River Crossing – Assumes five towers located on piers placed parallel to the existing transmission line
- Susquehanna River Crossing – Assumes a single tower
- Piers to support towers needed for major river crossings assumed to be colocated (side-by-side) with existing piers
- Typical transmission support structure to consist of lattice tower or mono-pole construction
- Typical transmission support structure to have a height of 145 to 180 ft.

The above characteristics represent reasonable assumptions regarding the likely design of a potential new 500 KV transmission line. During detailed design, efforts will be made to minimize environmental impacts while providing safe, reliable, and cost-effective transmission design.

9.4.4 REFERENCES

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9.4-2 Ator, Scott W., Judith M. Denver, David E. Krantz, Wayne L. Newell, and Sarah K. Martucci. 2005. A Surficial Hydrogeologic Framework for the Mid-Atlantic Coastal Plain. Professional Paper 1680. U.S. Geological Survey, Reston, VA.

9.4-3 Drbal, et. al, “Power Plant Engineering,” New York: Springer, 1995.

9.4-4 Natural Resources Conservation Service. 1973. The National Soils Survey Handbook (Part 622). http://soils.usda.gov/technical/handbook/contents/part622.html.

9.4-5 U.S. Environmental Protection Agency, “Chapter 4: Dry Cooling, Cooling Water Intake Structures-CWA 316(b), Phase I New Facilities, Technical Development Document for the Final Regulations,” Technical Report Number EPA-821-R-01-036, November 2001.

9.4-6 U.S. Environmental Protection Agency, “National Pollutant Discharge Elimination System: Regulations Addressing Cooling Water Intake Structures for New Facilities; Final Rule,” Federal Register: December 18, 2001 (Volume 66, Number 243, Pages 65256-65345).

9.4-7 U.S. Nuclear Regulatory Commission, “NUREG-1437: Generic Environmental Impact Statement for License Renewal of Nuclear Plants,” May 1996, http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1437/v1/index.html.

Table 9.4-1
Counties Potentially Intersected by Each Transmission Macro-Corridor

	West Macro-Corridor	South Macro-Corridor
Salem County, NJ	X	X
New Castle County, DE	X	X
Kent County, DE		X
Sussex County, DE		X
Cecil County, MD	X	
Harford County, MD	X	
Chester County, PA	X	
Lancaster County, PA	X	
York County, PA	X	

Table 9.4-2
Land Use/Land Cover (acres) within Macro-Corridors and Hypothetical Rights-of-Way

	5-Mi. Wide Corridor			Projected 200-ft Wide Right-of-Way			Adjusted 200-ft Wide Right-of-Way[a]			
South Corridor	**6-Mile Vicinity**	**6-50+ Mile Region**	**Total**	**6-Mile Vicinity**	**6-50+ Mile Region**	**Total**	**6-Mile Vicinity**	**6-50+ Mile Region**	**Total**	**Percent**
Open Water	4468	21,686	26,154	34	164	198	39	187	225	8.3%
Developed - Open Space	282	6360	6642	2	48	50	2	55	57	2.1%
Developed - Low Intensity	199	5696	5895	2	43	45	2	49	51	1.9%
Developed - Medium Intensity	90	2684	2774	1	20	21	1	23	24	0.9%
Developed - High Intensity	192	1394	1586	1	11	12	2	12	14	0.5%
Barren Land	493	3110	3603	4	24	27	4	27	31	1.1%
Deciduous Forest	2243	39,052	41,295	17	296	313	19	337	356	13.1%
Evergreen Forest	58	4106	4165	0	31	32	1	35	36	1.3%
Mixed Forest	11	1807	1817	0	14	14	0	16	16	0.6%
Pasture Hay	3416	32,175	35,591	26	244	270	29	277	307	11.2%
Cultivated Crops	11,704	110,191	121,895	89	835	923	101	950	1051	38.5%
Woody Wetlands	7742	18,707	26,448	59	142	200	67	161	228	8.4%
Emergent Herbaceous Wetlands	11,648	26,915	38,563	88	204	292	100	232	332	12.2%
Total	**42,545**	**273,884**	**316,429**	**322**	**2075**	**2397**	**367**	**2361**	**2728**	**100.0%**
West Corridor										
Open Water	1976	18,744	20,721	15	142	157	16	152	168	10.8%
Developed - Open Space	98	7609	7706	1	58	58	1	62	63	4.0%
Developed - Low Intensity	97	8769	8867	1	66	67	1	71	72	4.6%
Developed - Medium Intensity	64	3726	3789	0	28	29	1	30	31	2.0%
Developed - High Intensity	191	1420	1610	1	11	12	2	12	13	0.8%
Barren Land	351	2570	2921	3	19	22	3	21	24	1.5%
Deciduous Forest	1086	33,969	35,055	8	257	266	9	276	285	18.3%
Evergreen Forest	13	1064	1077	0	8	8	0	9	9	0.6%
Mixed Forest	9	32	42	0	0	0	0	0	0	0.0%
Pasture Hay	934	45,122	46,055	7	342	349	8	367	374	24.0%
Cultivated Crops	4310	31,396	35,706	33	238	270	35	255	290	18.6%
Woody Wetlands	4276	11,534	15,810	32	87	120	35	94	129	8.3%
Emergent Herbaceous Wetlands	7675	4490	12,164	58	34	92	62	36	99	6.4%
Total	**21,077**	**170,446**	**191,523**	**160**	**1291**	**1451**	**171**	**1386**	**1557**	**100.0%**

a) 200-ft projected corridor was adjusted to account for the actual route length, 14% adjustment for the South Corridor and 7% adjustment for the West Corridor.

Table 9.4-3
Stream Length (miles) within Macro-Corridors and Hypothetical Rights-of-Way

	5-Mi. Wide Corridor			Projected 200-ft Wide Right-of-Way			Adjusted 200-ft Wide Right-of-Way[(a)]			
South Corridor	**6-Mile Vicinity**	**6-50+ Mile Region**	**Total**	**6-Mile Vicinity**	**6-50+ Mile Region**	**Total**	**6-Mile Vicinity**	**6-50+ Mile Region**	**Total**	**Percent**
Channelized Waterway	197.3	431.2	628.5	1.5	3.3	4.8	1.7	3.7	5.4	37.0%
Intermittent Stream	0.2	130.0	130.2	0.0	1.0	1.0	0.0	1.1	1.1	7.7%
Perennial Stream	320.4	617.6	938.0	2.4	4.7	7.1	2.8	5.3	8.1	55.3%
Total	**518.0**	**1178.8**	**1696.7**	**3.9**	**8.9**	**12.9**	**4.5**	**10.2**	**14.6**	**100.0%**
West Corridor										
Channelized Waterway	140.0	184.0	324.1	1.1	1.4	2.5	1.1	1.5	2.6	33.4%
Intermittent Stream	0.0	79.7	79.7	0.0	0.6	0.6	0.0	0.6	0.6	8.2%
Perennial Stream	236.0	330.3	566.3	1.8	2.5	4.3	1.9	2.7	4.6	58.4%
Total	**376.0**	**594.0**	**970.1**	**2.8**	**4.5**	**7.3**	**3.1**	**4.8**	**7.9**	**100.0%**

a) 200-ft projected corridor was adjusted to account for the actual route length, 14% adjustment for the South Corridor and 7% adjustment for the West Corridor.

Table 9-4-4
Wetlands (acres) within Macro-Corridors and Hypothetical Rights-of-Way

	5-Mi. Wide Corridor			Projected 200-ft Wide Right-of-Way			Adjusted 200-ft Wide Right-of-Way[a]			
South Corridor	**6-Mile Vicinity**	**6-50+ Mile Region**	**Total**	**6-Mile Vicinity**	**6-50+ Mile Region**	**Total**	**6-Mile Vicinity**	**6-50+ Mile Region**	**Total**	**Percent**
Estuarine and Marine Deepwater	3858	8749	12,607	29	66	96	33	75	109	13.4%
Estuarine and Marine Wetland	16,551	32,707	49,257	125	248	373	143	282	425	52.2%
Freshwater Emergent Wetland	1522	3934	5457	12	30	41	13	34	47	5.8%
Freshwater Forested/Shrub Wetland	1677	22,730	24,408	13	172	185	14	196	210	25.9%
Freshwater Pond	284	1017	1301	2	8	10	2	9	11	1.4%
Lake	1	766	767	0	6	6	0	7	7	0.8%
Riverine	17	328	344	0	2	3	0	3	3	0.4%
Other[b]	63	208	271	0	2	2	1	2	2	0.3%
Total	**23,973**	**70,440**	**94,413**	**182**	**534**	**715**	**207**	**607**	**814**	**100.0%**
West Corridor										
Estuarine and Marine Deepwater	2347	4333	6680	18	33	51	19	35	54	18.8%
Estuarine and Marine Wetland	10,121	5241	15,362	77	40	116	82	43	125	43.3%
Freshwater Emergent Wetland	1400	2788	4188	11	21	32	11	23	34	11.8%
Freshwater Forested/Shrub Wetland	1164	6173	7337	9	47	56	9	50	60	20.7%
Freshwater Pond	172	833	1005	1	6	8	1	7	8	2.8%
Lake	1	335	336	0	3	3	0	3	3	0.9%
Riverine	17	414	430	0	3	3	0	3	3	1.2%
Other[b]	63	114	177	0	1	1	1	1	1	0.5%
Total	**15,285**	**20,231**	**35,516**	**116**	**153**	**269**	**124**	**164**	**289**	**100.0%**

a) 200-ft projected corridor was adjusted to account for the actual route length, 14% adjustment for the South Corridor and 7% adjustment for the West Corridor.
b) Other wetlands include those classified as farmed wetlands, excavated/disturbed wetlands, and seasonal wetlands.

Table 9.4-5
Prime and Special Status Farmland (acres) within Macro-Corridors and Hypothetical Rights-of-Way (a)

	5-Mi. Wide Corridor			Projected 200-ft Wide Right-of-Way			Adjusted 200-ft Wide Right-of-Way(b)			
South Corridor	**6-Mile Vicinity**	**6-50+ Mile Region**	**Total**	**6-Mile Vicinity**	**6-50+ Mile Region**	**Total**	**6-Mile Vicinity**	**6-50+ Mile Region**	**Total**	**Percent**
NRCS Prime Farmland	8361	88,679	97,040	63	672	735	72	765	837	41.83%
Farmland of Unique Importance	19,381	12,954	32,335	147	98	245	167	112	279	13.94%
Farmland of Statewide Importance	5349	36,790	42,139	41	279	319	46	317	363	18.16%
Prime farmland if protected from flooding or not frequently flooded during the growing season	0	0	0	0	0	0	0	0	0	0.00%
Prime farmland if irrigated	0	31,385	31,385	0	238	238	0	271	271	13.53%
Prime farmland if drained	0	811	811	0	6	6	0	7	7	0.35%
New Castle County, DE Cultivated Cropland	7394	20,889	28,283	56	158	214	64	180	244	12.19%
Total	**40,484**	**191,507**	**231,992**	**307**	**1451**	**1758**	**349**	**1651**	**2000**	**100.00%**
West Corridor										
NRCS Prime Farmland	8361	105,055	113,416	63	796	859	68	854	922	92.90%
Farmland of Unique Importance	19,381	0	19,381	0	0	0	0	0	0	0.00%
Farmland of Statewide Importance	5349	0	5349	0	0	0	0	0	0	0.00%
Prime farmland if protected from flooding or not frequently flooded during the growing season	0	14	14	0	0	0	0	0	0	0.00%
Prime farmland if irrigated	0	0	0	0	0	0	0	0	0	0.00%
Prime farmland if drained	0	0	0	0	0	0	0	0	0	0.00%
New Castle County, DE Cultivated Cropland	0	8667	8667	0	66	66	0	70	70	7.10%
Total	**33,091**	**113,737**	**146,827**	**63**	**862**	**925**	**68**	**924**	**992**	**100.00%**

a) Soils data used in determining prime farmland was not available for New Castle County, DE. Cultivated cropland data from USGS was used as a surrogate.
b) 200-ft projected corridor was adjusted to account for the actual route length, 14% adjustment for the South Corridor and 7% adjustment for the West Corridor.

Table 9.4-6
Sensitive Resources within Macro-Corridors[a]

South Corridor	6-Mile Vicinity	6-50+ Mile Region	Description
Unspecified Natural Heritage Resource, NJ	X		18 quadrangles with at least 1 sensitive plant occurrence
Abbott's Meadow Wildlife Management Area, NJ	X		1324 acres
Hancock House State Historic Site, NJ	X		2 acres
Mad Horse Creek Wildlife Management Area, NJ	X		4694 acres
Fort duPont State Park, DE		X	274 acres
Bombay Hook National Wildlife Refuge, DE		X	3640 acres
Prime Hook National Wildlife Refuge, DE		X	492 acres
Supawna National Wildlife Refuge, NJ		X	2479 acres
Dover Air Base, DE		X	2804 acres
Unspecified Natural Heritage Resource, NJ		X	2 endangered plant occurrences within 197 acres
Unspecified Natural Heritage Resource, NJ		X	endangered plant occurrence within 68 acres
Unspecified Natural Heritage Resource, NJ		X	29 quadrangles with at least 1 sensitive plant occurrence
Unspecified Natural Heritage Resource, NJ		X	22 quadrangles with at least 1 sensitive plant occurrence
Salem River State Park, NJ		X	204 acres
Fort Mott State Park, NJ		X	92 acres
West Corridor			
Unspecified Natural Heritage Resource, NJ	X		18 quadrangles with at least 1 sensitive plant occurrence
Abbott's Meadow Wildlife Management Area, NJ	X		1324 acres
Hancock House State Historic Site, NJ	X		2 acres
Mad Horse Creek Wildlife Management Area, NJ	X		4694 acres
Unspecified Natural Heritage Resource, NJ		X	2 endangered plant occurrences within 197 acres
Unspecified Natural Heritage Resource, NJ		X	endangered plant occurrence within 68 acres
Unspecified Natural Heritage Resource, NJ		X	29 quadrangles with at least 1 sensitive plant occurrence
Unspecified Natural Heritage Resource, NJ		X	22 quadrangles with at least 1 sensitive plant occurrence
Fort duPont State Park, DE		X	15 acres
Supawna National Wildlife Refuge, NJ		X	2479 acres
Salem River State Park, NJ		X	204 acres
Fort Mott State Park, NJ		X	92 acres
County Owned Land, MD		X	496 acres
DNR Owned Land, MD		X	557 acres
Nature Conservancy Land, MD		X	30 acres
Fair Hill Rural Legacy Area, MD		X	4142 acres
State Forest, PA		X	79 acres
Humanistic Forest, PA		X	10,514 acres
Naturalistic Forest, PA		X	14,454 acres
Fort Delaware State Park, DE		X	289 acres
Sensitive Species Project Areas, MD		X	18,623 acres
Forest Interior Habitat, MD		X	16,773 acres

a) Available data identified no sensitive resources outside of the 50-mile radius for either macro-corridor.

Table 9.4-7
Number of NRHP[a] Historic Properties within Macro-Corridors and Hypothetical Rights-of-Way[b]

	5-Mi. Wide Corridor			Projected 200-ft Wide Right-of-Way			Adjusted 200-ft Wide Right-of-Way[c]			
South Corridor	**6-Mile Vicinity**	**6-50+ Mile Region**	**Total**	**6-Mile Vicinity**	**6-50+ Mile Region**	**Total**	**6-Mile Vicinity**	**6-50+ Mile Region**	**Total**	**Percent**
NJ-Salem County	6	5	11	† [d]	†	†	†	†	†	7.5%
DE-New Castle County	18	43	61	†	†	1	†	†	1	41.5%
DE-Kent County	0	54	54	†	†	†	†	1	1	36.7%
DE-Sussex County	0	21	21	†	†	†	†	†	†	14.3%
Total	**24**	**123**	**147**	**0**	**0**	**1**	**0**	**1**	**2**	**100.0%**
West Corridor										
NJ-Salem County	6	5	11	†	†	†	†	†	†	21.2%
DE-New Castle County	0	21	21	†	†	†	†	†	†	40.4%
MD-Cecil County	0	20	20	†	†	†	†	†	†	38.5%
MD-Harford County	0	0	0	†	†	†	†	†	†	0.0%
PA-Chester County	0	0	0	†	†	†	†	†	†	0.0%
PA-Lancaster County	0	0	0	†	†	†	†	†	†	0.0%
PA-York County	0	0	0	†	†	†	†	†	†	0.0%
Total	**6**	**46**	**52**	**0**	**0**	**0**	**0**	**0**	**0**	**100.0%**

a) National Register of Historic Places

b) The projected and adjusted values are fractions because they are modified using percentages.

c) 200-ft projected corridor was adjusted to account for the actual route length, 14% adjustment for the South Corridor and 7% adjustment for the West Corridor.

d) † Calculated value between 0 and 1.

Table 9.4-8
Infrastructure (miles) within Macro-Corridors and Hypothetical Rights-of-Way

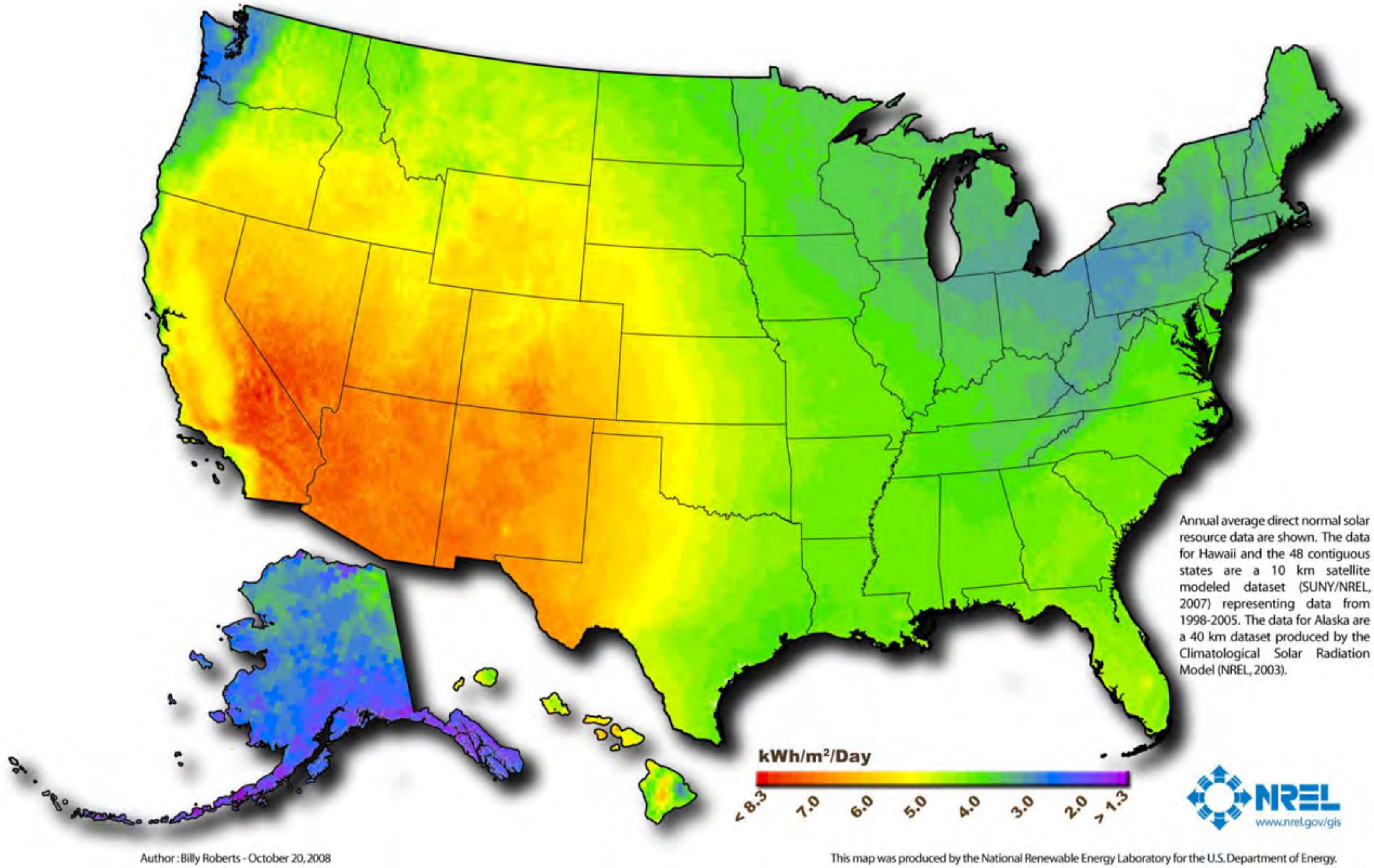
	5-Mi. Wide Corridor			Projected 200-ft Wide Right-of-Way			Adjusted 200-ft Wide Right-of-Way[a]			
South Corridor	**6-Mile Vicinity**	**6-50+ Mile Region**	**Total**	**6-Mile Vicinity**	**6-50+ Mile Region**	**Total**	**6-Mile Vicinity**	**6-50+ Mile Region**	**Total**	**Percent**
Road/Highways	28.87	268.67	297.54	0.22	2.04	2.25	0.25	2.32	2.57	91.5%
Railroad	0.00	27.68	27.68	0.00	0.21	0.21	0.00	0.24	0.24	8.5%
Total	**28.87**	**296.35**	**325.22**	**0.22**	**2.25**	**2.46**	**0.25**	**2.55**	**2.80**	**100.0%**
West Corridor										
Road/Highways	10.01	225.00	235.00	0.08	1.70	1.78	0.08	1.83	1.91	83.3%
Railroad	0.00	47.07	47.07	0.00	0.36	0.36	0.00	0.38	0.38	16.7%
Total	**10.01**	**272.07**	**282.08**	**0.08**	**2.06**	**2.14**	**0.08**	**2.21**	**2.29**	**100.0%**

a) 200-ft projected corridor was adjusted to account for the actual route length, 14% adjustment for the South Corridor and 7% adjustment for the West Corridor.

Table 9.4-9
100-Year Floodplain (acres) within Macro-Corridors and Hypothetical Rights-of-Way

	5-Mi. Wide Corridor			Projected 200-ft Wide Right-of-Way			Adjusted 200-ft Wide Right-of-Way[a]			
	6-Mile Vicinity	6-50+ Mile Region	Total	6-Mile Vicinity	6-50+ Mile Region	Total	6-Mile Vicinity	6-50+ Mile Region	Total	Percent of Right-of-Way
South Corridor	30,922	88,143	119,065	234	668	902	267	760	1026	38%
West Corridor	18,392	42,104	60,496	139	319	458	150	342	492	32%

[a] 200-ft projected corridor was adjusted to account for the actual route length, 14% adjustment for the South Corridor and 7% adjustment for the West Corridor.



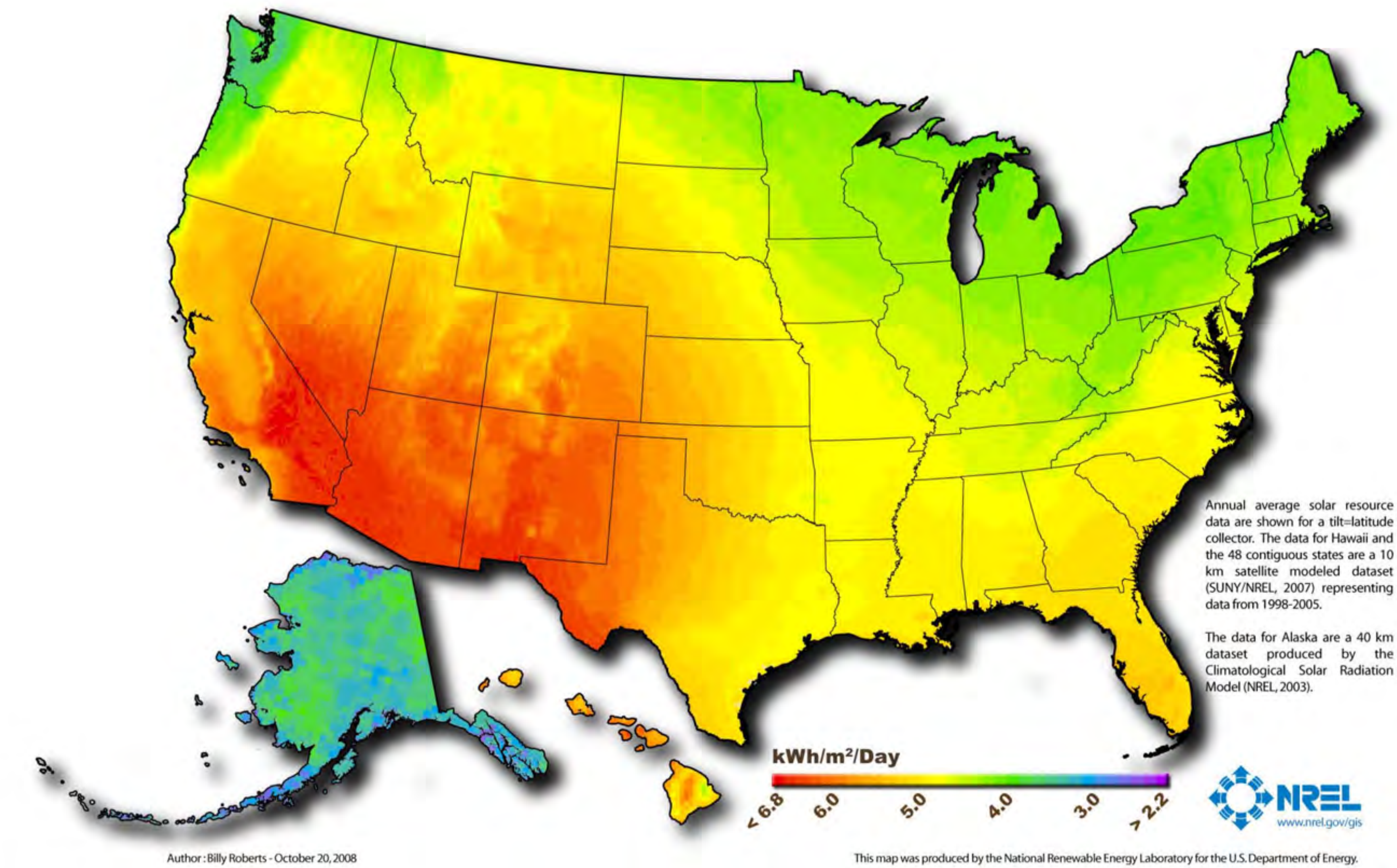
PSEG Power, LLC

PSEG Site ESPA
Part 3, Environmental Report

Concentrating Solar Power
Insolation Values

FIGURE 9.2-1

Rev 0



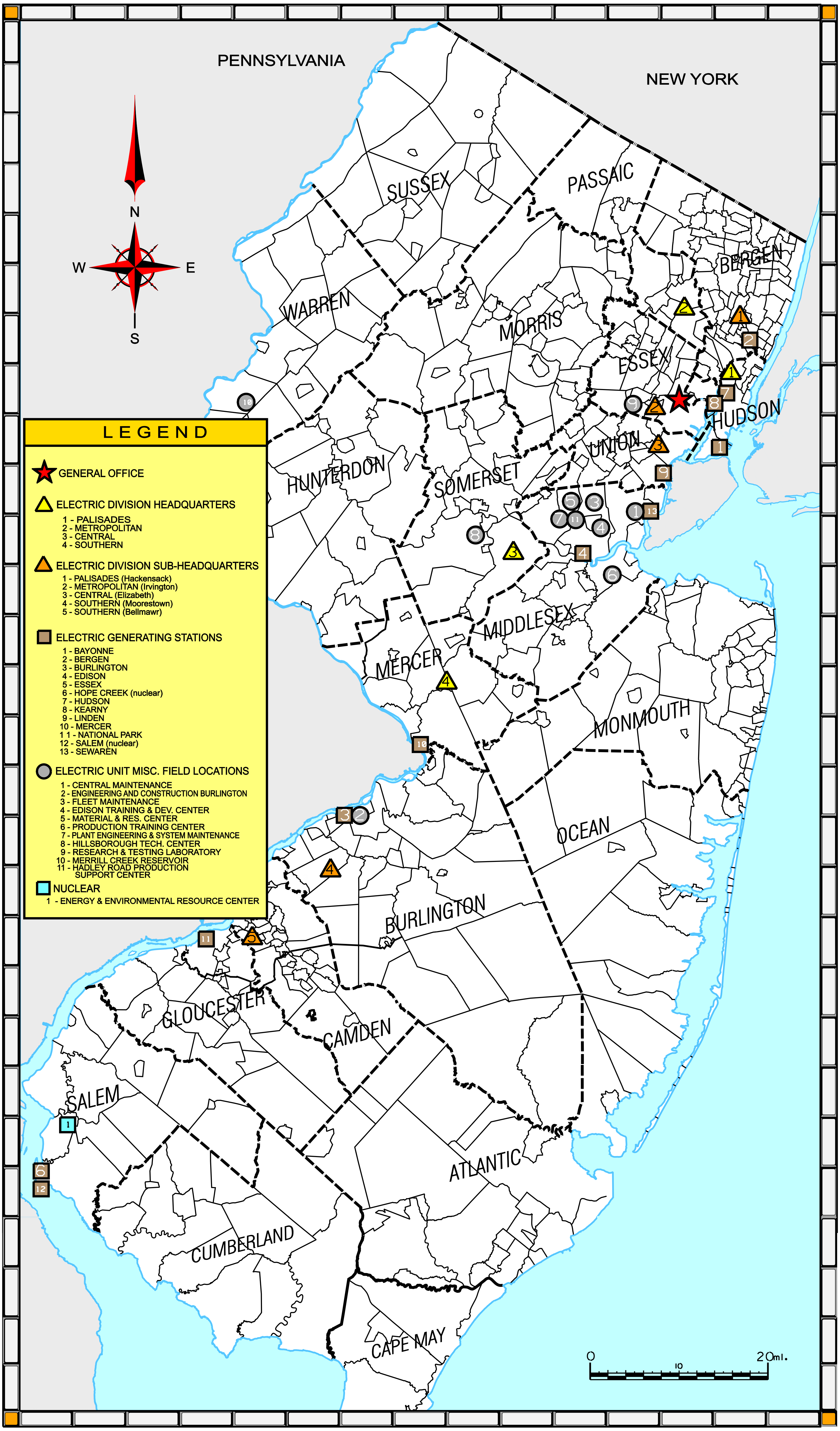
PSEG Power, LLC

PSEG Site ESPA
Part 3, Environmental Report

Photovoltaics
Insolation Values

FIGURE 9.2-2

Rev 0



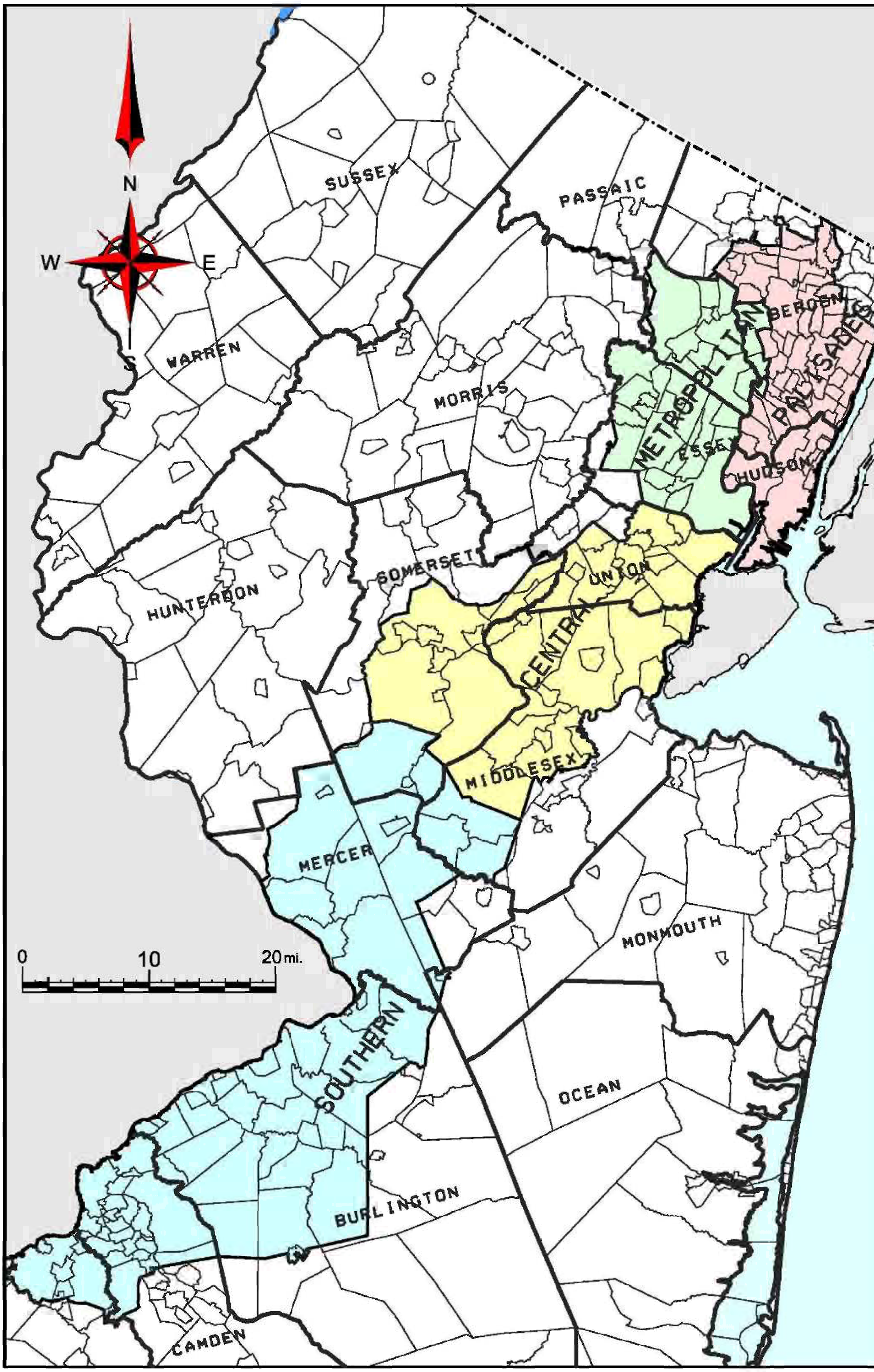
PSEG Power, LLC

PSEG Site ESPA
Part 3, Environmental Report

Public Service Enterprise Group Power Plants and Offices in New Jersey

FIGURE 9.3-1

Rev 0



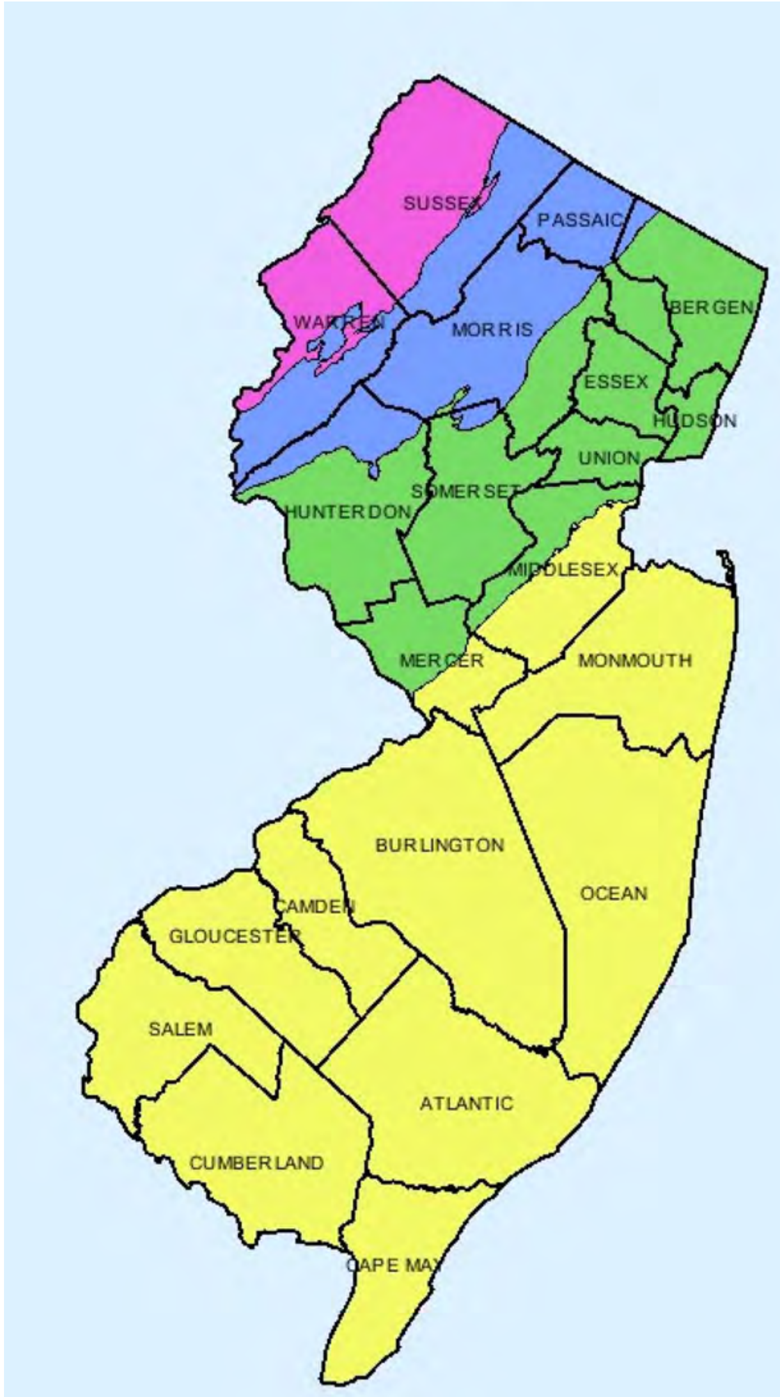
PSEG Power, LLC

PSEG Site ESPA
Part 3, Environmental Report

PSE&G Electric Service Area

FIGURE 9.3-2

Rev 0



Counties – Physiographic Provinces
Coastal Plain
Highlands
Peidmont
Valley and Ridge

Reference 9.3-12

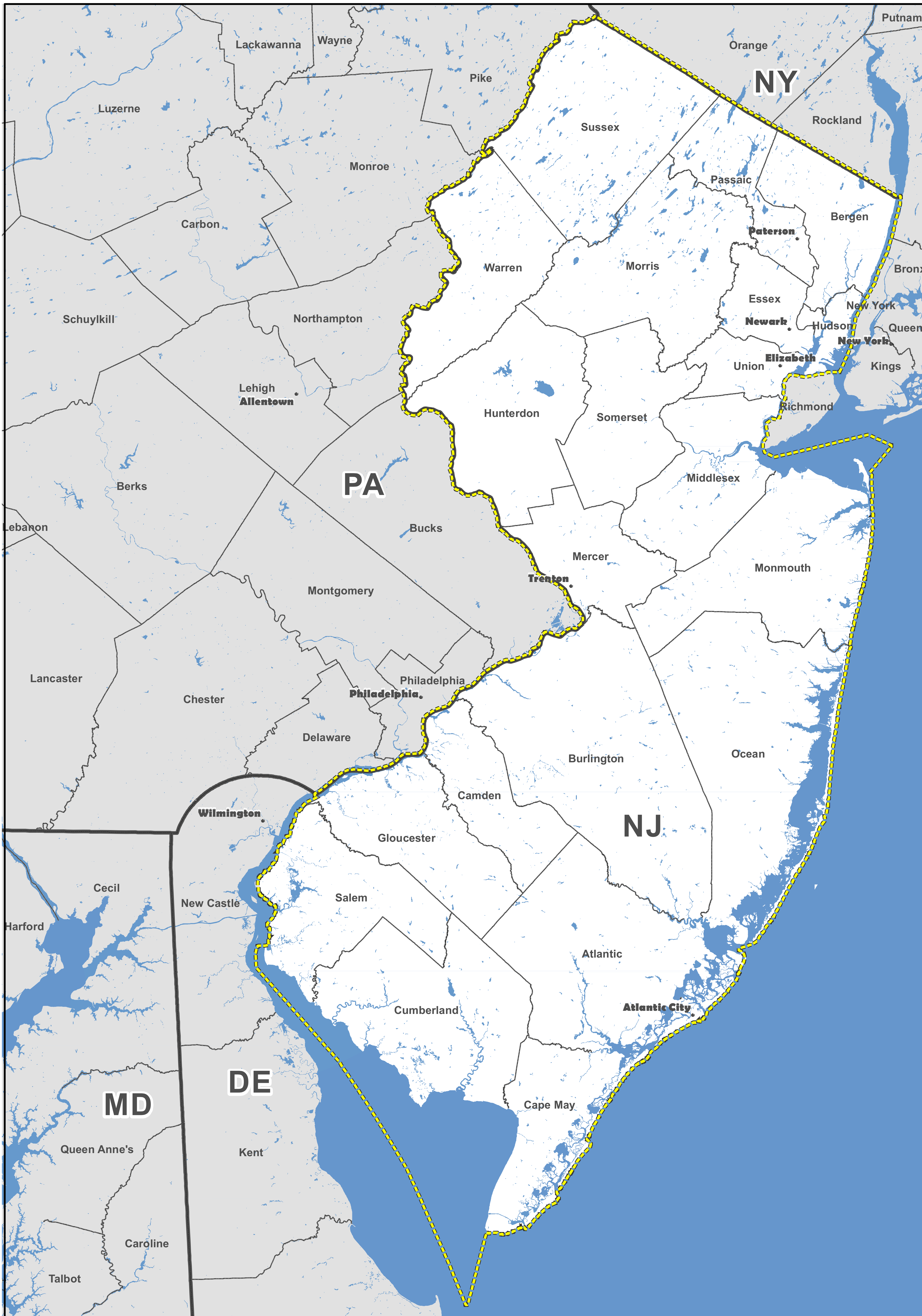
PSEG Power, LLC

PSEG Site ESPA
Part 3, Environmental Report

Major Landforms in New Jersey

FIGURE 9.3-3

Rev 0



LEGEND

Region of Interest Boundary

State Boundary

County Boundary

N W E S

0 10 20 Kilometers

0 10 20 Miles

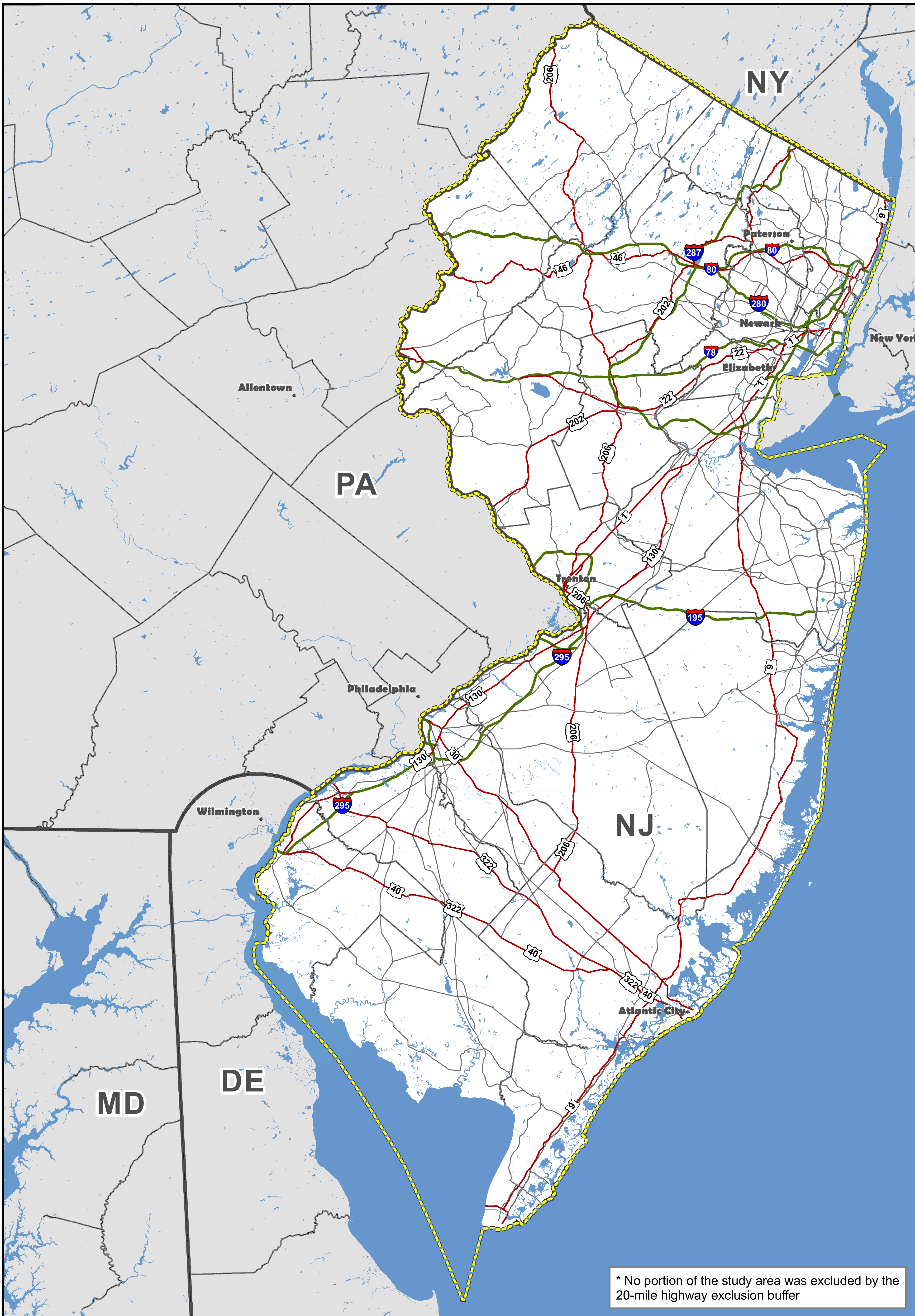
PSEG Power, LLC

PSEG Site ESPA
Part 3, Environmental Report

Region of Interest

FIGURE 9.3-4

Rev 0



LEGEND

Region of Interest Boundary

Primary Highway

Interstate

US Highway

State Highway

N
W E
S

0 10 20
Kilometers

0 10 20
Miles

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PSEG Site ESPA
Part 3, Environmental Report

Primary Highways
and Excluded Areas

FIGURE 9.3-5

Rev 0

LEGEND

- Region of Interest Boundary
- Railways
- Bargeable Waterways

N W E S

0 10 20 Kilometers

0 10 20 Miles

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PSEG Site ESPA
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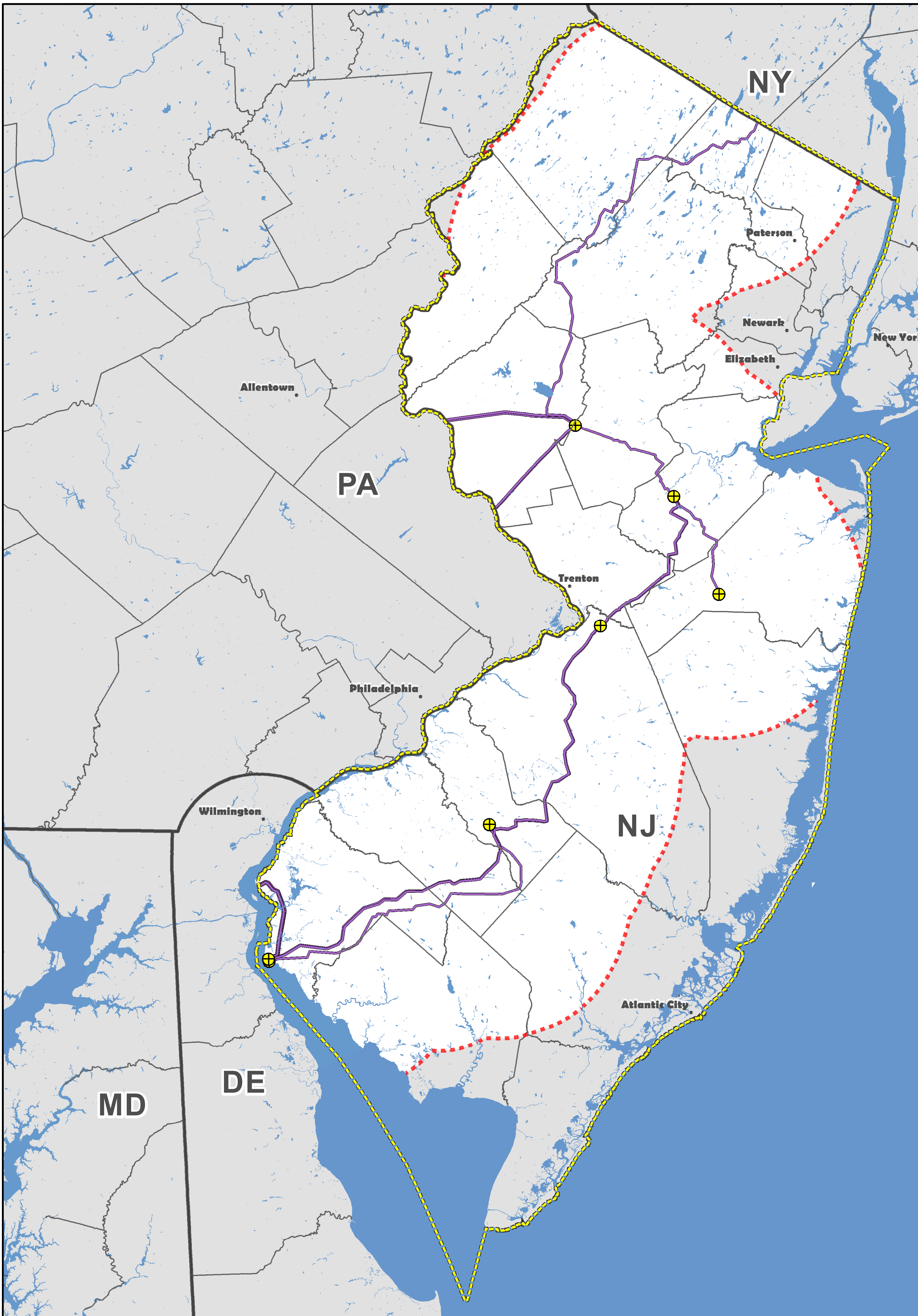
Rail and Barge Transportation and Excluded Areas

FIGURE 9.3-6

Rev 0



LEGEND

- Region of Interest Boundary
- Substations > = 500 kV
- Transmission Lines > = 500 kV
- 20-Mile Exclusion Buffer
- Excluded Areas

N
W E
S

0 10 20
Kilometers

0 10 20
Miles

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PSEG Site ESPA
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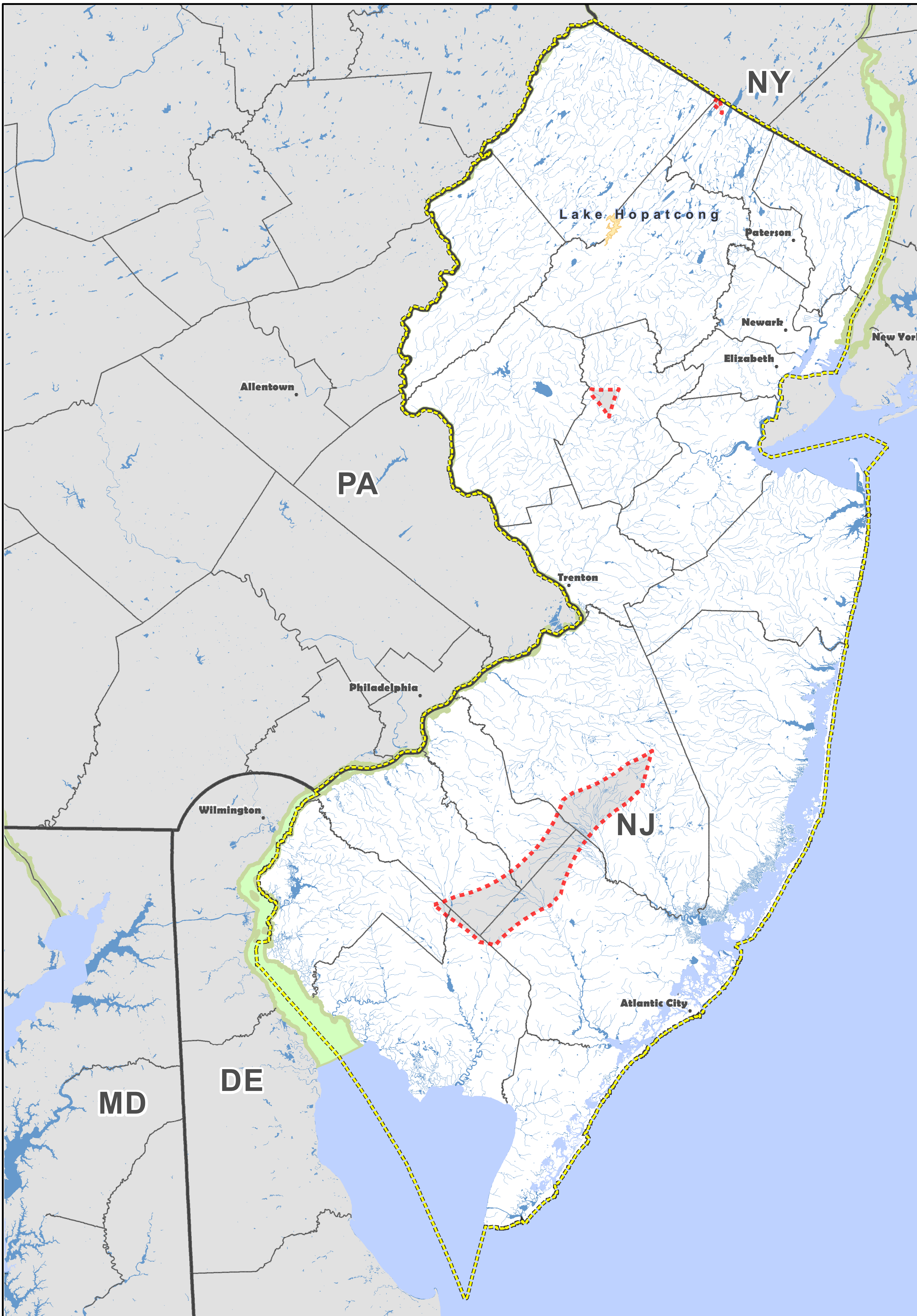
Transmission Lines
and Excluded Areas

FIGURE 9.3-7

Rev 0



LEGEND

- Region of Interest Boundary
- Atlantic Ocean
- Lakes > = 2,000 Acres
- Rivers with 7Q10 low-flow > = 175,000 gpm
- 20-Mile Exclusion Buffer
- Excluded Areas

N W E S

0 10 20 Kilometers

0 10 20 Miles

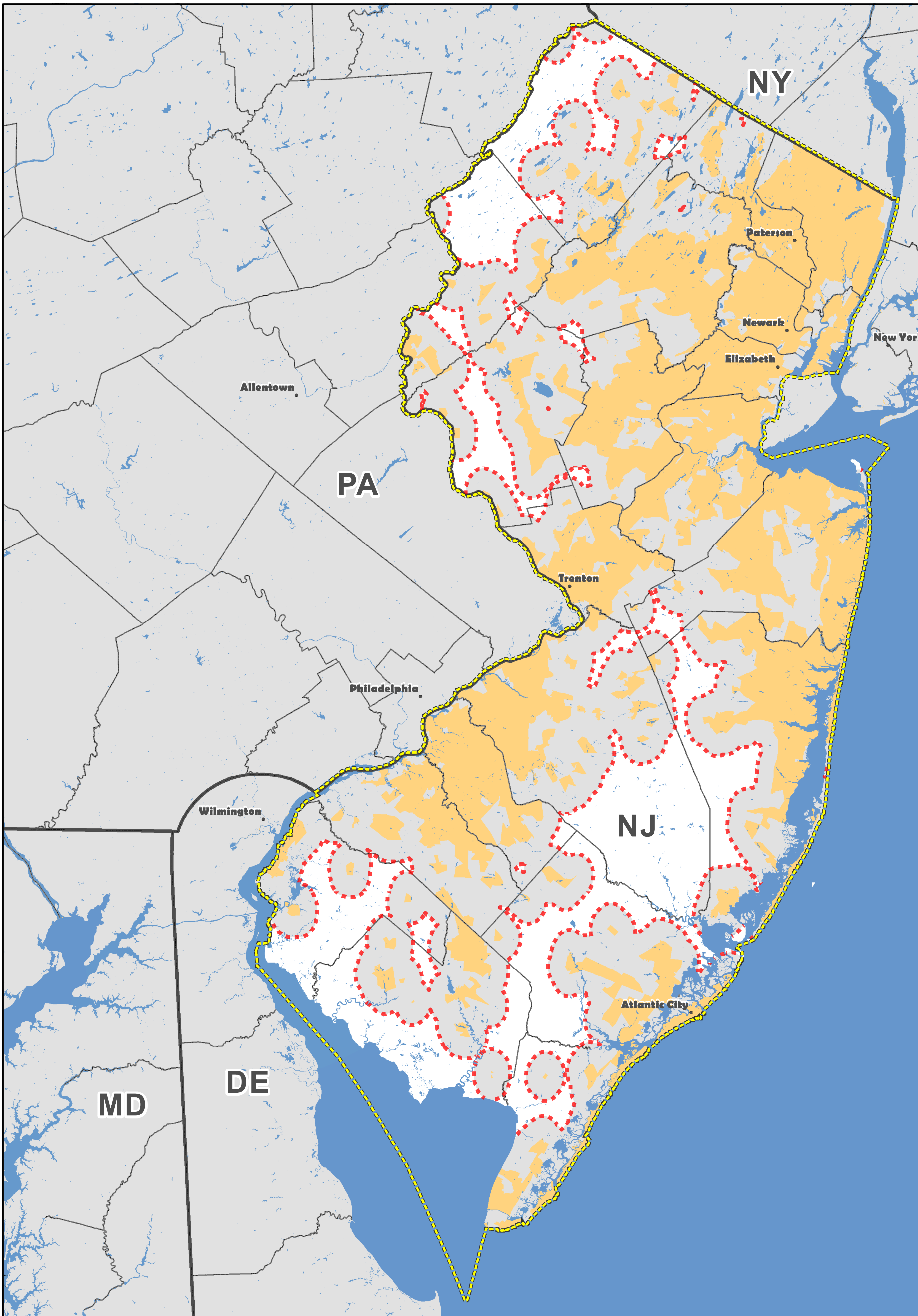
PSEG Power, LLC

PSEG Site ESPA
Part 3, Environmental Report

Water Sources
and Excluded Areas

FIGURE 9.3-8

Rev 0



LEGEND

- Region of Interest Boundary
- 3-Mile Exclusion Buffer
- Densely Populated Areas
- Excluded Areas

N W E S

0 10 20 Kilometers

0 10 20 Miles

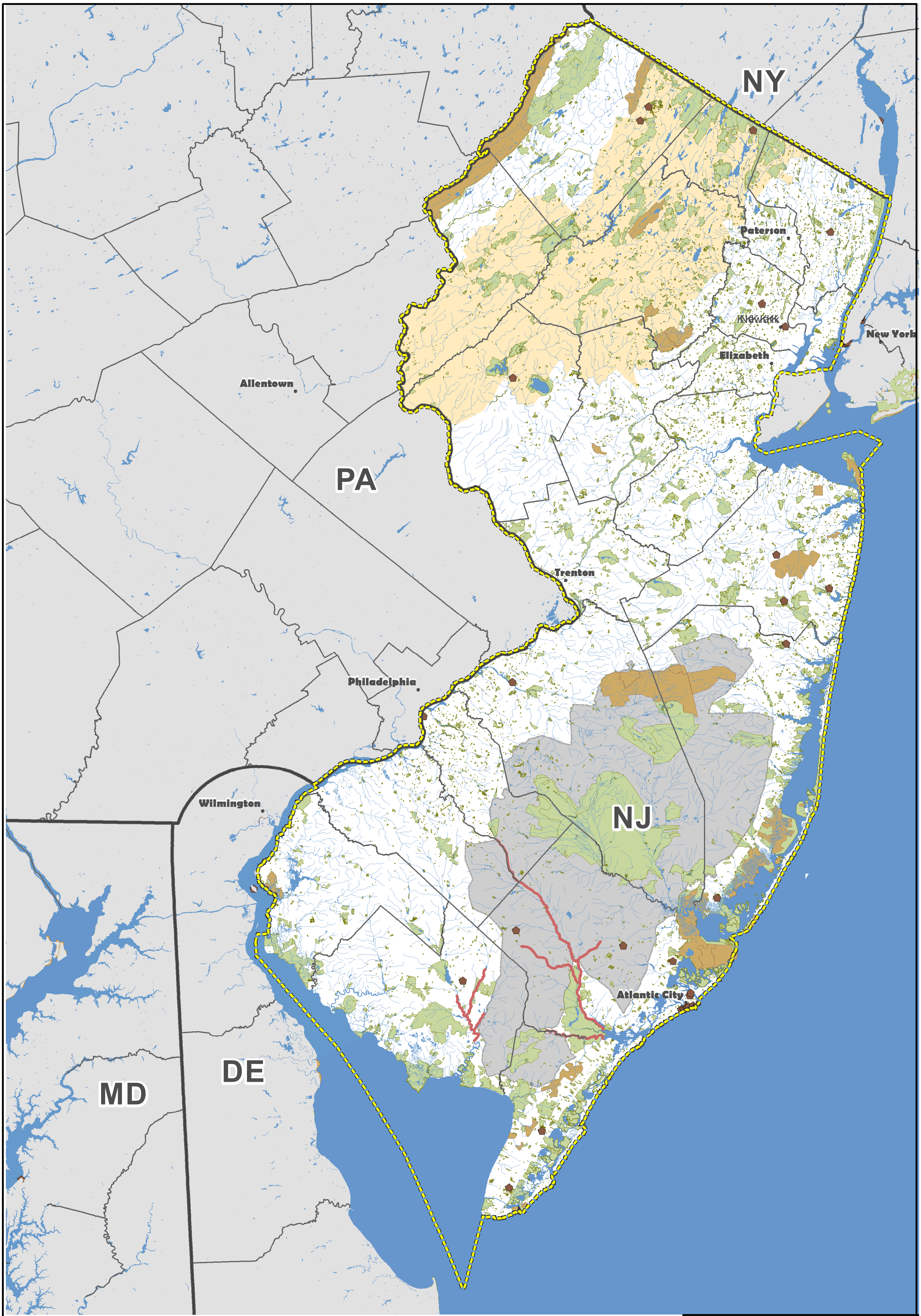
PSEG Power, LLC

PSEG Site ESPA
Part 3, Environmental Report

Densely Populated Zones and Excluded Areas

FIGURE 9.3-9

Rev 0



LEGEND

Excluded Areas

- Federal Land
- Parks and Preserves
- Highlands
- Pinelands
- Region of Interest Boundary
- Recreation Areas
- Wild and Scenic Rivers

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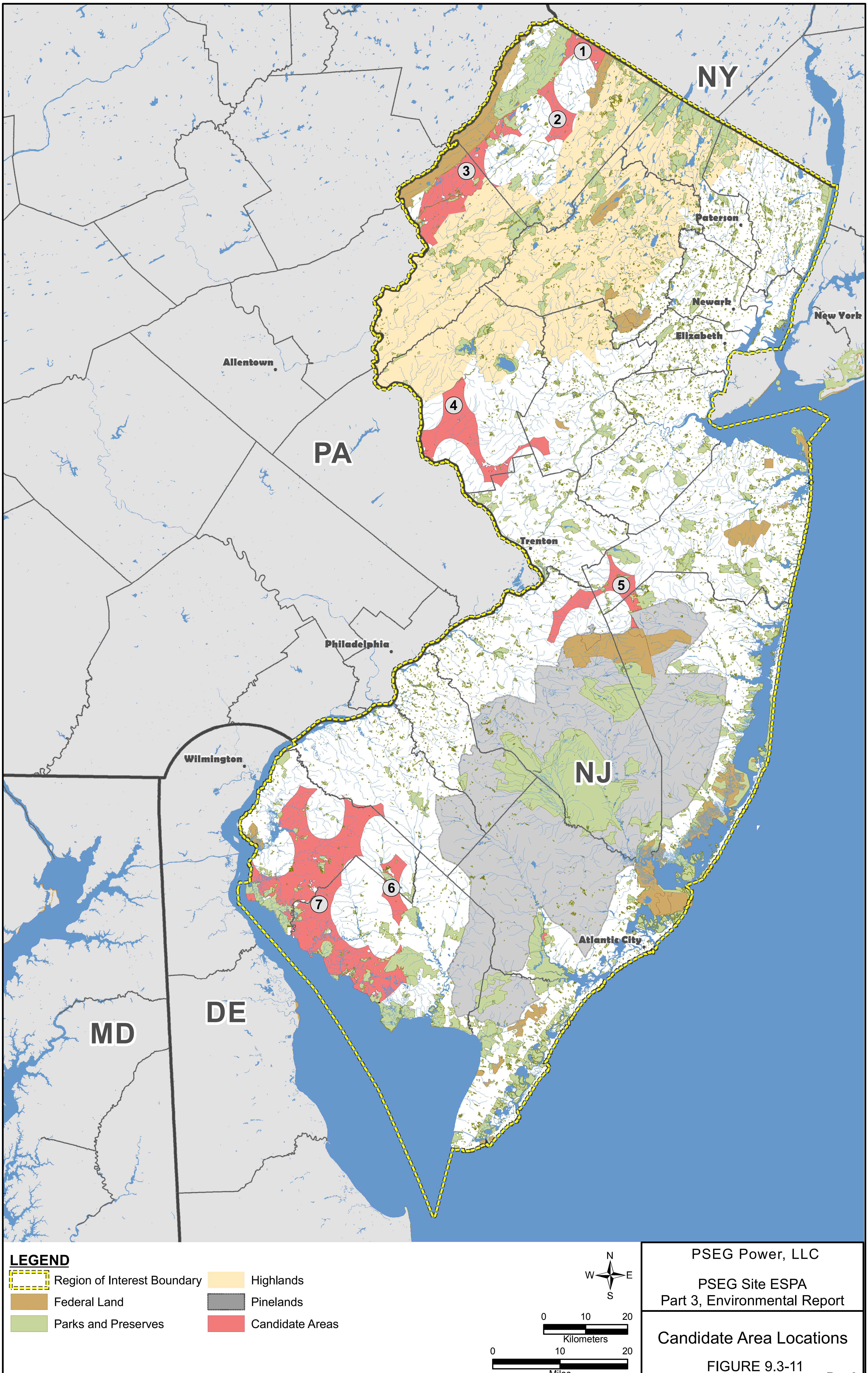
Designated Lands and Excluded Areas

FIGURE 9.3-10

Rev 0



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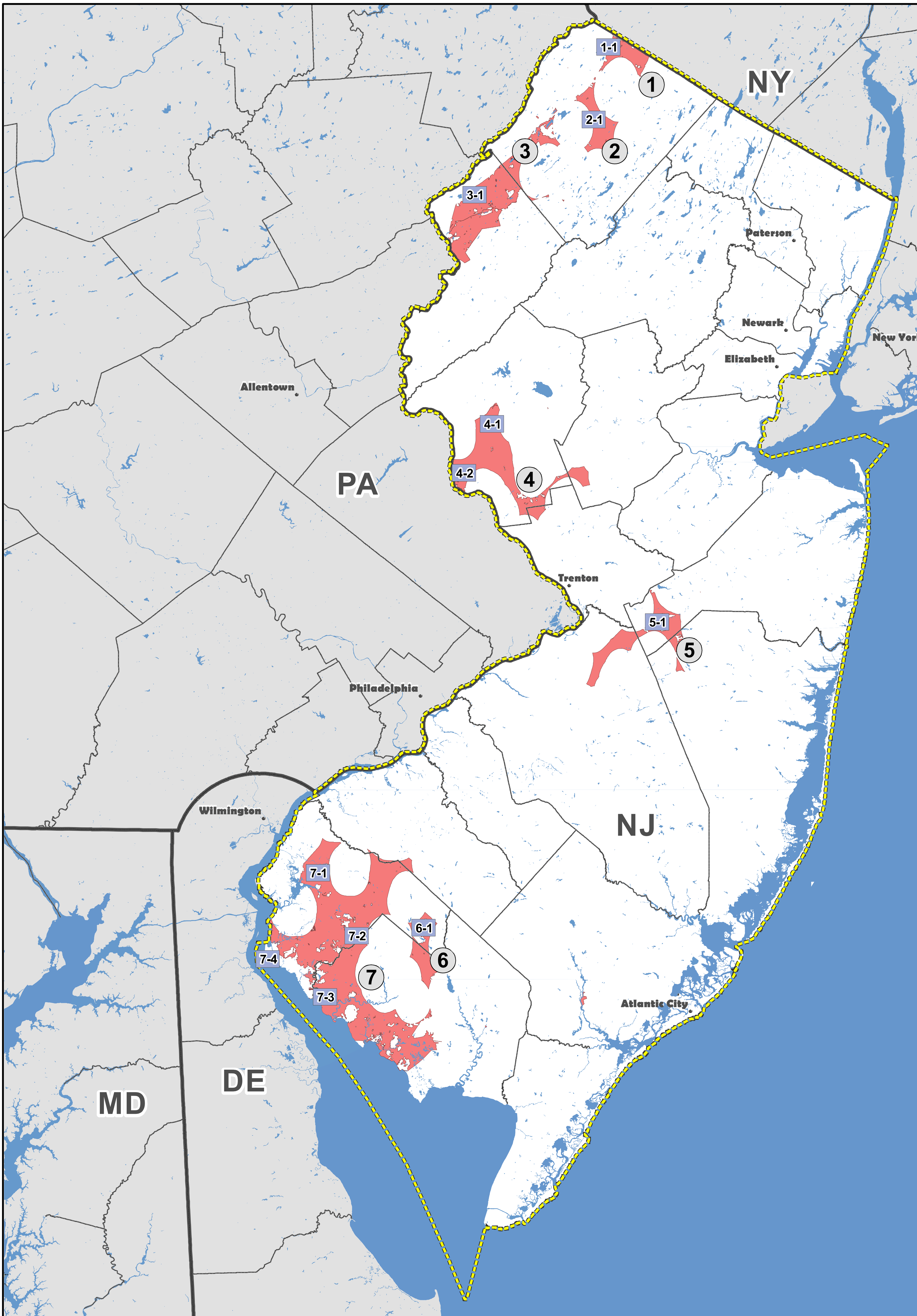
Candidate Area Locations

FIGURE 9.3-11

Rev 0



LEGEND

Region of Interest Boundary

Candidate Areas

N
W E
S

0 10 20
Kilometers

0 10 20
Miles

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Potential Site Locations

FIGURE 9.3-12

Rev 0

LEGEND

Region of Interest Boundary

Candidate Sites

N W E S

0 10 20 Kilometers

0 10 20 Miles

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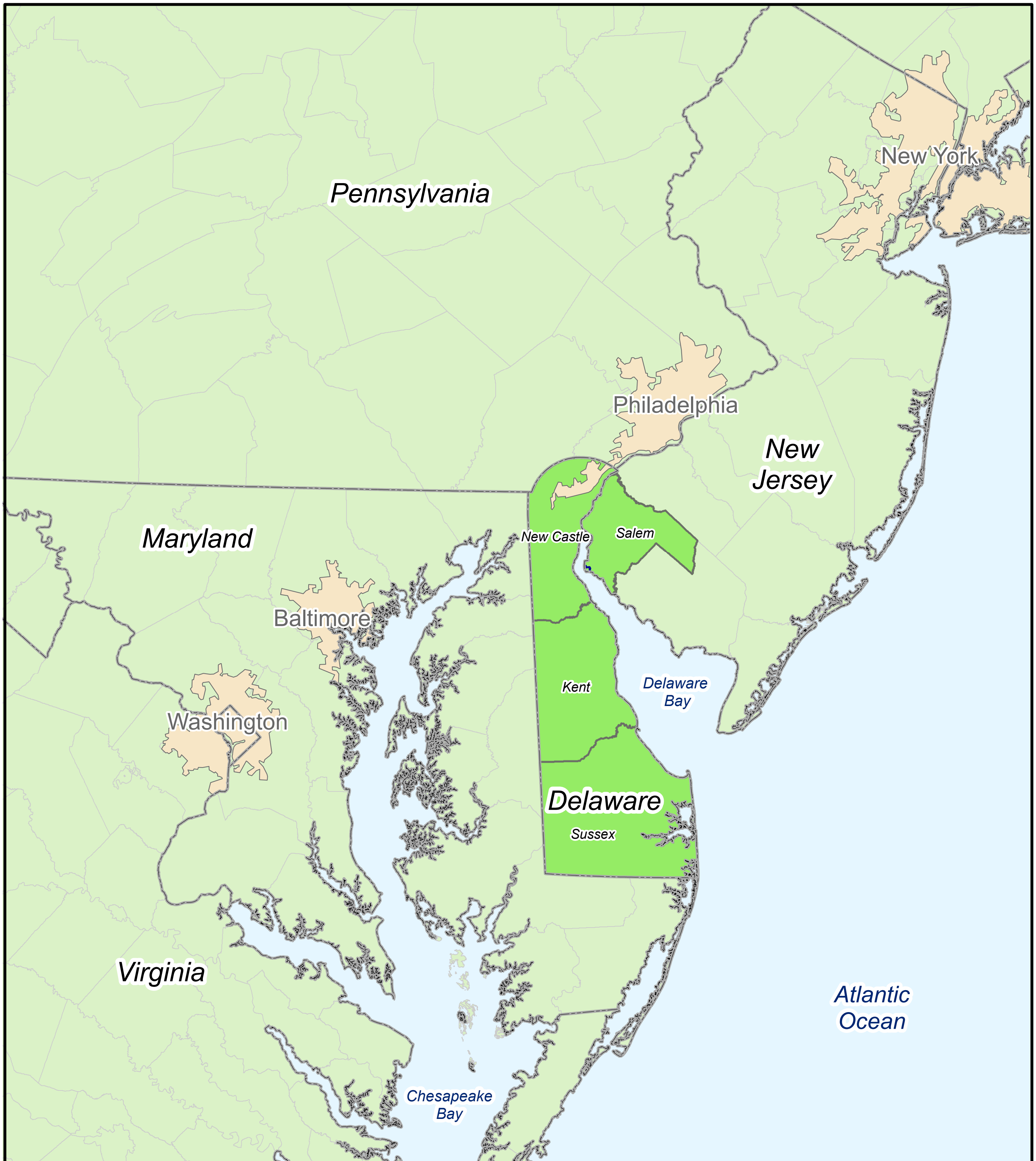
Candidate Site Locations

FIGURE 9.3-13

Rev 0



LEGEND

County Potentially Intersected by the South Macro-Corridor

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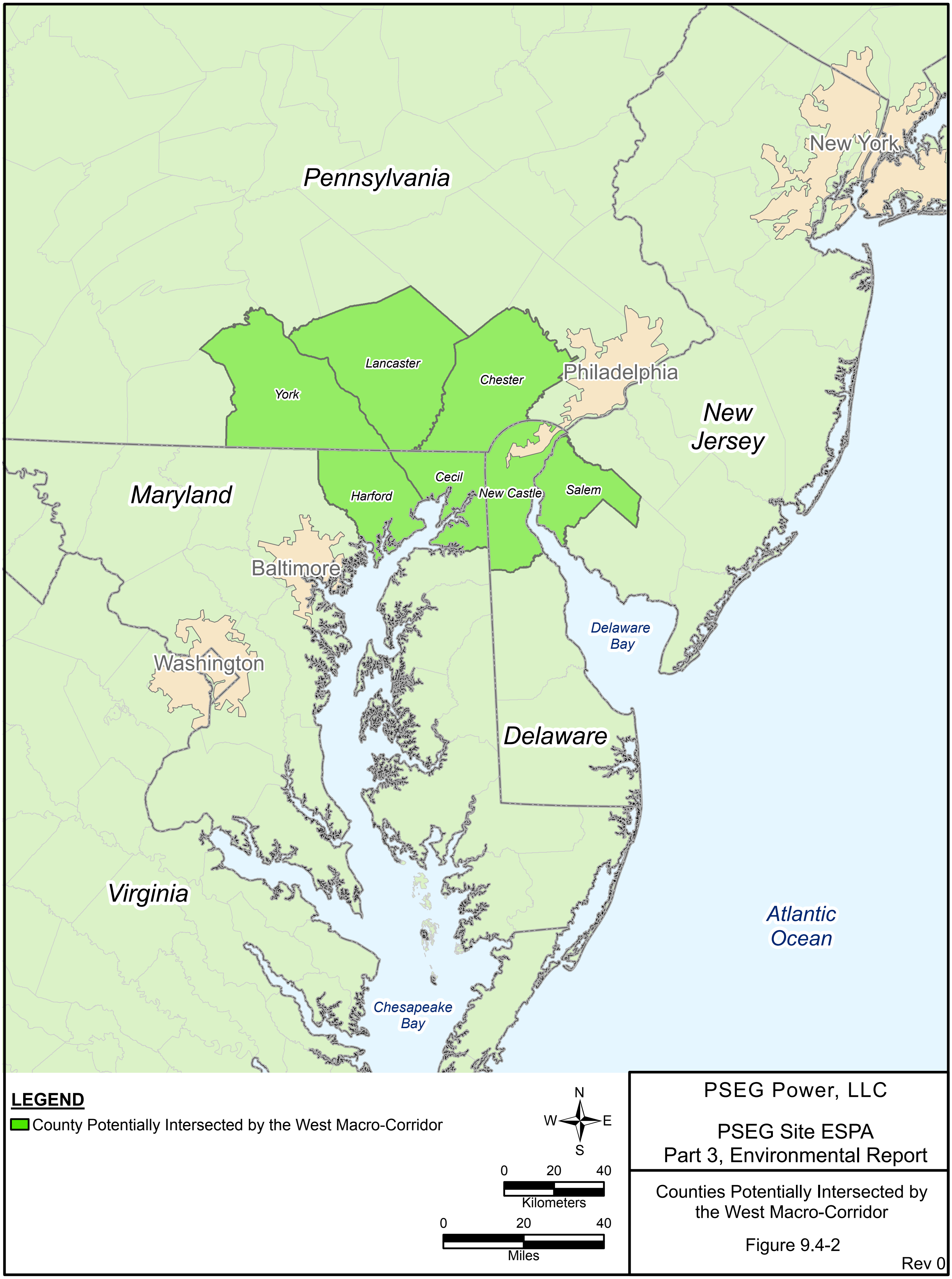
Counties Potentially Intersected by the South Macro-Corridor

Figure 9.4-1

Rev 0



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PSEG Site ESPA
Part 3, Environmental Report

Counties Potentially Intersected by the West Macro-Corridor

Figure 9.4-2

Rev 0

CHAPTER 10

ENVIRONMENTAL CONSEQUENCES OF THE PROPOSED ACTION

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ACRONYMS AND ABBREVIATIONS

Acronym	Definition
ABWR	Advanced Boiling Water Reactor
ac.	acre
AP1000	Advanced Passive 1000
BMP	best management practices
CDF	confined disposal facility
CO	carbon monoxide
CO_2	carbon dioxide
COL	combined license
CWS	cooling water system
dBA	A-weighted decibels
DOE	U.S. Department of Energy
DRBC	Delaware River Basin Commission
EAB	Exclusion Area Boundary
ER	Environmental Report
ESP	early site permit
°F	degrees Fahrenheit
ft.	feet
ft/sec	feet per sec
GWe	gigawatts electric
gpm	gallons per minute
HCGS	Hope Creek Generating Station
HPO	Historic Preservation Office
hr.	hour
IGCC	integrated gasification combined cycle
kV	kilovolt

Acronym	Definition
kW	kilowatt
kWh	kilowatt-hour
LOS	level of service
Mgy	million gallons per year
mi.	mile
MIT	Massachusetts Institute of Technology
MWe	megawatt electric
MWh	megawatt-hour
NAAQS	National Ambient Air Quality Standard
NEI	National Electric Institute
NESC	National Electrical Safety Code
NJAAQS	New Jersey Ambient Air Quality Standard
NJDEP	New Jersey Department of Environmental Protection
NJPDES	New Jersey Pollutant Discharge Elimination System
NOAA	National Oceanic and Atmospheric Administration
NO_x	nitrogen oxides
NRC	Nuclear Regulatory Commission
NRHP	National Register of Historic Places
OECD	Organization for Economic Co-operation and Development
OSHA	Occupational Safety and Health Administration
PJM	PJM Interconnection, LLC
PM_{10}	particulate matter less than 10 micrometers in diameter

ACRONYMS AND ABBREVIATIONS (CONTINUED)

Acronym	Definition
$PM_{2.5}$	particulate matter less than 2.5 micrometers in diameter
PPE	plant parameter envelope
PSD	Prevention of Significant Deterioration
RSA	relevant service area
RTO	Regional Transmission Organization
SGS	Salem Generating Station
SHPO	State Historic Preservation Office
SIL	significant impact levels
SO_x	sulfur oxides
SWPPP	Stormwater Pollution Prevention Plan
TEDE	total effective dose equivalent
US-APWR	U.S. Advanced Pressurized Water Reactor
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
U.S. EPR	U.S. Evolutionary Power Reactor
USFWS	U.S. Fish and Wildlife Service

CHAPTER 10

ENVIRONMENTAL CONSEQUENCES OF THE PROPOSED ACTION

10.0 INTRODUCTION

This chapter presents the potential environmental consequences of constructing and operating a new plant at the PSEG Site. The environmental consequences are evaluated in the following five sections:

- Unavoidable adverse impacts of construction and operations (Section 10.1)
- Irreversible and irretrievable commitments of resources (Section 10.2)
- Relationship between short-term uses and long-term productivity of the human environment (Section 10.3)
- Benefit-cost balance (Section 10.4)
- Cumulative impacts (Section 10.5)

During development of the ESP application, PSEG completed a conceptual evaluation of transmission requirements associated with the addition of generation at the PSEG Site. This evaluation included the PJM Interconnect, LLC (PJM) Regional Transmission Expansion Plan, existing operational limits at Hope Creek Generating Station (HCGS) and Salem Generating Station (SGS), and other PJM transmission planning inputs. PJM routinely performs analyses of the regional transmission system and forecasts appropriate upgrades to the system as part of its long term planning cycle. These evaluations are not specific to the addition of new generation at the PSEG Site.

PSEG's conceptual evaluation indicates that a new off-site transmission line may be needed to accommodate new generation at the PSEG Site to ensure transient stability of the transmission system. The need for a new transmission line is dependent upon a range of factors including the specific reactor technology selected and the progress of regional transmission upgrade projects as part of PJM's regional planning efforts. Since the completion of this conceptual evaluation, PJM, as an example of their continuing assessment of system reliability, recently determined that additional grid improvements are necessary to address voltage and stability constraints in the region of Artificial Island. In response, PJM has solicited proposals from both regulated and non-regulated (merchant) transmission providers for system enhancements to address these constraints. PJM's determination of the need for this transmission system upgrade is independent of PSEG's interest in new nuclear generation and is not predicated on the construction of a new nuclear facility at the PSEG Site. Therefore, any transmission upgrade project mandated by PJM, including a new off-site transmission line, is considered to be reasonably foreseeable and is considered to be an action that is independent from the potential development of the PSEG Site. Similarly, since this PJM-sponsored grid improvement serves to enhance power delivery throughout the region, it inherently possesses independent utility. Although PJM has not formally assessed the scope and structure of this future transmission system upgrade, PSEG has accordingly identified the potential impacts of a new off-site transmission line whose technical attributes best meet PJM's goal of addressing these regional constraints.

Of the two potential transmission corridors presented in Subsection 9.4.3, the West Macro-Corridor to the Peach Bottom substation is considered to be the most effective route for

addressing the regional voltage and stability constraints that PJM is attempting to resolve. Therefore, PSEG is using the characteristics of the West Macro-Corridor to evaluate the potential impacts of a new transmission line as representative of the regional transmission upgrade project currently being pursued by PJM. However, for consistency with earlier parts of the ER, Sections 10.1 to 10.4 provide a summary of potential adverse impacts as discussed in Chapters 4 and 5. These sections include a discussion of the potential impacts of the South Macro-Corridor, whereas Section 10.5 provides an analysis of only the West Macro-Corridor as part of the cumulative impact assessment.

10.1 UNAVOIDABLE ADVERSE ENVIRONMENTAL IMPACTS

Unavoidable adverse impacts are predicted adverse environmental impacts that cannot be avoided and for which there are no practical means of further mitigation. This section considers unavoidable adverse impacts from construction and operation of a new plant at the PSEG Site, any potential transmission line and a proposed causeway.

10.1.1 UNAVOIDABLE ADVERSE ENVIRONMENTAL IMPACTS OF CONSTRUCTION

Construction impacts are discussed in detail in Chapter 4. Table 4.6-1 describes those impacts and identifies the measures and controls available to reduce or eliminate impacts. As noted in Table 4.6-1, most of the impacts are SMALL, as they are either not detectable or are minor compared to the availability of the affected resources. Table 10.1-1 summarizes construction-related impacts that result in a measurable loss or permanent change in resources, the mitigation and control measures available to reduce those impacts, and the remaining unavoidable adverse impacts after mitigation and control measures are applied. For many of the impacts related to construction activities, the mitigation measures are referred to as best management practices (BMPs). Typically, these mitigation measures are based on the types of activities that are to be performed. The mitigation measures are implemented through permitting requirements, and plans and procedures developed for the construction activities.

Unavoidable adverse impacts from construction of a new plant at the PSEG Site occur mostly in Salem County, New Jersey (NJ), excepting any potential transmission line. If a new 500 kilovolt (kV) transmission line is required, unavoidable adverse impacts occur in Salem County, NJ, and either Kent, New Castle and Sussex counties in Delaware (DE), or New Castle County in DE, Cecil and Harford Counties in Maryland (MD), and York County in Pennsylvania (PA), dependent upon routing.

Unavoidable adverse impacts of the new plant include land use changes on up to 2728 acres (ac.) of land along potential off-site transmission rights-of-way, impacts to three archaeological sites identified as potentially eligible for the National Register of Historic Places (NRHP) along the proposed causeway, impacts to potential submerged archeological resources in areas where dredging is necessary, and effects on up to 229 ac. of wetlands (139 ac. jurisdictional, 90 ac. in licensed disposal facilities that are considered non-jurisdictional) on-site and along the proposed causeway (Table 4.3-3).

In addition, the potential off-site transmission rights-of-way cross up to 814 ac. of wetlands (Table 4.3-5) and 1026 ac. of floodplains (Subsection 4.2.1.3.2). Most wetlands and floodplains are unaffected by transmission line construction except in the limited footprints of transmission towers and any necessary access points, but 210 ac. of forested wetlands potentially are converted to non-forested (herbaceous) wetland types by tree clearing. It is not certain that a new transmission line is required, but potential impacts can be mitigated by using BMPs during construction. To the extent possible, the new transmission line will use or be located adjacent to existing rights-of-way.

Impacts to archaeological sites from construction of the proposed causeway will be mitigated through additional Phase II surveys and consultation with the New Jersey Historic Preservation Office (HPO) for identification of appropriate mitigation methods, if required. Consultation with HPO will be conducted during the design phase to determine needs for additional surveys and

mitigative measures. Similarly, Phase II surveys and consultations will be conducted for areas subject to disturbance by dredging. Phase I reports for both of these potential impacts have been reviewed and concurred with by NJ HPO subject to the Phase II survey and consultation requirements after detail design is completed. Wetland losses are mitigated by restoration and enhancement in accordance with U.S. Army Corps of Engineers (USACE), U.S. Fish and Wildlife Service (USFWS), and New Jersey Department of Environmental Protection (NJDEP) requirements. Mitigation measures for decreases in level of service (LOS) on local roads due to construction traffic may include carpooling, staggered shifts, new signals/traffic controls and new turn lanes.

10.1.2 UNAVOIDABLE ADVERSE ENVIRONMENTAL IMPACTS OF OPERATIONS

Operational impacts of the new plant at the PSEG Site are discussed in detail in Chapter 5. Table 5.10-1 describes these impacts and identifies measures and controls available to reduce or eliminate adverse impacts. As noted in Table 5.10-1, the operations-related impacts are SMALL, as they are either not detectable or are minor compared to the availability of the affected resource. Table 10.1-2 summarizes operations-related impacts that result in a measurable loss or permanent change in resources, the mitigation and control measures available to reduce these impacts, and the remaining adverse impacts after mitigation and controls measures are applied.

As indicated in Table 10.1-2 most of the adverse impacts are either avoidable or negligible after mitigation and control measures are considered. For example, under low flow conditions in the Delaware River, the potential exists for the surface water consumption by the new plant to exacerbate low flow effects (e.g., salt line movement). However, this consumptive use is a small percent of Delaware River flow at the PSEG Site and its potential effect is mitigated by water releases from PSEG's dedicated water storage allocation at the existing upstream Merrill Creek reservoir. Similarly, operational groundwater use at the PSEG Site (210 gpm) is within the capacity of aquifer and consistent with the current daily and monthly permitted withdrawals. Site water permits and authorizations will be modified to address total PSEG Site demands.

The discharge of non-contact cooling water results in small near-field increases in ambient Delaware River chemical concentrations and temperatures that may impact aquatic biota and Essential Fish Habitat. The discharge is designed to promote rapid mixing and assure that impacts from chemical and thermal discharges are minor. The potential for prolonged exposures of aquatic biota is low as the plume dissipates rapidly, is limited to less than 5 percent of Delaware River width, and within the regulatory heat dissipation area limits. Discharges are controlled in accordance with NJPDES permit and DRBC docket requirements.

The new plant is in compliance with 10 CFR 20, 10 CFR 50, and 40 CFR 190 radiation dose limits. These dose limits are established to protect members of the public from radiation exposure. 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 40 CFR 190. The Committee on the Biological Effects of Ionizing Radiation (BEIR) concludes that the evidence indicates that no other living organisms have been identified that are likely to be more radiosensitive than humans. 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.

While air quality impacts are generally minor, the modeled 24-hour (hr.) particulate matter ($PM_{2.5}$) concentration due to emissions from the auxiliary boiler and cooling towers (during the winter months) exceeds the U.S. Environmental Protection Agency (USEPA) significant impact level (SIL) in some locations, including a small part of the $PM_{2.5}$ non-attainment area in New Castle County, DE. In addition, the modeled 24-hr. $PM_{2.5}$ concentration due to the auxiliary boiler and mechanical draft cooling towers shows a slight exceedance of the applicable National Ambient Air Quality Standard (NAAQS) when combined with available background concentrations in NJ.

PSEG will consult with NJDEP and perform more detailed modeling, as necessary, after a reactor technology is selected and detailed design is completed for the cooling towers and combustion sources (including auxiliary boiler equipment). Applicable emissions rates in effect at the time will be used in detailed equipment design and specification, along with identification of the appropriate engineering and operational controls. The final modeling will demonstrate compliance with the applicable NAAQS, New Jersey Ambient Air Quality Standards (NJAAQS), and Prevention of Significant Deterioration (PSD) increments.

10.1.3 SUMMARY OF ADVERSE ENVIRONMENTAL IMPACTS FROM CONSTRUCTION AND OPERATIONS

Tables 10.1-1 and 10.1-2 indicate that most of the adverse environmental impacts associated with the new plant construction and operation at the PSEG Site are SMALL or reduced to SMALL through the application of mitigation and control measures. The existing Hope Creek Generating Station (HCGS) and Salem Generating Station (SGS) transmission lines have sufficient capacity for the new plant. Interconnection impact studies performed by PJM Interconnect, LLC (PJM) may identify the need for a new off-site transmission line to ensure grid stability. Despite the uncertainty regarding the need for a new line and the other regional transmission projects, the impacts associated with a hypothetical transmission line right-of-way are included for bounding purposes.

Most of the impacts from construction and operation are SMALL due to design features that result in lower levels of impact, BMPs that control and mitigate emissions and discharges to air and water, use of industrial zoned lands that were previously altered or disturbed, and applicable federal and state permitting requirements designed to protect humans and biota. These SMALL impacts generally have no detectable adverse impacts or only minor adverse impacts. MODERATE impacts include wetland losses, transmission impacts to land-use and terrestrial ecology, decreases in LOS on local roads, potential causeway disturbance of historic properties, and the modeled exceedance of the 24-hr. $PM_{2.5}$ NAAQS and SIL. These MODERATE impacts have measurable adverse effects that are offset by mitigation measures that eliminate unavoidable impacts and ensure that any remaining unavoidable impacts are SMALL.

Wetlands impacts are limited to construction of on-site features, the proposed causeway, and any required transmission line, and are offset by restoration and enhancement of off-site wetland areas in accordance with applicable USACE, USFWS, and NJDEP requirements. Restoration and enhancement activities to offset wetland losses reduce the MODERATE impacts to SMALL impacts. However, some short-term wetlands impacts are unavoidable.

Impacts to historic properties along the proposed access causeway and the potential transmission corridor will be mitigated in consultation with the State Historic Preservation Office (SHPO) for NJ, DE, MD, and PA. Any required mitigation reduces the MODERATE impacts to SMALL impacts. If a transmission line is not required, then impacts to historic properties are limited to the proposed causeway and potential visual impacts in DE and NJ.

Changes in land-use resulting from the construction of a potential off-site transmission line, if required, are minimized by using existing transmission line rights-of-way to the extent possible. For lands crossed by transmission lines, current agricultural and other uses may continue, which reduces impacts. If a new transmission line is not required, the MODERATE land use impacts are reduced to SMALL.

Mitigation measures will be employed to address decreases in LOS on local roads resulting from construction-related traffic. Carpooling, staggered shifts, the installation of traffic lights/ controls and construction of additional turn lanes at key intersections will be evaluated to address the impacts. These construction-related LOS mitigation measures also serve to keep LOS impacts from operations-related traffic SMALL.

The new plant may use oil-fired auxiliary boilers to provide plant-related heating during the winter months and steam for plant start-up purposes. Auxiliary boiler operation results in emissions of carbon monoxide (CO), nitrogen oxides (NO_x), sulfur oxides (SO_x), and particulate matter including $PM_{2.5}$. While the impacts of these emissions on final air quality are SMALL, the modeled 24-hr. $PM_{2.5}$ concentration due to auxiliary boiler emissions in combination with the cooling tower emissions exceeds the applicable SIL in some locations, including a small part of the $PM_{2.5}$ non-attainment area in New Castle County, DE. The modeled 24-hr. $PM_{2.5}$ concentration due to the auxiliary boilers and mechanical draft cooling towers shows a slight exceedance of the applicable NAAQS when combined with background concentrations in NJ. After a reactor technology is selected and detailed design is completed for the cooling towers and auxiliary boiler equipment, PSEG will consult with NJDEP and perform more detailed modeling as necessary. Applicable emissions rates in effect at the time will be used in detailed equipment design and specification, along with identification of the appropriate engineering and operational controls. The final modeling will demonstrate that all air quality impacts are SMALL.

The majority of the adverse environmental impacts associated with the new plant construction and operation at the PSEG Site are SMALL or reduced to SMALL through the application of mitigation and control measures. MODERATE impacts include wetland losses, changes in land use, decreases in LOS on local roads, potential disturbance of historic properties, and the modeled exceedance of the 24-hr. $PM_{2.5}$ NAAQS and SIL. These MODERATE impacts have measurable adverse effects that are offset by mitigative measures that eliminate unavoidable impacts and ensure that any remaining unavoidable impacts are SMALL.

Table 10.1-1 (Sheet 1 of 7)
Construction-Related Unavoidable Adverse Environmental Impacts

Element	Adverse Impact	Mitigation Measure	Unavoidable Adverse Environmental Impacts
Land Use	Construction of the new plant and causeway impacts 500 ac. of predominantly disturbed or otherwise degraded land. Impacts include *Phragmites*-dominated wetland, marsh creek channels, farmland, and floodplain.	Construction activities comply with all relevant federal, state, and local regulatory requirements, including BMPs and stormwater management plans to control erosion and runoff. Wetland and marsh creek channel impacts are offset by the wetland restoration program. Causeway impacts are minimized by the use of a structure roadway design including pilings/ piers.	A total of 270 ac. of land is occupied on a long term basis, consisting of 225 ac. on-site and 45 ac. off-site for the proposed causeway. A minor loss of locally important farmland and floodplain occurs.
	Construction of off-site transmission, if required, may result in long term alteration of up to 2728 ac. of current land uses.	BMPs are used to minimize impacts and to the extent possible any new transmission line will use and/or be located adjacent to existing rights-of-way. For lands crossed by transmission lines, continued use of lands for agriculture (and other current uses where possible) reduces impacts.	Conversion of forested land uses and limited loss of agricultural and wetland land uses will result.
	Potential for disturbance to three archaeological sites identified as potentially eligible for NRHP exists during construction of the proposed causeway.	Phase II survey and consultation with the New Jersey Historic Preservation Office (NJ HPO) will identify mitigation, as appropriate.	Unavoidable adverse environmental impacts are not anticipated.
	Potential for impacts to lands that may contain archaeological resources and other historic properties exists during construction of off-site transmission, if required.	Phase I (and where necessary Phase II) surveys will identify archaeological sites during route development. Consultation with States Historic Preservation Offices (SHPOs) will identify mitigation for unavoidable sites, as appropriate.	Minor potential disturbance of previously unidentified archaeological resources may occur.

Table 10.1-1 (Sheet 2 of 7)
Construction-Related Unavoidable Adverse Environmental Impacts

Element	Adverse Impact	Mitigation Measure	Unavoidable Adverse Environmental Impacts
Hydrologic Alterations	Localized alteration in Delaware River flow velocities and patterns due to localized dredging and construction of permanent shoreline structures.	Shoreline structures are designed to include shoreline stabilization that minimizes effects of flow alterations. Dredged area is minimized.	Unavoidable adverse environmental impacts are not anticipated.
	Loss of 152 ac. of floodplain occurs due to filling during construction in on-site and adjacent off-site areas. Potential off-site transmission crosses up to 1026 ac. of floodplain, but only minor losses are anticipated from any required transmission construction.	Specific measures and controls are not needed as impacts are minor in context of available floodplain.	Changes in local flood levels are not anticipated.
	Increase in local runoff to Delaware River from loss of wetlands, artificial ponds, and increase in impervious surfaces is anticipated.	Stormwater Pollution Prevention Plans (SWPPP) provide for the collection of stormwater to temporary storage areas for permitted discharge. Grading design/BMPs are used to direct runoff to storage basins prior to controlled and permitted discharge to the Delaware River.	Minor potential exists for increased runoff to the Delaware River with minor changes to localized flows.
	Loss of marsh creek channels and resultant changes in tidal exchange to limited marsh areas during construction.	Reconnection of isolated marsh creek channels and restoration of marsh creek channels is part of the wetland mitigation program.	Unavoidable adverse environmental impacts are not anticipated.

Table 10.1-1 (Sheet 3 of 7)
Construction-Related Unavoidable Adverse Environmental Impacts

Element	Adverse Impact	Mitigation Measure	Unavoidable Adverse Environmental Impacts
Water Use	Groundwater is supplied from aquifers that provide water for HCGS and SGS. Additional needs of up to nominally 119 gallons per minute (gpm) have been identified, which is available under existing water withdrawal authorizations.	The current site groundwater withdrawal permit limit is adequate to address the new plant needs. Specific measures and controls are not needed as impacts are minor.	Unavoidable adverse environmental impacts are not anticipated.
Water Quality	There are increased suspended solids and potential for pollutant loading due to land disturbance activities, filling of site utilization areas to raise elevation for plant buildings and support facilities, construction of cooling water intake and discharge structures in the Delaware River, dredging of water intake, discharge, and barge access areas, and proposed causeway construction.	BMPs and stormwater management plans will be developed to control erosion and runoff. Grading design includes provisions to manage runoff for controlled and permitted discharge to the Delaware River; and cofferdams and/or silt curtains are used to limit mixing and transport of suspended sediments. Disposal of dredged materials in approved disposal facilities areas.	Some localized impacts to surface water quality due to sediments in runoff may occur.
	There is an increase in the potential for chemical discharges from accidental spills to surface and groundwater.	Spill prevention control plans will be implemented. Construction is limited to shallow aquifers to avoid adverse effects on deeper aquifers used for site and regional potable water. Secondary containments will be used where applicable to prevent and control spills.	Some localized short-term decreases in water quality may occur.

Table 10.1-1 (Sheet 4 of 7)
Construction-Related Unavoidable Adverse Environmental Impacts

Element	Adverse Impact	Mitigation Measure	Unavoidable Adverse Environmental Impacts
Terrestrial Ecology	There are impacts to 229 ac. of wetlands on the PSEG Site and nearby off-site areas. This includes impacts to 139 ac. of jurisdictional wetlands (mostly *Phragmites*-dominated wetlands); and 90 ac. of wetlands in licensed disposal facilities (considered as non-jurisdictional) 20 ac. of coastal wetlands are impacted temporarily during construction of the proposed causeway. Permanent conversion of 210 ac. of forested wetlands to herbaceous types and minor wetland losses are anticipated due to off-site transmission construction, if required.	Wetlands losses are offset by restoration and enhancement per USACE and NJDEP requirements (DE, PA and MD requirements are applicable if off-site transmission construction is required).	There is a temporary loss of wetland function until wetland restoration area(s) are fully functional.
	Fauna displacement, particularly birds and mammals, occurs. Flora in upland areas and some less mobile fauna are impacted.	Construction is generally confined to areas that have been previously disturbed and that are of low biological value. Specific measures and controls are not needed as impacts are minor.	Temporary displacement of fauna and minor loss of flora and less mobile fauna in upland areas are anticipated.
	Important species habitat alteration or elimination and displacement from the off-site transmission corridor may occur due to off-site transmission construction, if required.	Consultations with state and federal agencies when the need for off-site transmission has been established, to minimize potential unavoidable impacts to listed species and define appropriate mitigating measures.	Minor loss of important species habitat may occur.
	There is a potential for bird collisions with man-made structures such as cranes and buildings during construction.	Previous HCGS surveys indicate very low incidence of bird collisions with plant buildings and structures. Specific measures and controls are not needed as impacts are minor.	Minor losses of birds due to collisions with structures may occur.

Table 10.1-1 (Sheet 5 of 7)
Construction-Related Unavoidable Adverse Environmental Impacts

Element	Adverse Impact	Mitigation Measure	Unavoidable Adverse Environmental Impacts
Aquatic Ecology	Elimination of 7265 feet (ft.) of marsh creeks and isolation of 2320 ft. of marsh creeks.	Restoration of marsh creeks is part of the restoration program for jurisdictional wetlands. Isolated marsh creeks will be reconnected, if possible, after construction completion.	Temporary loss of marsh creek habitat occurs until wetland restoration area(s) are fully functional.
	Elimination of 9.5 ac. of coastal wetlands and shallow water areas along shoreline of the Delaware River occurs.	Restoration is included as part of the restoration program for jurisdictional wetlands.	Temporary loss of aquatic habitat occurs until wetland restoration area(s) are fully functional.
	There is an increased potential for release of suspended solids and chemicals from runoff and accidental spills.	Stormwater discharges will meet applicable New Jersey Pollutant Discharge Elimination System (NJPDES) permit requirements. BMPs will be used to minimize erosion and sedimentation based on NJ SWPPP requirements. Spill prevention control plans and remediation per NJDEP requirements will be implemented.	Minor and localized impacts to aquatic biota are anticipated.
	There are impacts to the Delaware River, creeks and wetlands from off-site transmission tower construction, if required, including potential impacts to other surface water resources and sensitive species from land clearing/tower construction.	Ongoing efforts will be made to avoid and minimize impacts to aquatic ecosystems as part of design and permitting process. Consultations with state and federal agencies will be conducted to identify steps necessary to minimize potential unavoidable impacts to listed species as part of off-site transmission line development.	Minor and localized impacts to aquatic biota are anticipated.

Table 10.1-1 (Sheet 6 of 7)
Construction-Related Unavoidable Adverse Environmental Impacts

Element	Adverse Impact	Mitigation Measure	Unavoidable Adverse Environmental Impacts
Socioeconomics	Construction workers, HCGS and SGS employees, and local residents are exposed to elevated levels of dust, noise and exhaust emissions from vehicles.	BMPs for controlling fugitive dust and proper maintenance of construction equipment for controlling emissions are implemented. Major noise-producing construction activities are limited to daytime and evening hours to minimize night time noise impacts. Construction workers are required to wear hearing protection equipment in areas with high noise levels.	Minor physical impacts are limited to on-site workforce. Minor impacts to off-site air quality and noise due to construction traffic are anticipated.
	Construction waste materials require appropriate disposal.	Construction wastes are recycled as practicable, with remaining waste disposed of in approved landfills.	Unavoidable adverse environmental impacts are not anticipated.
	There is a decrease in LOS on local roads due to increased traffic from construction vehicles.	Mitigation may include installation of traffic controls/signals and additional turning lanes to mitigate delays due to increased traffic. Off-site parking/car pooling will be evaluated. The construction workforce will work in three shifts to spread additional construction traffic volume over a 24-hr. period.	Minor delays at intersections in and around Salem City occurs.
	There is an increase in the local population and associated increased demand for local public services, schooling, housing, and land.	Increases in local tax revenues support increased services. Specific measures and controls are not needed as impacts are minor.	Unavoidable adverse environmental impacts are not anticipated.
	Regional/local purchases and tax revenues increase.	Specific measures and controls are not needed as impacts are beneficial.	A small beneficial increase in local tax revenues occurs.

Table 10.1-1 (Sheet 7 of 7)
Construction-Related Unavoidable Adverse Environmental Impacts

Element	Adverse Impact	Mitigation Measure	Unavoidable Adverse Environmental Impacts
Radiation Exposure	The construction workforce is exposed to gaseous and liquid radioactive releases from HCGS and SGS as well as ISFSI dose.	Gaseous and liquid release rates from normal operations are within established regulatory standards and the applicable HCGS and SGS license limits. Dose from existing operations is within regulatory limits at the fence line. Mitigation is not anticipated.	Radioactive releases are below regulatory limits and unavoidable adverse environmental impacts are not anticipated.
Atmospheric and Meteorological	An increase in dust and emissions from construction equipment and construction workforce vehicles occurs.	BMPs are used for controlling fugitive dust. Proper maintenance of construction equipment and vehicles is used to control air emissions.	Minor localized increases in air emissions occur, mostly at and near the PSEG Site. Detectable changes to local meteorology are not anticipated.
Environmental Justice	There is a potential for adverse impacts to low-income and minority populations due to decreased LOS on roadways in Salem City.	Mitigation may include installation of traffic controls/signals and additional turning lanes to mitigate delays due to increased traffic. Off-site parking/car pooling will be evaluated. The construction workforce will work in three shifts to spread additional construction traffic volume over a 24-hr. period.	Impacts to low income and minority populations are not anticipated.

Table 10.1-2 (Sheet 1 of 8)
Operations-Related Unavoidable Adverse Environmental Impacts

Element	Adverse Impact	Mitigation/Control Measure	Unavoidable Adverse Environmental Impacts
Land Use	Low-level radiological wastes are disposed of in the existing permitted repository. Non-radiological wastes are disposed of in existing permitted off-site landfills/facilities.	Specific measures and controls are not needed as impacts are minor and mitigation is not required.	Unavoidable adverse environmental impacts are not anticipated.
	Visual impacts result from cooling towers and off-site transmission lines.	The PSEG Site has an existing cooling tower and is remote from residential and commercial areas. Consultation with NJ and DE Historic Preservation Offices will identify any necessary mitigation. If a new transmission line is needed it will be located within or adjacent to existing transmission line rights-of-way to the extent possible to minimize any impact.	Minor impacts to viewscape occur due to additional cooling tower(s) at the PSEG Site. Visual impacts may exist from a transmission line that may pass through commercial and residential areas or deviate from existing rights-of-way.
	Maximum salt deposition on vegetation is 0.8 lb/ac/mo within 2300 ft. of cooling towers.	Specific measures and controls for salt deposition effects on vegetation productivity are not warranted as salt deposition on local saline-tolerant vegetation is below impact levels.	Unavoidable adverse environmental impacts are not anticipated.
Hydrological and Water Use	The potential exists for low flows in the Delaware River due to surface water consumption by the new plant during drought conditions.	Water consumption during drought periods is offset, as required by Delaware River Basin Commission (DRBC), by water release from PSEG's existing allocation upstream reservoir water storage.	Minor consumptive use of the Delaware River occurs.

Table 10.1-2 (Sheet 2 of 8)
Operations-Related Unavoidable Adverse Environmental Impacts

Element	Adverse Impact	Mitigation/Control Measure	Unavoidable Adverse Environmental Impacts
Hydrological and Water Use, continued	Groundwater withdrawal is 210 gpm under average conditions. Consumptive use of surface water is 26,420 gpm (0.01 percent of Delaware River flow at the PSEG Site).	The additional demand is within the capacity of existing aquifers and within the current daily and monthly permitted withdrawals. Current permits and authorizations will be modified as necessary to meet total PSEG Site demands No mitigation required for consumptive use.	Unavoidable adverse environmental impacts are not anticipated.
	Minor changes in existing/ambient Delaware River flow patterns occurs due to blowdown discharge and water intake structure operation. Periodic maintenance dredging of intake approach area is necessary. Storm water runoff increases.	Use of closed-cycle cooling system results in negligible changes in Delaware River flow patterns that are limited to the immediate area of the discharge and intake structure openings. Stormwater BMPs and design features to collect and control runoff will be implemented.	Localized but negligible changes to Delaware River flow patterns are anticipated.
Water Quality	There are minor impacts to Delaware River water quality due to chemical and thermal discharges from plant, storm water runoff, and periodic maintenance dredging of the intake channel.	Chemical and thermal discharges are limited by the NJPDES and DRBC authorizations and requirements. The discharge design includes provisions for rapid mixing to minimize size of chemical and thermal plumes. BMPs for storm water and dredging to control and limit suspended solids impacts to water quality are implemented.	Minor and localized alteration of water quality is anticipated.

Table 10.1-2 (Sheet 3 of 8)
Operations-Related Unavoidable Adverse Environmental Impacts

Element	Adverse Impact	Mitigation/Control Measure	Unavoidable Adverse Environmental Impacts
Water Quality, continued	There is a potential for impacts to groundwater quality due to accidental spills.	Design assures that accidental spills affect only soils and shallow aquifers that are not used for potable water. BMPs and spill controls and countermeasures are used to limit and contain chemical spills. Any necessary remedial measures are implemented as required by NJDEP.	A minor potential for shallow groundwater water quality impact exists. Impacts are not anticipated to water quality of deeper aquifers used for potable water.
	Potential water quality impacts may occur from maintenance of transmission corridors.	Established right-of-way management measures and state-mandated BMPs are implemented by PSE&G and other interfacing utilities. Herbicides are applied per an integrated pest management plan with provisions to address application near waterways.	Minor, infrequent and short-term decreases in water quality results are due primarily to maintenance vehicles crossing shallow streams in remote locations along off-site transmission line rights-of-way.
Aquatic Ecology	The cooling water intake results in entrainment and impingement of aquatic biota.	The closed cycle cooling system design includes provisions to assure that intake volumes and velocities are in accordance with USEPA 316(b) Phase I facility requirements. Intake monitoring is implemented per NJPDES requirements to demonstrate compliance with USEPA requirements.	There is a minor loss of aquatic biota, predominantly fish and crabs, relative to abundant standing stocks.

**Table 10.1-2 (Sheet 4 of 8)
Operations-Related Unavoidable Adverse Environmental Impacts**

Element	Adverse Impact	Mitigation/Control Measure	Unavoidable Adverse Environmental Impacts
Aquatic Ecology, continued	The discharge of non-contact cooling water results in near-field increases in ambient Delaware River chemical concentrations and temperatures that may impact aquatic biota.	The discharge is designed to promote rapid mixing and assure that impacts from chemical and thermal plume are minor. The potential for prolonged exposures of aquatic biota is minor as the plume dissipates rapidly and is limited to less than 5 percent of Delaware River width. Discharges are controlled in accordance with the NJPDES permit requirements.	Minor impacts on aquatic biota exposed to the discharge plumes are anticipated.
	Loss of benthic habitat occurs due to bottom scouring at discharge structure.	Rock rip rap, concrete aprons, or other engineering controls are included at the discharge opening to minimize bottom scour.	Some minor losses of benthic habitat occurs in the immediate area of the discharge outfall.
	There may be temporary exposure of aquatic biota to decreases in water quality due to transmission line maintenance activities.	Vegetation height is maintained in accordance with preestablished BMPs and includes mechanical measures where appropriate. Use of herbicides is per an integrated pest management plan and applicable permit/BMP requirements. BMPs are developed to assure maintenance activities are managed in a way to preserve habitat and to protect important species.	Minor, infrequent and short-term exposure of aquatic biota to decreases in water quality may occur.

Table 10.1-2 (Sheet 5 of 8)
Operations-Related Unavoidable Adverse Environmental Impacts

Category	Adverse Impact	Mitigation/Control Measure	Unavoidable Adverse Environmental Impacts
Terrestrial Ecology	Deposition of elevated levels of salt from the cooling towers on salt marsh vegetation occurs. Maximum salt deposition on vegetation is 0.8 lb/ac/mo within 2300 ft. of cooling towers	No specific measures or controls for salt deposition effects on vegetation are necessary or warranted as salt deposition on local saline-tolerant vegetation is below impact levels.	Impacts on vegetation are not anticipated.
	Decreases in productivity of local vegetation due to cooling tower plume fogging and shadowing may occur.	Specific measures and controls are not needed as the impacts are minor and of short duration and infrequent occurrence.	Intermittent minor losses of productivity of vegetation near the cooling tower(s) may occur.
	Elevated noise levels on-site and during transmission line maintenance activities may displace biota.	Noise levels beyond the property boundaries generally will be less than 65 dBA. Noise levels for transmission line maintenance activities are of infrequent, short duration and only cause temporary displacement. Mitigation is not required as impacts are minor.	Noise levels are below regulatory limits at the site boundary and no unavoidable adverse environmental impacts are anticipated.
	Possible exposure of terrestrial fauna to herbicides due to vegetation management practices may occur.	Established PSE&G right-of-way management measures and BMPs will be implemented. Herbicides will be applied per an integrated pest management plan and applicable permit/BMP requirements.	Intermittent and short-term exposure of terrestrial fauna to herbicides may occur.

Table 10.1-2 (Sheet 6 of 8)
Operations-Related Unavoidable Adverse Environmental Impacts

Element	Adverse Impact	Mitigation/Control Measure	Unavoidable Adverse Environmental Impacts
Terrestrial Ecology, continued	Bird collisions with the cooling towers or the transmission lines may occur. There is a potential for electrocution of birds roosting on/near transmission lines.	Previous HCGS surveys indicate low incidence of bird collisions with plant buildings and structures. Specific measures and controls for bird collisions are not needed as impacts are minor. Towers and lines are designed to industry standards to minimize risks of avian contact with energized components.	Occasional bird collisions and contacts occur with cooling towers and transmission lines.
Socioeconomic	Public exposure to increased noise levels due to plant equipment and cooling tower operation is a potential impact.	The nearest residences are almost three miles from the plant, and noise levels at nearest residences are below protective levels for daytime and night time, mitigation is not warranted or necessary.	Unavoidable adverse environmental impacts are not anticipated.
	Public exposure to transmission line noise and potential electric shock.	Noise levels at the edge of rights-of-way and under transmission lines are below NJDEP protective level of 65 dBA or equivalent DE, MD, or PA mandates, mitigation is not warranted or necessary. Transmission lines are designed to comply with NESC standards to avoid electric shock risks; therefore, no mitigation is necessary.	Unavoidable adverse environmental impacts are not anticipated.
	The cooling tower(s), cooling tower plumes, and new off-site transmission, if required, alter the existing viewscape.	The PSEG Site has an existing cooling tower and is remote from residential and commercial areas. Consultation with NJ HPO and DE SHPO will identify any necessary mitigation. If a new transmission line is needed it will be located within or adjacent to existing transmission line rights-of-way to the extent possible to minimize any required mitigation.	Minor changes in viewscape occur.

Table 10.1-2 (Sheet 7 of 8)
Operations-Related Unavoidable Adverse Environmental Impacts

Element	Adverse Impact	Mitigation/Control Measure	Unavoidable Adverse Environmental Impacts
Socioeconomic, continued	There is an increase in traffic volume on local roads due to operations and refueling outage workforce travel to and from the plant and delivery of goods and services to plant.	Shifts are staggered, and improvements made to mitigate LOS impacts from construction traffic remain in place. These measures serve as mitigation sufficient to handle the smaller operations-related traffic volume.	Minor delays occur at intersections in and around Salem City.
	Emissions of air pollutants from operation of cooling towers and auxiliary boilers/other combustion equipment may affect ambient air quality.	Alignment and consultation with NJDEP provides inputs on final modeling of air emissions. Monitoring of background air quality and measures to mitigate impacts on air quality are evaluated to determine appropriate equipment and operational measures to reduce impacts and assure compliance with NAAQS/ NJAAQS and PSD increments.	A minor localized decrease in air quality during the winter months may occur, but significant deterioration of regional air quality is not anticipated.
	An increase in four-county and regional populations of less than 0.2 percent occurs.	Adequate housing, school capacity, water supply and water treatment capacities exist to accommodate minor population increase; therefore, mitigation is not required.	Unavoidable adverse environmental impacts are not anticipated.
	There are no adverse impacts to tax revenues, because there is an increase in tax revenues to local taxing jurisdictions.	There is an increase in tax revenues collected by county and regional taxing authorities and does not create any adverse impacts. No mitigation is required.	Unavoidable adverse environmental impacts are not anticipated. The increase in tax revenues is beneficial, particularly to Lower Alloways Creek Township and Salem County.
Radiological	Potential doses to the public from releases to air and surface water may occur.	All releases comply with regulatory limits and therefore, mitigation is not required.	Radioactive releases comply with regulatory limits, and unavoidable adverse environmental impacts are not anticipated.

Table 10.1-2 (Sheet 8 of 8)
Operations-Related Unavoidable Adverse Environmental Impacts

Element	Adverse Impact	Mitigation/Control Measure	Unavoidable Adverse Environmental Impacts
Atmospheric and Meteorological	Fogging from cooling tower plume on on-site roads may occur.	Fogging potential is limited to mechanical draft cooling towers, with most fogging occurring within 1000 ft. of the cooling towers. Fogging events are infrequent and short-term. Appropriate lighting and warnings will be posted on-site, and further mitigation is not required.	Infrequent and short-term increase in on-site fogging events may occur.
	Some changes in local climate due to increased precipitation, shadowing, and heat from cooling tower plume may occur.	Mitigation is not required as most detectable effects are limited to the area within 1000 ft. of the cooling towers .	Minor changes to on-site climatic conditions may occur due to cooling tower plume.
Environmental Justice	No adverse impacts on minority or low-income populations have been identified.	Level of impact is comparable for all populations and mitigation is not required.	Impacts to low income and minority populations are not anticipated.

10.2 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

This section describes the expected irreversible and irretrievable environmental resource commitments used in the new plant construction and operation. The term irreversible commitments of resources describes environmental resources that are potentially changed by the new plant construction or operation and that could not be restored at some later time to the resource's state prior to construction or operation. Irretrievable commitments of resources are generally materials that are used for the new plant in such a way that they could not, by practical means, be recycled or restored for other uses.

10.2.1 IRREVERSIBLE ENVIRONMENTAL COMMITMENTS OF RESOURCES

Irreversible environmental resource commitments resulting from the new plant, in addition to the materials used for the nuclear fuel include:

- Groundwater and surface water
- Land
- Aquatic and terrestrial biota
- Releases to air and surface water

10.2.1.1 Groundwater and Surface Water

The new plant requires Delaware River surface water for cooling purposes. Groundwater is used for construction, site potable requirements, and other plant operational needs.

Roughly one-third (26,420 gallons per minute [gpm]) of the surface water used for cooling purposes is consumed and lost to the atmosphere due to evaporation and drift from the cooling towers. Of the surface water lost to the atmosphere, 4756 gpm is considered freshwater (per the DRBC equivalent impact factor as further described in Subsection 5.2.1.2) and the remainder is salt water. The surface water losses to the atmosphere and the groundwater uses for plant operations are considered consumptive, as they are no longer available for other uses. 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. Consequently, the consumptive use is not anticipated to have any discernable effect.

Existing aquifers used by the HCGS and SGS plants have sufficient capacity to meet the additional groundwater needs of the new plant. The groundwater withdrawal for operation of the new plant is 210 gpm (Section 5.2.1.3), which equals 110.4 million gallons per year (Mgy). This value bounds the anticipated need of the new plant for groundwater during construction. The cumulative maximum withdrawal for operations, including SGS and HCGS average historic withdrawals (Table 2.3-24) and based on the PPE for the new plant, is 309 Mgy, which is 3 percent above the current SGS and HCGS site permitted annual water withdrawal. After a reactor technology is selected and a final site water balance is developed, PSEG will re-evaluate total site (SGS, HCGS, and new plant) water use against the site water allocation permit limits. The current water withdrawal permits and authorizations will be modified as necessary to include the new plant, or new permit(s) will be obtained. Groundwater use for the new plant, combined with long-term average SGS and HCGS groundwater use, is only slightly above the current site authorization, therefore the impact of additional water use is SMALL.

Previous modeling studies to establish the current annual permitted amount of groundwater withdrawal indicated that the affected aquifers can support withdrawals of more than twice the permitted amount with no adverse impacts (Subsection 4.2.2). In both cases, the impact to the resource is minor relative to available surface water and ground water resources and the impact is SMALL.

10.2.1.2 Land Use

Most of the land use changes associated with the new plant construction and operation are not considered permanent changes. A small number of acres of wetland impacts may be permanent if causeway use continues after decommissioning. The additional land requirements needed for disposal of radioactive and non-radioactive wastes are also considered to be permanently committed to that use. In conjunction with the new plant construction and operation and proposed causeway, 270 ac. of lands on-site are converted from non-industrial to industrial use (Table 4.1-1). A small percentage of up to 2728 ac. of lands off-site may be altered for the life of the plant if a new transmission line is required (Table 4.1-3). Most of the potential transmission impacts are related to the small footprint of the individual towers, or land use that is modified by fill, or where forested lands need to be maintained below a certain height for transmission safety. Potential impacts to wetlands (on-site or off-site) will be mitigated by the development of wetland restoration areas either on-site or in the vicinity of the PSEG Site at replacement ratios in accordance with USACE and NJDEP permit conditions. Consequently, the irreversible and irretrievable effect to wetlands is small. After operations cease and the plant is decommissioned in accordance with NRC requirements, the land that supports the on-site facilities could be returned to other industrial or nonindustrial uses. The land use impacts associated with a new transmission line may be permanent if the transmission line is used by other generating stations after decommissioning.

Permanent on-site land use impacts are not anticipated. Permanent off-site land-use changes are those associated with the additional land required for the disposal of radioactive and non-radioactive wastes during the life of the plant, and wetlands, forested lands and agricultural lands should the causeway and transmission line, if required, continue to be used after plant decommissioning at the PSEG Site.

10.2.1.3 Aquatic and Terrestrial Biota

Long-term irreversible losses of aquatic and terrestrial biota are not anticipated. Construction has a temporary adverse affect on the abundance and distribution of local flora and fauna on the PSEG Site and along the off-site transmission line corridor. Subsequent to the completion of construction, floral and faunal use is expected to recover in areas that are not affected by on-going operations or where land use was not altered (such as reduction in forested canopy height due to transmission line requirements). Losses due to operations are primarily attributable to intake operations and the resultant entrainment and impingement of aquatic biota. These losses are minor compared to available standing stocks, and most of the impacted species have high reproductive outputs. Therefore, losses due to entrainment and impingement are not expected to have a long-term impact on population levels of the affected species.

10.2.1.4 Releases to Air and Surface Water

Radioactivity, air pollutants, and chemicals are released from the new plant during normal operations. Releases can alter air and water quality. Emissions are below established regulatory standards, or are controlled in accordance with permitting requirements and are not expected to adversely affect air and water quality. New Castle County DE is near the PSEG Site and is in non-attainment for 24-hr $PM_{2.5}$, and therefore $PM_{2.5}$ emissions must meet more stringent standards to prevent further degradation of air quality. The new plant uses an auxiliary boiler to provide plant-related heating during the winter months and process steam during plant start-ups. The combined operation of the auxiliary boilers and cooling towers results in increases in CO, NO_x, SO_x, and particulate emissions. While air quality impacts are generally minor, the modeled 24-h $PM_{2.5}$ concentration due to emissions from the auxiliary boiler and cooling towers (during the winter months) exceeds the SIL in some locations, including a small part of the $PM_{2.5}$ non-attainment area in New Castle County, DE. In addition, the modeled 24-hr. $PM_{2.5}$ concentration due to the auxiliary boiler and mechanical draft cooling towers shows a slight exceedance of the applicable NAAQS when combined with available background concentrations in NJ. 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 modeling. Applicable emissions rates in effect at the time will be used in detailed equipment design and specification, along with identification of the appropriate engineering and operational controls. The final modeling will demonstrate that the new plant is in compliance with the NAAQS/NJAAQS and PSD increments, to ensure that the air quality impacts are SMALL.

10.2.2 IRRETRIEVABLE COMMITMENTS OF RESOURCES

Irretrievable commitments of resources during new plant construction are generally similar to that of any major, multi-year, construction project. Unlike previous nuclear plant construction, asbestos and other materials considered hazardous are not used, or used sparingly and in accordance with safety regulations and practices. U.S. Department of Energy (DOE) estimates of bulk materials required for construction of a single unit of a GEN III+ unit (advanced reactor designs that include the Advanced Passive 1000 [AP1000], U.S. Advanced Pressurized Water Reactor [US-APWR], Advanced Boiling Water Reactor [ABWR], and U.S. Evolutionary Power Reactor [U.S. EPR]) are listed in Table 10.2-1. The amounts of these materials are typical of other types of power plants (e.g., hydroelectric and coal-fired plants) and other large industrial facilities (e.g., refineries and manufacturing plants) that are constructed throughout the United States. Use of construction materials in the quantities associated with a nuclear power plant, while irretrievable unless they are recycled at decommissioning, have a SMALL impact, with respect to the availability of such resources.

During operations, the main resources that are irreversibly and irretrievably committed are the uranium used as fuel, and the energy required to produce the fuel. The World Nuclear Association studies of supply and demand of uranium indicate that an 80-year supply of uranium is available at current market prices based on known resources (Reference 10.2-4). This could increase to a 200-year supply as market prices rise and other conventional sources of uranium are used. Therefore, the uranium that is used to generate power by the new plant, while irretrievable, has a negligible impact with respect to the long-term availability of uranium worldwide. The assessment that the use of uranium constitutes an irretrievable resource

commitment can change as a result of a national adoption of a closed fuel cycle and spent fuel recycling for reuse in reactors.

The inventories of minerals used in the construction of power plants, as tabulated by the U.S. Census Bureau for 2000, 2007 and 2008, are shown in Table 10.2-2. While aluminum supplies have dropped since 2000 (from 3688 million metric tons in 2000 to 2284 million metric tons in 2006), the supplies during the 2006 to 2008 period have been increasing (2284 million metric tons in 2006 to 2640 million metric tons in 2008). The supply of other minerals has remained reasonably stable since 2000, with only minor fluctuations in availability during 2006 to 2008. The reasonably stable supply of minerals suggests that they will continue to be available for the foreseeable future in response to demand. Another important measure is industry capacity in those sectors that may affect nuclear power plant construction. The data in Table 10.2-3 suggest that most industries have surplus capacity. Over the 2004 to 2008 period, the primary metal, fabricated metal, and electrical equipment manufacturers used only 68 to 76 percent of their capacity. The data appear to indicate that the capacity utilization has been slightly increasing over this period. However, in 2008 the unused industrial capacity was still 24 to 28 percent, indicating that sufficient industrial capacity is available for construction of new plants.

While a given quantity of material consumed during new plant construction and operation at the PSEG Site is irretrievable, except for materials recycled during decommissioning, the impact on their availability is SMALL.

10.2.3 REFERENCES

10.2-1 U.S. Census Bureau, *The 2010 Statistical Abstract: Mining, Mineral Industries*, Website, http://www.census.gov/compendia/statab/cats/forestry_fishing_and_mining/mining_mineral_industries.html, accessed on January 25, 2010.

10.2-2 U.S. Census Bureau, *Survey of Plant Capacity Utilization: 2007 and 2008 Quarterly and 2006 Annual Reports,* Website, http://www.census.gov/manufacturing/capacity/historical_data/index.html, accessed on January 25, 2010.

10.2-3 U.S. Department of Energy, *DOE NP2010 Nuclear Power Plant Construction Infrastructure Assessment,* Report MPR-2776, Revision 0, Washington, DC, October 2005.

10.2-4 World Nuclear Association, *Supply of Uranium-September 2009*, Website: http://www.world-nuclear.org/info/inf75.html, accessed on December 9, 2009.

**Table 10.2-1
Estimated Construction Bulk Material Requirements for
Constructing Two GEN III+ Units**

Construction Bulk Material	Quantities[a]
Concrete (cubic yard)	920,000
Reinforcing Steel and Embedded Parts (ton)	92.000
Structural Steel, Miscellaneous Steel and Decking (ton)	50,000
Large Bore Pipe (>2 ½ in.) (ft.)	520,000
Small Bore Pipe (ft.)	860,000
Cable Tray (ft.)	440,000
Conduit (ft.)	2,400,000
Power Cable (ft.)	2,800,000
Control Wire (ft.)	10,800,000
Process and Instrument Tubing (ft.)	1,480,000

Reference 10.2-3.

a) Quantities represent a two unit plant. Reference 10.2-3 quantities are for a single unit and have conservatively been doubled.

Table 10.2-2
United States Inventories for Minerals Used in Construction of Power Plants

Minerals	Inventory in 1000 Metric Tons by Year			
	2000	2006	2007	2008
Aluminum	3688	2284	2554	2640
Copper	1450	1200	1170	1310
Iron Ore	61	53	51	56
Lead	449	419	434	420
Titanium	300	300	300	200
Zinc	796	699	769	794
Portland Cement	84	93	90	85
Masonry Cement	4	5	4	3
Construction Sand and Gravel	1120	1320	1230	1040

Reference 10.2-1.

Table 10.2-3
Percent Capacity Utilization for Manufacturing Industries Relevant to Power Plant Construction, 2004 – 2008

Industry	Year				
	2004	2005	2006	2007	2008
Primary Metal Manufacturing	74	79	73	76	74
Ferrous Metal Foundries	68	72	72	NA	NA
Nonferrous Metal Foundries	60	66	64	NA	NA
Fabricated Metal Products	66	68	70	71	72
Electrical Equipment	69	68	69	76	70

NA = not available
Reference 10.2-2

10.3 RELATIONSHIP BETWEEN SHORT-TERM USES AND LONG TERM PRODUCTIVITY OF THE HUMAN ENVIRONMENT

This Environmental Report (ER) focuses on the analyses and resulting conclusions associated with the environmental impacts from activities during the new plant construction and operation at the PSEG Site. These activities are considered short-term uses for purposes of this section. In this section, the long-term is considered to be initiated with the conclusion of new plant decommissioning at the PSEG Site. This section includes an evaluation of the extent that the short-term uses preclude any options for future long term use of the PSEG Site.

10.3.1 CONSTRUCTION OF NEW PLANT AT THE PSEG SITE AND LONG-TERM PRODUCTIVITY

Section 10.1 summarizes the potential unavoidable adverse environmental impacts of new plant construction and the measures proposed to reduce those impacts. Some SMALL adverse environmental impacts remain after all practical measures to avoid or mitigate the impacts have been taken. However, none of these impacts represent a long-term effect that precludes any options for future use of the PSEG Site.

The acreage disturbed during construction of the new plant, the proposed causeway and any potential transmission is larger than that required for the actual structures and other ancillary facilities because of the need for construction support facilities and laydown, batch plant operations, and parking areas for the construction workforce. Preparation of these on-site areas coupled with noise from construction activities, displace some wildlife and alter existing vegetation. Once the new plant is completed, the areas not needed for plant operations begin to revert to naturalized habitats that provide wildlife use.

Noise emitted by some construction activities increases the ambient noise levels on-site and in adjacent off-site areas. Upon completion of construction activities, noise levels are expected to decrease to the levels similar to those associated with the operation of the existing SGS and HCGS. The workforce is protected from excessive noise levels by adherence to the Occupational Safety and Health Administration (OSHA) requirements within high noise environments. There are no effects on the long-term productivity of the PSEG Site as a result of these impacts.

Construction traffic increases the volume of traffic on local roads and has adverse impacts on the LOS. These LOS impacts are mitigated and traffic volumes on local roads decrease once construction is completed. Consequently, there are no effects on long-term productivity from these impacts.

The new plant construction has beneficial effects on the local area such as new construction-related jobs, local spending by the construction workforce, and payment of taxes within the area and region. As indicated in Subsection 10.4.2, overnight costs for the construction of a 2200 MWe plant at the PSEG Site result in purchases of goods and services of $8.8 to $9.9 billion over a period of approximately 6 years. Based on the SGS and HCGS reported benefits, the multiplier effect from these expenditures result in an estimated additional indirect economic output of $0.88 for each construction dollar spent in the Region of Influence and $1.07 for each construction dollar in the DE-NJ-PA area (Subsection 4.4.2.2.1). This increase in the indirect economic output also results in an estimated 586 additional jobs in the Region of Influence and

4000 jobs in the DE-NJ-PA area. This additional indirect economic output and associated increase in indirect jobs further increase the amount of property taxes and sales taxes paid to state and local taxing jurisdictions to support and improve public and social services. The beneficial impacts from the in-migration of the construction workforce and indirect economic output and employment resulting from construction expenditures to the communities within the region cease once construction is complete. However, the changes that are the result of increased tax revenues continue throughout the operational life of the new plant. Tax revenue-related impacts are beneficial. Construction has a beneficial impact on the short-term economic productivity of the area, particularly in Salem County, NJ. There are potentially minor long-term beneficial impacts.

10.3.2 OPERATION OF NEW PLANT AT THE PSEG SITE AND LONG-TERM PRODUCTIVITY

Section 10.1 summarizes the potential unavoidable adverse environmental impacts of new plant operation and the measures proposed to reduce or eliminate those impacts. Some SMALL adverse environmental impacts could remain after all practical measures to avoid or mitigate them have been taken. However, none of these impacts represent long-term effects that preclude any options for future use of the PSEG Site.

The PSEG Site is located in an area that has been developed with three existing nuclear powered electric generation facilities. Therefore, the new plant operation represents a continuation of the current and planned land use. Once the reactors cease to operate and the plant is decommissioned to NRC standards, the land is available for other industrial or non-industrial uses. If an additional transmission line is required, portions of this line could remain in place and be used by future electric generating stations, thereby, helping to reduce associated land use and other impacts.

The new plant requires cooling water withdrawn from the Delaware River. Some of the water is lost to evaporation, but the losses are minor relative to the available surface water. Consumptive groundwater uses are needed to support plant operations and plant personnel. After the reactor(s) ceases to operate and the plant is decommissioned, consumptive ground and surface water use is no longer required.

The new plant operation will slightly increase air emissions because of intermittent short-term use of diesel generators or combustion turbines for emergency power supply, use of other combustion equipment, winter-use of auxiliary boiler(s) for plant heating or process steam for plant start-up, and continuous use of cooling towers for cooling water heat dissipation. This equipment is operated in accordance with applicable federal, state, and local regulations, and is not expected to result in any long-term decrease in regional air quality. Preliminary modeling shows maximum predicted PM_{10} and $PM_{2.5}$ concentrations exceed SILs in some locations. These are addressed during detailed design and plant equipment selection. Any other mitigative measures are developed in cooperation with NJDEP such that new plant emissions comply with applicable regulatory requirements and are protective of regional air quality. Salt deposition from the cooling towers will not result in any long-term decreases in productivity because deposition rates are low, and because the areas receiving the highest concentrations are salt marsh communities that are tolerant to salt deposition from the Delaware River. Particulate emissions and salt deposition will not affect long-term productivity of flora. Furthermore, the SMALL impacts associated with these activities no longer exist once the plant ceases operation.

Blowdown from the new plant cooling water system is discharged into the Delaware River. This discharge results in a small area that is characterized as having a higher temperature and concentration of heat and chemicals relative to ambient conditions. This discharge is permitted by NJDEP via a NJPDES permit to assure compliance with state and federal regulations that are protective to humans and aquatic biota. Thermal modeling indicates that there is no impact on the balanced indigenous community or the far-field water quality of the Delaware River. After decommissioning, there are no plant-related discharges to the Delaware River. Therefore, there are no long-term impacts to the productive use of the site after decommissioning due to plant discharges.

Impacts due to gaseous and liquid radioactive releases and direct radiation from the operating plant are SMALL and in accordance with state and federal regulations. These releases and direct radiation will not contaminate the PSEG Site or the surrounding land. No radiological releases occur after the new plant ceases operation and is decommissioned. Therefore, radiological impacts have no long-term impact on the productive use of the PSEG Site.

The new plant operation produces long-term socioeconomic changes that continue after the plant has been decommissioned. As indicated by the 2005 to 2008 HCGS and SGS expenditure data in Table 2.5-28, purchases of goods and services for the new plant operation and maintenance are significant. As described in Subsection 5.8.2.2.1, it is estimated that the multiplier effect from these expenditures results in additional indirect economic output of $0.88 for each dollar spent in the Region of Influence and $1.07 for each dollar spent in the DE-NJ-PA area. The increase in the additional indirect economic output could result in an average of 185 additional jobs in the Region of Influence and 1267 jobs in the DE-NJ-PA area. This additional indirect economic output and associated increase in indirect jobs further increases the amount of property taxes and sales taxes paid to state and local taxing jurisdictions to support and improve public and social services. The beneficial impacts from the in-migration of the operations workforce and indirect economic output and employment resulting from operation and maintenance expenditures to the communities within the region cease once decommissioning is complete. The proposed causeway may remain in place if future recreational use of the areas on/near the PSEG Site is desired. Property taxes paid by PSEG to Lower Alloways Creek Township and Salem County may be used to support greater township and county infrastructure and social services during the life of the plant. Infrastructure improvements may remain in place after plant decommissioning. These long-term improvements to the township and county have no long-term impact on the productive use of the PSEG Site.

10.3.3 SUMMARY OF RELATIONSHIP BETWEEN SHORT-TERM USE AND LONG-TERM PRODUCTIVITY

The impacts resulting from the new plant construction and operation at the PSEG Site result in both adverse and beneficial short-term impacts. The principal short-term adverse impacts are SMALL residual impacts (after mitigation measures are implemented) to land use, aquatic biota, local traffic, and air quality. There are no long-term impacts to the environment. The principal short-term benefits are the production of electrical energy, creation of additional jobs, additional tax revenues to taxing jurisdictions, and improvements to local infrastructure and social services. The principal long-term benefit is the continued availability of the improved infrastructure, particularly in Salem County, after plant decommissioning. The short-term

impacts and benefits and long-term benefits do not affect long-term productive use of the PSEG Site.

10.4 BENEFIT-COST BALANCE

10 CFR 51.50, *Environmental report—construction permit, early site permit, or combined license stage*, Section (b)(2) does not require an assessment of benefits and costs at the ESP stage. However, PSEG intends to apply for a combined license (COL) for a new plant at the PSEG Site in the future and prepared this ER with the environmental information needed for a COL application. For this reason, PSEG included this assessment of the benefit-cost balance in this ESPA.

10.4.1 BENEFITS

10.4.1.1 Need for Power

The new plant (assuming the bounding AP1000 design) consists of two units, with each unit generating 1100 megawatts electric (MWe) net, for a total of 2200 MWe. Assuming a conservatively low capacity factor of 85 percent, the 2-unit plant average annual electrical-energy generation is more than 16,000,000 megawatt-hours (MWh). A more reasonable capacity factor of 93 percent results in 18,000,000 MWh of electricity generated annually.

Chapter 8 analyzes the need for power based on annual PJM resource and load forecast data. The Relevant Service Area (RSA) for the new plant is the State of NJ which is part of PJM, the Regional Transmission Organization (RTO) for the area. As the RTO, PJM is responsible for the reliable supply of bulk electricity within the region. Analysis of PJM data indicates that an additional 7900 MWe (Section 8.4) of baseload capacity is required to meet 2021 energy needs.

The new plant provides regional baseload capacity to PJM to meet up to 28 percent of the additional baseload energy needs projected for NJ in 2021. Given the increasing concerns regarding carbon emissions, including CO_2, and associated climate change, the new plant helps PJM meets its baseload capacity needs without increasing carbon emissions for electrical generation.

One of the major benefits of a new plant at the PSEG Site is the supply of up to 2200 MWe of additional electricity to meet projected baseload capacity requirements. This additional baseload capacity:

- Provides up to 28 percent of the projected additional baseload power need in 2021 within NJ
- Reduces the amount of power imported into NJ
- Reduces reliance on oil fueled generation (domestic or foreign supplied) or other fossil fueled generation
- Reduces the potential for transmission congestion
- Lowers locational marginal prices
- Produces electricity with only incidental air emissions for support equipment

10.4.1.2 Energy Alternatives

Chapter 9 analyzes alternatives to meet the baseload power demand other than the proposed new plant, and demonstrates that there are no environmentally preferable alternatives for generating baseload power on the scale provided by the proposed plant.

PSEG's ability to supply affordable electricity to its customers is derived from its use of a diversity of fuels for its power generation facilities, promotion of conservation measures, and effective management of its baseload, intermediate, and peaking facilities. As shown in the energy alternatives analysis in Chapter 9, energy conservation and efficiency measures only partially meet PJM's projected increase in baseload capacity, and demand side management initiatives only impact peak demand.

Wind and solar generation facilities are variable in their output and, even with storage technologies, are unreliable and/or environmentally prohibitive as baseload generators within the RSA. Geothermal, solar, hydropower, and photovoltaic facilities are not viable due to the lack of suitable sites, lack of geothermal resources, or low solar insolation in the region. Hydropower, solar, and oil are less competitive than nuclear because of their greater environmental impact. Plants using fuel cells and photovoltaic cells are not competitive due to limited generation capacity and high development costs. An integrated gasification combined cycle (IGCC) plant is not competitive because this technology has unproven reliability at the scale needed and has high costs. Biomass as a fuel source is not competitive due to its low energy value, which results in larger fuel requirements and higher fuel costs. While biomass in combination with coal or natural gas may increase efficiency and reduce emissions, biomass has higher costs, larger land requirements for producing, collecting, and managing the required biomass, and higher air emissions, making either combination less competitive than nuclear. Only plants using coal and natural gas as fuel sources are considered competitive with a nuclear-fueled plant for baseload capacity.

A detailed analysis of coal and natural gas energy alternatives and systems is provided in Subsection 9.2.3. This analysis indicates that, overall, the proposed new plant is environmentally preferable to an alternative power generating facility fueled by coal or natural gas. Each of these two alternatives or a combination with other alternatives (wind, solar, biomass, etc.) has a much greater environmental impact on air quality and other natural resources than a nuclear power generating facility. Therefore, a power generating facility fueled by coal, natural gas, or a combination of either with other alternatives is not environmentally preferable to the new nuclear plant at the PSEG Site.

10.4.1.3 Benefits of the Proposed Facility

In addition to supporting PJM in meeting projected baseload capacity requirements for the RSA, a new plant at the PSEG Site provides benefits to the local economy, and helps reduce air and carbon emissions.

10.4.1.3.1 Socioeconomic Benefits

Additional important benefits from the new plant construction and operation include economic effects such as increases in:

- Property tax revenues to local taxing jurisdictions
- Purchases of local and regional goods and services
- Local and regional direct and indirect employment

The new plant provides benefits to the local economy in the form of additional property taxes, purchases of goods and services, and jobs. PSEG pays property tax on the 734 ac. it currently

owns at the PSEG Site and lands included as part of the Estuary Enhancement Program. As indicated in Subsection 2.5.2, these property taxes ranged from $1.2 to $1.5 million per year for the current site property and $0.25 to $0.31 million per year for the ecosystem restoration properties during 2005-2009. As described in Subsection 2.2.1, the existing PSEG property boundary will be expanded as part of an agreement with the USACE by an additional 85 ac. to accommodate the needs of the new plant. Additional lands may be required to restore wetlands lost during construction of the new plant, the proposed causeway, and any necessary off-site transmission. Site property taxes are expected to increase based on the land area to be acquired. Tax payments are considered a benefit to the taxing entity because they support the development of infrastructure that supports further economic development and growth.

New plant construction and operation is also expected to have an economic multiplier effect in the area. The economic multiplier effect means that for every dollar spent additional indirect economic revenue is generated over the construction and operation period within the Region of Influence. The multiplier effect from the purchase of goods and services for HCGS and SGS construction, 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 (Subsection 4.4.2.2.1 and 5.8.2.2.1). The economic multiplier effect is one way of measuring direct and secondary effects. Direct effects reflect expenditures for goods, services, and labor, while secondary effects include subsequent spending in the community. The economic multiplier effect due to the increased spending by this direct and indirect labor force increases economic activity in the region, most noticeably in Cumberland, Gloucester, and Salem counties in NJ and New Castle County in DE.

In 2009, the existing HCGS and SGS had a combined workforce of approximately 1574 employees (Subsection 2.5.1). As stated in Subsection 5.8.2, new plant operation adds an additional 600 direct employees to the on-site workforce. Based on projections derived from the 2006 NEI report, 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. Many of these jobs are in the service sector and are expected to be filled by local residents, which strengthens the economy and also lessens additional demands on social service agencies. The new jobs will exist throughout the life of the plant.

10.4.1.3.2 Emission Reduction Benefits

Given concerns regarding climate change and carbon emissions, as well as emissions of SOx, NO_x, and particulates, a new plant at the PSEG Site provides an important environmental benefit by reducing emissions of carbon and other pollutants, when compared to coal-fired and natural gas-fired plants. Table 10.4-1 compares the CO_2, SO_2, NO_x, and particulates from coal, gas and nuclear plants. For the PSEG Site, it is assumed that an oil-fired auxiliary boiler is used for plant heating during the winter months and for process steam during plant start-ups. The PSEG Site emissions noted in Table 10.4-1 are conservative and are expected to be lower once the boiler type is specified and the fuel is selected. Once the new plant is operational, it produces substantially lower amounts of carbon compared to coal-fired and natural gas-fired generating plants. Even with the conservative PSEG Site emission assumptions, it is clear that the new plant's emissions are a small fraction of those associated with comparably sized coal- and gas-fired power plants. The lower carbon emissions from a new nuclear plant at the PSEG

Site is beneficial in light of the increasing global concerns regarding climate change and transition to a carbon-constrained regulatory environment.

10.4.1.3.3 Licensing Certainty

The regulatory scheme used for the existing domestic fleet of nuclear plants, under 10 CFR 50, was a two-step process that resulted in uncertainty regarding cost projections and ultimately in final costs. This was due, in part, to the fact that the industry had to make large capital investments prior to resolving licensing issues. In large, capital-intensive construction projects, interest costs are a significant portion of the project cost. As indicated in Subsection 10.4.2.2, interest charges on overnight capital costs account for a quarter of the levelized cost of electricity from nuclear power plants. Under 10 CFR 50, delays in obtaining an operating license quickly and substantially increased project cost. Design changes had similar effects, whether driven by licensing concerns, backfit requirements, or other factors.

The NRC's 10 CFR 52 licensing process, particularly the issuance of an ESP, provides early resolution of siting, design, and operational issues prior to large investments of financial capital and human resources in new plant design and construction. This process also provides for: early resolution of issues on the environmental impacts of construction and operation of proposed reactors, the ability to bank sites where nuclear plants may be located, and the facilitation of future decisions on whether to build new nuclear plants. This licensing process should reduce project costs by decreasing premiums associated with uncertainty and making licensing and construction scheduling more controllable and reliable.

10.4.2 COSTS

The costs associated with new plant construction and operation are broken down into internal and external costs. Internal costs are those expended by the applicant in support of the construction and operation of a new plant and are generally expressed in monetary values or quantities (materials). External costs are the environmental costs that result from the construction and operation of the new plant, and are expressed in terms of monetary, quantitative, and qualitative values.

10.4.2.1 Internal Costs

This section summarizes estimated internal costs for new plant construction and operation at the PSEG Site. Internal costs include capital costs of the facility, transmission lines, operating costs (staffing, maintenance, and fuel) and decommissioning costs. A number of studies have estimated construction and operation costs for the new generation (GEN III+) of nuclear reactors. These estimated costs vary depending on the assumptions used. Four studies commonly referenced are:

- Organization for Economic Co-operation and Development (OECD) study of projected electricity generating costs (Reference 10.4-5)
- University of Chicago study on the economic future of nuclear power (Reference 10.4-7)
- Updated Massachusetts Institute of Technology (MIT) study on the future of nuclear power (Reference 10.4-2)

- The Keystone Center nuclear power study (Reference 10.4-1)

By conducting a systematic review of nuclear power economics, the studies generated a financial model that estimated the costs of new nuclear plants. To develop that model, the following were considered:

- Factors affecting nuclear power competitiveness, including levelized costs, comparisons with international nuclear costs, capital costs, effects of learning by doing, and financing issues

- An analysis of technologies that could reduce the costs of gas- and coal-fired electricity, future changes in fuel price, and the potential economic impact of greenhouse gas control policies and technologies

- An analysis of several federal financing policy alternatives designed to make nuclear power competitive in the future

A December 2009 NEI study on the cost of new nuclear plants (Reference 10.4-4) summarized findings from a number of studies, including the updated MIT study, and cost data submitted by Florida Power and Light, Progress Energy Florida, and South Carolina Electric and Gas. This study was used as the basis for estimating the internal monetary costs of constructing and operating a new plant at the PSEG Site.

A major consideration in the competitive cost of nuclear power is the offsetting effect of the financial risk premium that resulted from past nuclear industry performance due to construction delays, cost overruns, and plants not being completed. Given the high capital costs for a nuclear plant and the long construction schedule, the higher financial rates of risk premiums contribute to the cost of constructing and operating a new nuclear plant. Until new plants are constructed and financial institutions are satisfied that the perceived risk is not justified, other incentives are required to offset the risk premium. The Energy Act of 2005 provides incentives to promote the construction and operation of new nuclear plants. Based on DOE summary information on the Energy Act of 2005 (Reference 10.4-6), the primary incentives are as follows:

- Loan guarantees up to 80 percent of the cost of construction
- Insurance of up to $500 million on the first two units against delays caused by litigation or the NRC
- Production tax credit of up to 1.8 cents per kWh for the first 6 GWe of new plants

These incentives help lower the financial costs by lowering the amount of developer’s equity (as low as 20 percent), ensuring a lower interest rate due to the government guarantee, and helping to offset production costs in the initial eight years of operation. The incentives included in the Energy Act of 2005 may not be available to PSEG, due to DOE COL application schedule requirements. PSEG anticipates that similar incentives may be available at the time it applies for a COL.

10.4.2.1.1 Monetary – Construction

The phrase commonly used to describe the monetary cost of constructing a nuclear plant is "overnight capital cost." These capital costs are those incurred during construction, when the actual outlays for equipment and construction and engineering are expended as if the plant was constructed overnight, with no interest or escalation factored in. Overnight costs are exclusive of interest and include engineering, procurement, construction costs, owner's costs, and contingencies. The NEI study estimated overnight capital costs ranging from $4000 per kW to $4500 per kW. Many factors account for the range: the specific technology and assumptions regarding the number of like-units built, allocation of first-of-a-kind costs, site location, the degree of modularization in the reactor technology/design, and allowances for contingencies.

10.4.2.1.2 Monetary – Operation

The four studies referenced above show a wide range of operation cost estimates. Operation costs are frequently expressed as levelized cost of electricity, which is the price at the busbar needed to cover operating costs and annualized capital costs. Overnight capital costs account for about one third of the levelized cost, and interest costs on the overnight costs account for another 25 percent (Reference 10.4-7). Factors affecting the range include choices for discount rate, construction duration, plant lifespan, capacity factor, cost of debt and equity and split between debt and equity financing, depreciation time, tax rates, and premium for uncertainty. Estimates include decommissioning but, due to the effect of discounting costs that occur as much as 40 years in the future, decommissioning costs have little effect on the levelized cost.

The NEI study (Reference 10.4-4) estimated that levelized costs of a new nuclear plant range from 7.5 to 8.1 cents per kWh. These costs are based on a merchant nuclear plant with an 80 percent debt/20 percent equity capital structure and support by a federal loan guarantee. PSEG has concluded that levelized costs in the NEI study are the most current available and that the assumptions used to derive the levelized costs are reasonable for a new plant at the PSEG Site. Therefore, PSEG has used levelized costs of 7.5 to 8.1 cents per kWh for a new plant at the PSEG Site.

In addition to nuclear plant costs, the four studies provide coal-fired and gas-fired generation costs for comparison to nuclear generation costs. The updated MIT and OECD studies (References 10.4-2 and 10.4-5) concluded that nuclear operating costs are competitive with coal and gas costs, while the other two studies concluded that nuclear operating costs are higher than coal and gas costs. The recent emphasis on CO_2 emissions and associated concerns regarding climate change are likely to cause significant increases in the cost of coal plants because they will be required to implement measures to reduce CO_2 emissions or pay for CO_2 emissions. The MIT study estimated that the levelized costs for coal-fired and gas-fired plants increases from 6.2 to 8.3 cents per kWh and 6.5 to 7.4 cent per kWh, respectively, due to the costs of eliminating or mitigating carbon emissions. The NEI compared levelized costs for nuclear, coal and gas power plants and found that nuclear (7.5 to 11.6 cent per kWh, depending on financial structure) and coal (7.4 to 11.6 cents per kWh, depending of financial structure and technology) costs are comparable without consideration of CO_2 emissions, while gas costs (5.6 to 9.7 cents per kWh) are less than nuclear. However, when the costs of controlling CO_2 emissions are factored in (2.5 cents per kWh for coal and 1.8 cents per kWh for gas) nuclear levelized costs are competitive with coal and natural gas levelized costs. Because CO_2 emissions from nuclear plants are negligible, they do not incur these additional costs. Therefore,

a new nuclear plant at the PSEG Site is among the most competitive means of supplying needed baseload electricity to its customers.

10.4.2.1.3 Tax Payments

As indicated in Section 2.1.1, PSEG currently owns 734 ac. of land and is working with the USACE to acquire an additional 85 ac. of land. PSEG currently pays $1.2 to $1.5 million in property taxes on the 734 ac. to Lower Alloways Creek Township each year (Table 2.5-37). Over $200,000 in property taxes for Estuary Enhancement Program restoration properties are also paid by PSEG each year to various other NJ townships (Table 2.5-37). PSEG will pay property taxes on the additional 85 ac. and any new ecological restoration properties it acquires. Based on the current taxes paid for the 734 ac., the additional 85 ac. results in an increase in property tax payments to Lower Alloways Creek Township.

PSEG pays corporate tax to NJ as a result of revenues generated by the new plant. As indicated in Table 2.5-29, corporate taxes are 9 percent for NJ. Sales/Use tax are also paid to NJ and PA associated with the purchase of goods and services during construction and operation and these range from 6 percent in PA to 7 percent in NJ (Table 2.5-29). Payroll taxes paid by PSEG vary from 0.5 to 5.95 percent for DE, 1.4 to 8.97 for NJ, and 3.07 for PA (Table 2.5-29).

10.4.2.1.4 Land

As indicated in Section 10.4.2.1.3, PSEG is developing an agreement in principle with the USACE for the acquisition of an additional 85 ac. of land. The terms of this acquisition and associated cost are not known at this time. If an additional transmission line is required, up to 2728 ac. (Table 4.1-3) of land rights may be acquired.

10.4.2.1.5 Material Costs

Large quantities of concrete, steel, pipe, cable, conduit, tubing and wire and the various minerals required to produce these bulk construction materials are used during new plant construction and operation at the PSEG Site. According to mineral production inventory data, relevant minerals inventories are reasonably stable and have kept pace with requirements. Data on plant production capacity for those industries producing equipment and materials required for power plant construction are operating well below capacity. Based on the mineral production inventories and surplus plant production capacity, construction of a new plant will not adversely affect the cost of the required construction materials.

10.4.2.2 External Costs

External costs are those environmental costs that remain after mitigation and controls have been taken into account. For new plant construction and operation, these include residual land use, archaeological resource, water use, aquatic biota, and radiological costs.

10.4.2.2.1 Land Use

In conjunction with the construction of the new plant and proposed causeway, 270 ac. of lands (Table 4.1-1) are converted to long-term industrial use. A small percentage of the 2728 ac. of

off-site lands (Table 4.1-3) may be altered if a new transmission line is required. Most of the potential transmission impacts are related to the small footprint of the individual towers, or land use that is modified by fill, or where forested lands need to be maintained below a certain height for transmission safety. After the new plant ceases operations and is decommissioned in accordance with NRC requirements, the land that supports the on-site facilities could be returned to other industrial or nonindustrial uses.

10.4.2.2.2 Archaeological Resources

PSEG will conduct Phase I and Phase II surveys, as appropriate, and work closely with the HPOs in DE, MD, NJ, and PA to identify, avoid, or minimize disturbance to archaeological resources along the transmission line rights-of-way, if required. There is a potential that some below-ground archaeological resources are unavoidable and could be lost or disturbed by construction activities.

10.4.2.2.3 Ground and Surface Water Use

New plant operations consume 26,420 gpm of surface water and 210 gpm of groundwater. The surface water consumption is the result of evaporative cooling losses, and the groundwater consumption is due to potable water needs by plant operations and personnel. The freshwater portion of the consumptive losses is 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.

The groundwater withdrawal for the new plant is 210 gpm, which equals 110.4 Mgy. The cumulative maximum withdrawal for operations, based on SGS and HCGS average historic withdrawals (see Table 2.3-24) and the new plant, is 309 Mgy, which is 3 percent above the current SGS and HCGS site permitted annual water withdrawal. After a reactor technology has been selected and a final site water balance 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. 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 impact of additional water use is SMALL.

10.4.2.2.4 Aquatic Biota

The new plant uses a closed-cycle cooling system consistent with EPA requirements. Cooling water make-up requirements are small and the intake is designed to keep flow velocities across the traveling screens less than 0.5 ft./sec. The cooling water system design features minimize aquatic biota losses due to entrainment and impingement. The losses are minor compared to available standing stocks, and are not expected to have a long-term impact on population levels of the affected species.

10.4.2.2.5 Radiological

There are gaseous and liquid radioactive releases and direct radiation from the new plant during normal plant operations. These releases are to the atmosphere and surface water. The

operations workforce and public could be exposed to these releases. However, the releases are monitored in accordance with protective state and federal regulations.

10.4.3 SUMMARY

Table 10.4-2 summarizes the benefits and costs of the proposed action. The primary benefits of a new plant include the availability of additional energy to meet projected demands, the avoidance of harmful air pollution emissions, additional tax revenues realized by local taxing jurisdictions, creation of additional jobs, and increased economic output. The primary costs of a new plant include the capital and operating costs, the construction materials consumed, and the environmental impacts remaining after implementation of proposed mitigation measures.

This analysis of the benefits and costs of a new plant at the PSEG Site indicates that:

- Additional electricity is needed in the RSA to meet projected baseload energy requirements
- Other alternatives such as importing electricity, implementation of additional energy conservation measures, or alternative energy sources are not adequate to meet this projected baseload energy need
- Construction of a baseload plant in the RSA is the most cost-effective way of meeting this projected baseload energy need
- Coal, natural gas, and nuclear plants are the most viable options for meeting this projected baseload energy need
- Construction and operation of a nuclear plant is cost competitive with coal-fired and natural gas-fired plants
- Government incentives for advanced nuclear plants reduce the perceived financial risks associated with construction of new plants
- Cost of carbon management at fossil-fueled plants will be high and favors nuclear plants over currently available coal-fired and gas-fired plants
- Construction and operation of the new nuclear plant increases both direct and indirect short-term and long-term employment, as well as increasing long-term direct and indirect economic output locally and within the region
- Construction and operation of the plant provides additional long-term tax revenues to local and state taxing jurisdictions for infrastructure and social services
- Air pollution emissions are an increasing domestic and international concern due to the contribution of greenhouse gases to climate change and overall environmental impacts are less with nuclear than with coal-fired and gas-fired-fired plants
- Use of the existing industrial-zoned site, which already has operating nuclear units, further minimizes environmental impacts

- Design features, BMPs, permitting, controls, and mitigation measures either avoid adverse environmental impacts or reduce impacts to SMALL
- A comparison of benefits and costs indicates that the benefits of a new nuclear plant at the PSEG Site are significantly greater than the economic and environmental costs
- The costs of plant construction and operation are reduced by continuing efforts to avoid and minimize impacts to ecological resources

As described in the previous section, the proposed new plant and associated development result in unavoidable impacts to ecological resources including waters of the United States and state waters. Direct wetland impacts from construction of the new plant and proposed causeway occur within the various site utilization areas (see Table 4.3-3 and Figure 4.3-2). However, PSEG has taken steps to minimize these potential impacts to the extent practicable as part of an overall avoidance and impact minimization strategy. Key elements of this strategy include reducing impacts to on-site wetlands and jurisdictional waters by the site layout configuration identified in Figure 3.1-2. Site utilization efforts minimize impacts to on-site wetlands by preferentially locating the key plant features (power block, cooling towers, etc.) in areas that are highly disturbed and are predominantly within existing licensed waste disposal facilities (i.e., PSEG's on-site desilt basin and the USACE confined disposal facility [CDF]). PSEG has made additional commitments to further avoid and minimize on-site impacts during the design phase by optimizing plant features within designated site utilization areas. Potential effects to the aquatic ecosystem are further minimized by avoiding impacts to marsh creeks within coastal wetlands.

Potential impacts within off-site areas are also minimized. Impacts to wetlands along the proposed causeway are minimized through the use of an elevated road and bridge design, thus reducing the width and magnitude of wetland impact when compared to construction on fill material. Within a 50-ft. width of impact, wetland impacts are limited to losses resulting from construction fill in areas directly affected by pier placement, and to shading effects. For potential off-site transmission, impacts are minimized by the commitment to site the transmission line in or along established rights-of-way to the extent practicable. Furthermore, additional consultations will be made with resource agencies to identify sensitive species of concern, avoid jurisdictional waters including wetlands, and mitigate any unavoidable adverse impacts.

10.4.4 REFERENCES

10.4-1 The Keystone Center, *Nuclear Power Joint Fact-Finding,* Keystone, Colorado, June 2007.

10.4-2 Massachusetts Institute of Technology, *Update of the MIT 2003 The Future of Nuclear* Power*; An Interdisciplinary MIT Study*, Boston, Massachusetts, 2009.

10.4-3 Not Used

10.4-4 Nuclear Energy Institute, *The Cost of New Generating Capacity in Perspective,* Washington, D.C., December 2009.

10.4-5 Organization for Economic Co-Operation and Development, and International Energy Agency, *Projected Costs of Generating Electricity; 2005 Update,* Website, http://browse.oecdbookshop.org/oecd/pdfs/browseit/6605011E.PDF, accessed December 17, 2009.

10.4-6 U.S. Department of Energy, Energy Policy Act of 2005: New Plant Incentives within the Energy Policy Act of 2005 (EPACT2005), Website, http://www.ne.doe.gov/energypolicyact2005/neEPACT2a.html, accessed January 26, 2010.

10.4-7 The University of Chicago, *The Economic Future of Nuclear Power,* Chicago, Illinois, August 2004.

Table 10.4-1
Comparison of Typical Air Emissions from Coal- and Gas-Fired Power Plants with Preliminary Air Emission from the PSEG Plant

Pollutant	Coal Plant Emissions (tons per year/ 1924 MW)[(a)]	Gas Plant Emissions (tons per year/ 2200 MW)[(a)]	New Nuclear Plant (tons per year/ 2200 MW)[(b)]
Sulfur dioxide	6410	63	230
Nitrogen oxides	5293	528	44
Carbon Dioxide	15,375,434	6,907,756	24,000
Particulates having a diameter of less than 10 microns	982	662	69

a) From Table 9.2-2, based on no CO_2 capture data.
b) From Table 5.8-1, except for CO_2. Emissions are due to the distillate-fueled auxiliary boiler use for heating during the winter months and monthly start-up testing of diesel generators.

Table 10.4-2 (Sheet 1 of 3)
PSEG Site Benefits and Costs Summary

Benefit Category	Description
Electricity Generated	• 16,000,000,000 to 18,000,000,000 kWh
Generating Capacity	• Up to 2200 MWe • Provide up to 28% of the projected increase in baseload demand • Reduce the need to import electricity into NJ • Reduce reliance on fossil fuels including imported oil • Reduce the potential for transmission congestion • Lower locational marginal prices
Fuel Diversity	• Nuclear alternative to coal-fired and gas-fired baseload generation
Emission Reduction	• Avoidance of up to 6410 tons per year of SO_2 • Avoidance of up to 5293 tons per year of NO_x • Avoidance of up to 15.38 million tons per year of CO_2 and associated climate change impacts. • Avoidance of up to 982 tons per year of particulates
Tax Payments	• Increase in current property taxes by an estimated 11 percent which helps support and enhance local public and social services • Purchases related to construction and operation of the plant result in additional sales taxes from direct expenditures and additional sales tax and payroll taxes from indirect expenditures to state and local taxing jurisdictions. These additional direct and indirect taxes help support and enhance state and local public and social services.
Local Economy	• 600 additional direct operations workforce jobs • 4100 construction workforce jobs (634 relocations to Region of Influence) • Additional 586 local and 4000 regional indirect jobs during construction and 185 local and 1265 regional indirect jobs during operation due to multiplier effect • Increase in local and regional direct and indirect economic activity due to construction-related and operations-related purchases of goods and services. An additional $0.88 of indirect economic activity for every dollar of local purchases and $1.07 for every dollar of purchases in the region.
Historic and Archaeological Resources	• Mitigation of identified sites determined to be unavoidable preserves resources and adds to local historic and prehistoric knowledge.
Licensing Certainty	• ESP provides early resolution of environmental issues, facilitation of future decisions on whether to build nuclear power plants.

Table 10.4-2 (Sheet 2 of 3)
PSEG Site Benefits and Costs Summary

Cost Category	Description
Internal Costs	
Construction Cost	• $4000-4500/kW (overnight capital cost).
Operating Costs	• 7.5 to 8.1 cents/kWh (levelized costs) as compared to 10.5 cents per kWh for coal-fired plants and 7.4 to 10.5 cents per kWh for gas-fired plants with CO_2 cost.
Tax Payments	• Corporate income and business taxes must be paid by PSEG to the State of NJ and property taxes to Lower Alloways Creek Township and Salem City. Although sales and payroll taxes associated with income and operation of the plant are not estimated, the tax payments on the current property may increase by an estimated 11 percent.
Land	• Acquisition of an additional 85 acres of land for the new plant and potential property rights for up to an additional 2728 acres for a potential transmission line, if required.
Materials	• Concrete – 920,000 cubic yards • Reinforcing steel and embedded parts – 92,000 tons • Structural steel, misc. steel, and decking – 50,000 tons • Large bore pipe (greater than 2-1/2 inches) – 520,000 ft. • Small bore pipe – 860,000 ft. • Cable tray – 440,000 ft. • Conduit – 2,400,000 ft. • Power cable – 2,800,000 ft. • Control wire – 10,800,000 ft. • Process and instrument tubing – 1,480,000 ft.

Table 10.4-2 (Sheet 3 of 3)
PSEG Site Benefits and Costs Summary

Cost Category	Description
External Costs	
Land Use	• Long-term use of 270 ac. of land on-site and within the proposed causeway. • Long-term use of up to 2728 ac. of land for transmission line rights-of-way, if required.
Archaeological Resources	• Potential disturbance or destruction of unidentified archaeological resources along off-site transmission line and proposed causeway.
Groundwater Use	• Consumptive use of an average of 210 gpm of groundwater from deep aquifers.
Surface Water Use	• Consumptive use of 26,420 gpm of water from Delaware River.
Aquatic Biota	• Minor losses due to entrainment and impingement
Radiological	• Construction worker dose: 18.2 millirem per year (total effective dose equivalent [TEDE]) • Operational worker dose: Less than current 309 person-rem per year (existing operating units plus new plant) • Maximum exposed individual (public) dose: 0.37 millirem/year (total body) during operation of existing units plus new plant • Collective dose to public: 60.1 person-rem per unit per reactor-year (total body) • Population dose risk from severe accident: 1.15E+00 person-rem per reactor-year

10.5 CUMULATIVE IMPACTS

This section discusses cumulative adverse impacts to the region's environment that could result from the new plant's construction and operation. A cumulative impact is defined in Council of Environmental Quality regulations (40 CFR 1508.7) as an "impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions."

To address cumulative impacts, the context of the existing environment in the region surrounding the PSEG Site (Chapter 2) is considered in conjunction with the environmental impacts presented in Chapters 4 and 5 for constructing and operating a new plant at PSEG Site. PSEG is also seeking renewal of its operating licenses for HSGS and SGS for 20 years beyond the current term of 40 years. This section contemplates the renewal of HCGS and SGS operating licenses, and the cumulative impacts of the three plants on the affected environment. Additionally, the effects of other identified "actions" as described in Section 2.8 of the ER are evaluated as part of the cumulative effects analysis. The cumulative impact ratings for each resource are developed by assessing the potential for the effects of other identified "actions" to change the prior impact rating assessed for each resource in Chapters 4 and 5.

As is described in Subsection 1.2.5, subsequent to submittal of the ESP application, PJM determined that additional grid improvements are necessary to address voltage and stability constraints in the region of Artificial Island. In response, PJM has solicited proposals from both regulated and non-regulated (merchant) transmission providers for system enhancement to address these constraints. PJM's determination of the need for this transmission system upgrade is independent of PSEG's interest in new nuclear generation and is not predicated on the construction of a new nuclear facility at the PSEG Site. Therefore, any transmission project mandated by PJM, including a new off-site transmission line, is considered to be reasonably foreseeable and is considered to be an action that is independent from the potential development of the PSEG Site. Similarly, since this PJM-sponsored grid improvement serves to enhance power delivery throughout the region, it inherently possesses independent utility. Although PJM has not formally assessed the scope and structure of this future transmission upgrade, PSEG identified the potential impacts of a new off-site transmission line whose technical attributes best meet PJM's goal of addressing these regional constraints.

Of the two potential transmission corridors presented in Subsection 9.4.3, the West Macro-Corridor to the Peach Bottom substation is considered to be the most effective route to address the regional voltage and stability constraints that PJM is attempting to resolve. Therefore, the characteristics of the West Macro-Corridor are used to evaluate the potential impacts of a new transmission line as representative of the regional transmission upgrade project currently being pursued by PJM. These potential impacts are addressed as part of the cumulative effects analysis provided in the following subsections.

10.5.1 CUMULATIVE IMPACTS FROM CONSTRUCTION

This subsection discusses the potential cumulative impacts of PSEG Site construction activities (including the proposed causeway) and the construction impacts of other major projects in the region. Impacts associated with construction of the new plant are summarized in tabular form in

Section 4.6. However, the potential transmission impacts for the South Macro-Corridor, as summarized in Section 4.6, are not assessed in this subsection. Instead, the potential impacts of a transmission line constructed in the West Macro-Corridor are assessed since the line is considered representative of the regional transmission project currently being pursued by PJM independent of nuclear development at the PSEG Site.

Past HCGS and SGS construction related impacts are part of the existing baseline conditions at the PSEG Site and are therefore intrinsically integrated as part of the cumulative effects analysis. Cumulative impacts of the new plant and other identified present and reasonably foreseeable future actions are assessed for land use, ecological resources (terrestrial and aquatic ecosystems, sensitive species), water resources (groundwater and surface water use and water quality, surface water hydrology) and the socioeconomic environment, (noise levels, air quality, socioeconomic resources, and environmental justice populations). The sensitivity of cumulative effects analysis is resource based, and an appropriate context of analysis was selected for each of the resources described below.

10.5.1.1 Land Use

PSEG currently owns 734 ac. of lands on the PSEG Site. As described in Subsection 2.2.1, PSEG is pursuing an agreement in principle with the USACE to acquire an additional 85 ac. immediately to the north of HCGS. With the land acquisition, the entire PSEG Site will be 819 ac. (Figure 3.1-2). The specific timing of land acquisition is not currently known and is subject to further PSEG and USACE actions. However, the agreement in principle with the USACE will establish the basis for eventual land acquisition and Exclusion Area Boundary (EAB) control, necessary to support the issuance of a future COL.

Subsequent to the agreement in principle with the USACE, PSEG will develop a lease agreement for the USACE CDF land to the north of the PSEG Site, as depicted on the Site Utilization Plan (see Figure 3.1-2) for the concrete batch plant and temporary construction/ laydown use. At the completion of construction, the leased land will be returned to the USACE, subject to any required long-term EAB control conditions.

The proposed causeway provides additional access to the PSEG Site and impacts 69 ac. of coastal marsh and adjacent uplands (45 ac. permanently and 24 ac. temporarily). Potential land use impacts of the West Macro-Corridor are associated with rights-of-way that include a total of 1557 ac. of land over a distance of up to 55 miles. Lands crossed by the potential off-site transmission line are influenced by past development patterns and are dominated by agricultural uses (cultivated fields, pastures, etc.), deciduous forests, and estuarine wetland types. Overhead transmission lines do not alter uses of common land use categories such as cultivated crops, pastures, open water, or emergent herbaceous wetlands. The amount of lands affected by the potential off-site transmission line and those in the vicinity and region are shown in Table 9.4-2. It is expected that any new transmission line constructed in the West Macro-Corridor will be routed in or along existing rights-of-way to the extent practicable to minimize land use impacts.

As described in Section 4.1, the impacts of construction on land use are SMALL. Impacts of a new transmission line in the West Macro-Corridor as is discussed in Subsection 9.4.3 are MODERATE based on the area of lands potentially affected. PSEG is not aware of any other large projects that may alter or change the predominant land uses in Salem County or the other

counties crossed by the West Macro-Corridor. Therefore, the incremental impacts from NRC-authorized activities are SMALL, and no further mitigation is warranted.

10.5.1.2 Water Resources

New plant construction results in impacts to both surface water and groundwater resources. Potential effects to surface water resources include the loss of perched artificial ponds within PSEG's desilt basin and the USACE CDF, filling of marsh creek channels to support site development, alteration of the shoreline of the Delaware River for barge facility, heavy haul road and intake structure construction, and dredging within the near-shore Delaware River to support barge facility operations and intake and discharge structures (Subsection 4.3.1).

The cumulative effects analysis on water resources is focused on other projects that may affect the Delaware River and Bay and its associated water resources. A project identified in the vicinity of the PSEG Site that entails disturbance of surface water resources is the USACE Main Channel Deepening Project. The resource potentially affected by both actions is the Delaware River. In their Environmental Assessment and Supplemental Environmental Impact Statement, the USACE has indicated that the project does not have a significant impact on the Delaware River. Water quality impacts at the point of dredging and at the CDFs are minimal (Reference 10.5-1). By comparison, the PSEG Site construction activities affect much smaller areas of the Delaware River and have smaller and more localized impacts on flow patterns and water quality than the USACE project.

The potential new off-site transmission line associated with the West Macro-Corridor crosses the Delaware River, parallel to the existing 500 kV transmission line (Figure 2.2-6). Similarly, the potential off-site transmission line crosses the Susquehanna River parallel to the existing transmission line. It is expected that work in the Delaware and Susquehanna rivers associated with construction of the footings for the transmission towers would employ many of the same BMPs used by PSEG to protect the aquatic ecosystem during construction of the barge and cooling water intake structures (CWIS). The footings for the towers result in some loss of river bottom habitat, but this loss is small compared to the available habitat in the river. Any impacts to water resources associated with the construction of the tower footings in the Delaware and Susquehanna rivers are SMALL.

The West Macro-Corridor crosses several intermittent and perennial streams (Table 9.4-3). The off-site transmission of electricity is anticipated to consist of elevated lines; therefore, impacts occur only within the footprint required for support structures and where access roads are necessary for construction or maintenance. It is anticipated that most support structures are sited in upland areas outside of stream channels, thus avoiding stream impacts. Furthermore, access roads are located to avoid and/or minimize impacts to streams. Construction impacts associated with these potential transmission line crossings are associated with clearing activities and potential runoff and sedimentation. In order to meet regulatory requirements, PSEG has developed procedures and BMPs to protect aquatic communities and prevent degradation of water quality as part of its program to maintain existing transmission corridors. It is expected that similar measures are used by the developer during the construction of any new transmission line in the West Macro-Corridor to meet the mandatory regulatory requirements.

Based on the results of the transmission macro-corridor analysis, the hypothetical rights-of-way of the West Macro-Corridor cross up to 492 ac. of floodplains (Subsection 9.4.3.1.2.8).

However, most floodplains are unaffected by the transmission line except in the limited footprints of transmission towers and any necessary access points.

As described in Section 4.2, the impacts of construction on surface water resources are SMALL. Impacts of a new transmission line in the West Macro-Corridor as is discussed in Subsection 9.4.3 are SMALL based on the surface water resources affected. The minor impacts from the PSEG project in conjunction with the USACE channel deepening project and potential off-site transmission are not expected to result in a greater incremental impact on surface water resources. PSEG is not aware of any other large projects that may alter or change the surface water resources in Salem County or the other counties crossed by the West Macro-Corridor. Therefore, the incremental impacts from NRC-authorized activities are SMALL, and no further mitigation is warranted.

As described in Section 4.2, the impacts of construction on groundwater resources are SMALL. Surface water will be used for construction. PSEG intends to install two additional production wells to facilitate new plant operations. However, there are no other large groundwater users in the vicinity of the PSEG Site. Construction of a new transmission line in the West Macro-Corridor is not expected to impact groundwater. PSEG is not aware of any other large projects that may alter or change the groundwater resources in Salem County or the other counties crossed by the West Macro-Corridor. Therefore, the incremental impacts from NRC-authorized activities are SMALL, and no further mitigation is warranted.

10.5.1.3 Ecological Resources

New plant construction at the PSEG Site impacts 385 ac. (permanent and temporary uses) of upland and wetland habitats on the site (Table 4.3-1). Much of these lands are characterized as low quality, previously disturbed old field habitats that have become naturalized following the construction of the HCGS and SGS plants. These low quality habitats are often dominated by the invasive common reed (*Phragmites australis*). Construction activities affect wetlands that consist of coastal wetlands (105 ac.), unmapped coastal wetlands (34 ac.), and unmapped coastal wetlands within permitted disposal facilities (90 ac. within PSEG's desilt basin and within the USACE CDF) (Table 4.3-3). A total of 9.5 ac. of coastal riparian zones and open water habitat along the shoreline of the Delaware River are affected by new plant development.

The proposed causeway impacts 41 ac. of wetlands, including 21 ac. of permanent impacts primarily due to shading effects and 20 ac. of temporary impacts during construction (Table 4.3-3).

The cumulative effects analysis on aquatic ecosystems and wetlands is focused on other projects that may affect the Delaware River and Bay and its associated water resources. Other projects identified in the vicinity of the PSEG Site that entail disturbance of similar resources include the USACE Main Channel Deepening Project; the habitat restoration at Mad Horse Creek Wildlife Management Area funded as a result of the 2004 *Athos I* oil spill on the Delaware River at Paulsboro, NJ (Section 2.8); and construction of a new transmission line in the West Macro-Corridor.

The channel deepening project affects a stretch of the Delaware Bay and Delaware River extending from the Philadelphia to the mouth of the Delaware Bay. New plant construction impacts on-site water bodies, small marsh creeks, and requires dredging of a 92-ac. area to

support barge facility and intake structure operations (Subsection 4.3.2.3). The effects of these activities on water quality and aquatic biota are localized and not contributory to any cumulative effects on the ecosystem of the Delaware River or Estuary. As indicated previously, the PSEG project is not expected to result in any incremental increases in impacts to ecological resources affected by the USACE project. Therefore, cumulative impacts of the PSEG project on aquatic ecosystems similarly affected by the main channel deepening are SMALL.

Subsection 2.8.2.5 describes the planned restoration activities within the Mad Horse Creek Wildlife Management Area. The proposed Mad Horse Creek restoration restores nearly 200 ac. of the Mad Horse Creek Wildlife Management Area to address injuries to shoreline and bird resources resulting from the 2004 *Athos I* oil spill. NJDEP and the National Oceanic and Atmospheric Administration (NOAA) are proposing a tidal wetland restoration project that allows construction of *Spartina alterniflora* habitat. Restoration is accomplished through fill material removal to lower the marsh elevation and allow tidal inundation. Unavoidable impacts of new plant construction to wetlands on the PSEG Site and within the vicinity is mitigated by habitat restoration and enhancement, as described in Subsection 4.3.1, using proven experience and techniques developed by the PSEG Estuary Enhancement Program. Sensitive species that utilize such marsh habitats (bald eagle-foraging only, northern harrier, osprey) are positively affected by the proposed Mad Horse Creek restoration effort and by the proposed mitigation for the new plant (i.e., restoration of low quality marsh habitats). Consequently, cumulative adverse impacts to sensitive species are not expected.

Construction of a new transmission line in the West Macro-Corridor to the Peach Bottom substation affects 1557 ac. of land over a distance of up to 55 mi. Ecological cover types crossed by the transmission line are influenced by past development patterns and are dominated by agricultural uses (cultivated fields, pastures, etc.), deciduous forests, and estuarine wetland types (Table 9.4-2). Construction of a new transmission line in the West Macro-Corridor to the Peach Bottom substation would also impact up to 289 ac. of wetlands (Table 9.4-4). It is expected that any new transmission line will be routed in or along existing rights-of-way to the extent practicable to minimize land cover impacts.

Table 9.4-3 presents the length of the streams for each of the USGS categories crossed by the hypothetical 200-ft. wide rights-of-way associated with the West Macro-Corridor. There are a total of 970 mi. of streams within the West Macro-Corridor. Based on the adjusted hypothetical rights-of-way, 7.9 mi. of streams are crossed. It is expected that approximately 95 percent of stream channels can be avoided in the location of transmission towers. Crossing of major rivers (Delaware River, Susquehanna River) will require the placement of in-stream structures. Structures placed near the navigation channel will likely require the placement of dikes, bulkheading, rip rap, or other protective structures to guard against collisions with marine vessels.

It is expected that in-stream work in the Delaware River and Susquehanna River associated with construction of the footings for the transmission towers will employ many of the same BMPs used by PSEG to protect the aquatic ecosystem during construction of the barge and CWIS structures. The footings for the towers result in some loss of river bottom habitat, but this loss is small compared to the available habitat in the river. It is expected that ecological protection provisions that minimize potential impacts to aquatic species are developed as part of the route development and permitting process.

As described in Section 4.3, the impacts of construction on ecological resources are SMALL. Impacts of a new transmission line in the West Macro-Corridor as is discussed in Subsection 9.4.3 are MODERATE for wetlands and terrestrial resources. PSEG is not aware of any other large projects that may adversely impact the ecological resources in Salem County or the other counties crossed by the West Macro-Corridor. Therefore, the incremental impacts from NRC-authorized activities are SMALL, and no further mitigation is warranted.

10.5.1.4 Socioeconomic Resources

Existing noise levels on the PSEG Site attenuate to background levels near the site boundary. During new plant construction, site and traffic noise levels increase above those now experienced at PSEG Site, but attenuate to acceptable levels prior to reaching off-site residential receptors. The noise emissions return to levels typical of a power generation facility after construction ceases. No other large construction activities are planned in the vicinity that contribute to noise levels of nearby sensitive resources (e.g., residential receptors). Consequently, cumulative effects associated with noise from construction are SMALL.

New plant construction results in increased air emissions from commuter traffic and the operation of construction equipment. Air emission impacts from construction are SMALL, because emissions are controlled at the sources where practicable, emissions are maintained within established regulatory limits designed to minimize impacts, and the distance between the construction site and the public limits off-site exposures. This is the only large construction project currently planned in the vicinity. Therefore, adverse cumulative impacts to air quality are not expected.

The maximum construction workforce for the new plant is 4100 people. Of these workers, 82 percent are expected to reside in the four-county Region of Influence (Salem County, Cumberland County, and Gloucester County in NJ and New Castle County in DE). This workforce could have short-term SMALL impacts to the housing markets, social services, educational facilities, and community support services (fire and police protection, water/wastewater infrastructure). While some large development projects are planned in the Philadelphia area (Section 2.8) no other construction projects of this magnitude have been identified in the four-county Region of Influence. Consequently, cumulative impacts on the physical or social environment due to other large construction workforces are not expected within the 50-mi. region and the Region of Influence.

Potential adverse impacts are not disproportionately concentrated in such a manner as to impact environmental justice populations within the 50-mi. region or the four-county Region of Influence. Transportation improvements mitigate the potential transportation related impacts to environmental justice populations in Salem County. Based on factors including the isolated location of the construction site, the established adequacy of community infrastructure and public services, effective planning procedures, and sufficient tax revenues generated by the construction-related activity, environmental justice populations within Salem County are not disproportionately affected. No other projects are identified that may affect the same environmental justice populations potentially affected by the new plant. Consequently, cumulative impacts to environmental justice populations are not expected.

Portions of any new transmission line constructed in the West Macro-Corridor may pass through developed areas. Although route selection for any new transmission line attempts to avoid

residential and other developed land to the extent feasible, some developed properties may be purchased along the transmission right-of-way. Because of the proximity of these developed land uses, a higher potential exists for fugitive dust, emissions, and noise impacts during construction. In un-forested areas, noise and emission impacts are minimal and confined to small areas near the towers. By comparison, emissions and noise levels may be greater in areas that require clearing due to the increased use of equipment and the workforce needed to clear wooded areas, remove woody debris, and grade the cleared areas. It is expected that appropriate construction management practices are employed to reduce noise and emissions in these areas. Any increases in fugitive dust, emissions, and noise are short-term, and impacts to the public are SMALL.

Transmission line construction is also expected to result in employment of a construction workforce over a prolonged period. However, most of these workers are expected to reside in the region surrounding the PSEG Site. Given the large resident workforce available within the region (Table 2.5-21), impacts from this workforce on housing markets, social services, educational facilities, and community support services (fire and police protection, water/wastewater infrastructure) are SMALL. Additionally, potential adverse impacts are not disproportionately concentrated in such a manner as to impact environmental justice populations within the region or areas along the West Macro-Corridor. Figures 2.5-10 to 2.5-16 indicated that few, if any, environmental justice populations are located in the area potentially crossed by the West Macro-Corridor. Therefore, cumulative impacts to environmental justice populations are SMALL.

As described in Section 4.5, the impacts of construction on socioeconomic resource are SMALL. Impacts of a new transmission line in the West Macro-Corridor are also SMALL. PSEG is not aware of any other large projects that may have an adverse impact on socioeconomic resources in Salem County or the other counties crossed by the West Macro-Corridor. Therefore, the incremental impacts from NRC-authorized activities are SMALL, and no further mitigation is warranted.

10.5.2 CUMULATIVE IMPACTS OF OPERATIONS

This subsection discusses the potential cumulative impacts of PSEG Site operation activities (including the proposed causeway) and the operation impacts of other major projects in the region. Impacts associated with operation of the new plant are summarized in tabular form in Section 5.10. However, the potential transmission impacts for the South Macro-Corridor, as summarized in Section 5.10, are not assessed in this subsection. Instead, the potential impacts of a transmission line constructed in the West Macro-Corridor are assessed since the line is considered representative of the regional transmission project currently being pursued by PJM independent of nuclear development at the PSEG Site.

Cumulative impacts to land use, ecological resources, water resources, the socioeconomic environment, and human health are discussed. The geographic context for each analysis is similar to that given in the previous subsection.

10.5.2.1 Land Use

Anticipated impacts to land use from new plant operation result from the deposition of solids from cooling tower operation, periodic maintenance activities of the cooling water intake

structure (desilting of the intake bays, and potentially limited dredging of the intake area to maintain depth), and periodic maintenance of the PSEG Site grounds. Each of these activities is predominantly confined to the PSEG Site and its immediate environs.

Operational activities in the vicinity of the PSEG Site are associated with maintenance of the proposed causeway and potential off-site transmission line (vicinity and region). PSEG's control and management of existing transmission rights-of-way preclude construction of residential and industrial features on the transmission corridors. It is expected that similar controls are in place restricting land use along developed portions of the West Macro-Corridor. However, as is described in Subsection 5.1.2, it is expected that the developer of any new transmission line acquires 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 rights-of-way is managed. Land use in the rights-of-way and underneath the high-voltage lines is compatible with the reliable transmission of electricity. Vegetation communities in the rights-of-way are kept at an early successional stage. Allowable activities within the rights-of-way are variable, but may include farming for feed (hay, wheat, corn) for livestock or grazing.

As described in Section 5.1, the impacts of operation on land use are SMALL. Impacts of the operation of a new transmission line in the West Macro-Corridor are SMALL. PSEG is not aware of any other large projects that may alter or change the predominant land uses in Salem County or the other counties crossed by the West Macro-Corridor. Therefore, the incremental impacts from NRC-authorized activities are SMALL, and no further mitigation is warranted.

PSEG also considered the potential for cumulative visual impacts due to cooling tower operation. As described in Subsection 5.1.3, the new plant cooling tower is predicted to be visible at a number of sites within the 10-mi. radius that are listed on the National Register of Historic Places. However, 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 minimize the cumulative impact of the view of the new cooling towers on the viewshed of historic properties. A new transmission line in the West Macro-Corridor is expected to be located along existing rights-of-way, and visual impacts are SMALL. PSEG is not aware of any other large projects that may alter or change the viewshed in Salem County or the other counties crossed by the West Macro-Corridor. Therefore, the incremental impacts from NRC-authorized activities are SMALL, and no further mitigation is warranted.

Non-radioactive solid wastes from new plant operation are disposed in permitted landfills. The volume of additional wastes is minimized through waste minimization programs in a manner similar to that at the existing SGS and HCGS. Landfill capacity required by the new plant is small relative to the regional residential and industrial demand. Consequently, cumulative impacts of waste disposal on off-site land use are SMALL.

10.5.2.2 Water Resources

The new plant uses groundwater for some operational systems. The average withdrawal rate for the existing units, combined with the new plant operations slightly exceeds the current site permitted annual withdrawal rate. No other significant current or future users of groundwater in the vicinity of the PSEG Site have been identified. Therefore, cumulative impacts to groundwater during operation are SMALL.

Operational activities that could impact surface water such as NJPDES permitted discharges are SMALL. Based on computer modeling, blowdown from the new plant cooling towers produces a thermal plume (1.5 degrees Fahrenheit [°F])) that extends up to 300 to 500 ft. downstream and upstream, and has a width of 450 ft. (Subsection 5.2.3). The plume is not large enough to affect the water quality or biota of the river. The new plant discharge is located north of the existing HCGS and SGS discharges and produces a plume that merges with those of the existing plants. As described in Subsection 5.2.3.1.2, the new plant plume is contained within SGS's thermal plume, such that the combined temperatures from the new plant and the existing SGS and HCGS thermal plumes are less than the maximum temperature elsewhere in the SGS thermal plume. Consequently, cumulative thermal impacts of new plant operation are SMALL.

The new plant cooling system withdraws make up water from the Delaware River. PSEG has an allocation of 6695 acre-feet of storage in the Merrill Creek Reservoir that is available to offset freshwater consumptive use during periods of declared drought. The total consumptive losses are 0.01 percent of the tidal flows at the PSEG Site (Subsection 5.2.2.1). No other significant current or future users of surface water in the vicinity of the PSEG Site have been identified. Consequently, the cumulative impacts of water withdrawal on the Delaware River are SMALL.

As described in Section 5.2, the impacts of operation to water resources are SMALL. PSEG is not aware of any other large projects that may alter or change the water use and quality in Salem County or the other counties crossed by the West Macro-Corridor. Therefore, the incremental impacts from NRC-authorized activities are SMALL, and no further mitigation is warranted.

10.5.2.3 Ecological Resources

Potential cumulative operational impacts of the new plant relate to the operation and maintenance of off-site transmission lines and the impingement and entrainment of aquatic biota from cooling water system (CWS) operation. Potential cumulative impacts from transmission operation include those associated with the operation of the existing HCGS and SGS transmission lines and those associated with a potential new transmission line in the West Macro-Corridor that is representative of the regional transmission upgrade project currently being pursued by PJM. Potential impacts include the potential for electrocution or physical collision. As discussed in Subsection 5.6.1, appropriate measures are included in transmission line designs to reduce avian power line interaction such that these effects are minimized. PSEG uses BMPs on vegetation within existing transmission corridors and works in consultation with resource agencies to minimize potential effects to sensitive species. Similarly, the developer of any new line in the West Macro-Corridor is expected to consult with agencies and use BMPs to minimize the effects to sensitive species.

The new plant CWS is designed as a closed-cycle system consisting of an intake structure that withdraws a small volume of water from the Delaware River, at a through-screen velocity of less than 0.5 ft/sec. As such, the design of the CWS is considered Best Technology Available under the Phase I Clean Water Act 316(b) regulations. As described in Subsection 5.3.1.2, estimated impingement mortality and entrainment rates result in the loss of a relatively 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. Regarding the potential impacts from intake operation on aquatic biota, species richness and diversity levels of the fish community in the vicinity of SGS and HCGS are documented in PSEG's NJPDES

permit renewal filings as high as, or higher than, they were in the 1970's. Species lists from preoperational studies and current studies are similar, and most of the important species' populations have either remained stable or varied due to regional or coast-wide environmental factors. The on-going HCGS and SGS operation does not result in an impact to the aquatic community that destabilizes resident populations.

As described in Section 5.3, the impacts of operation on ecological resources are SMALL. Impacts of the operation of a new transmission line in the West Macro-Corridor as is discussed in Subsection 9.4.3 are SMALL. PSEG is not aware of any other large projects that may adversely impact ecological resources in Salem County or the other counties crossed by the West Macro-Corridor. Therefore, the incremental impacts from NRC-authorized activities are SMALL, and no further mitigation is warranted.

10.5.2.4 Socioeconomic Resources

PSEG has not determined the cooling tower configuration for the new plant. In terms of visual impact, the bounding condition assumes the operation of two natural draft cooling towers that are slightly taller in size and similar in configuration to the HCGS tower. The three cooling towers are visually grouped together so the aesthetics and visual impact is only slightly different from that which currently exists.

It is expected that any new transmission line in the West Macro-Corridor is located parallel to existing transmission lines to the extent practicable, and in accordance with established industry practices and procedures that take into consideration environmental and visual impacts. As is described in Subsection 5.6.3.5, natural vegetation normally is retained at transmission line road crossings to help minimize ground-level visual impacts, where possible. Contractors performing routine vegetation control on 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 any new transmission line are expected to be SMALL. PSEG is not aware of any other large projects that may alter or change the predominant viewshed in Salem County or the other counties crossed by the West Macro-Corridor. Therefore, cumulative impacts on the viewscape are SMALL.

Cooling tower operation results in localized effects such as ground level fogging, shadowing from the cooling tower and associated plume, and salt deposition on surrounding terrestrial ecosystems. Aside from the existing cooling tower at the HCGS site, there are no other cooling towers located nearby that could contribute to these effects. Because of the distances between the existing HCGS cooling tower and the new plant cooling towers (more than 2000 ft.) the localized effects of cooling tower operation (i.e., less than 1000 ft.) and the salt-tolerance of the adjacent plant communities, the cumulative impacts of cooling tower operation are SMALL.

Air quality impacts do not result from the reactors, but from support equipment and cooling towers. Emissions of criteria pollutants from the new plant are from the emergency diesel generators and/or combustion turbines and the auxiliary boiler(s). The region surrounding the PSEG Site has several large industrial facilities with permitted releases to the air. Areas having air quality as good as, or better than, the NAAQS are designated as attainment areas. Areas having air quality that is worse than the NAAQS are designated as non-attainment areas. Salem County is next to (but not included in) the Philadelphia-Wilmington $PM_{2.5}$ non-attainment area

and is located in the Philadelphia-Wilmington-Atlantic City 8-hr. ozone non-attainment area. Based on modeling results, NO_x impacts are in compliance with the NAAQS and PSD increment. However, predicted SO_2 and $PM_{10}/PM_{2.5}$ concentrations indicate that a modeling analysis must be conducted during the PSD permitting phase that includes background concentrations and other sources to demonstrate compliance with the NAAQS and PSD increments. After a reactor technology is selected and detailed design is completed for the cooling towers, emergency power equipment and auxiliary boiler equipment, PSEG will consult with NJDEP and perform more detailed multi-source modeling. Applicable emissions rates in effect at the time will be used in detailed equipment design and specification, along with identification of the appropriate engineering and operational controls. The modeling will demonstrate that the new plant will be in compliance with the NAAQS/NJAAQS and ensure that the cumulative impacts to air quality are SMALL.

Noise from the existing HCGS and SGS is typically indistinguishable from background at the site boundary, and the new plant generates similar levels of noise (primarily associated with cooling tower and intake structure operation). Additional traffic generated noise occurs on the regional roadway network. No other sources of industrial noise occur in the vicinity of the PSEG Site such that the new plant operation results in a cumulatively greater impact on noise pollution. 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. However, as described in Subsection 5.6.3.3, transmission line noise typically meets regulatory limits at the edge of the right-of-way. No audible noise issues are expected from any new transmission line in the West Macro-Corridor, and noise impacts are expected to be SMALL. Therefore, cumulative impacts from operations-related noise are SMALL.

Socioeconomic impacts, including increased tax revenues to Salem County, are cumulative with socioeconomic changes brought about through the operation of the existing HCGS and SGS plants, and changes due to normal population growth. 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 the 50-mi. region. Some of these employees, as well as most new workers from outside the 50-mi. region, are expected to relocate to localities within the Region of Influence that provide convenient access to the new PSEG plant. Taxes resulting from the new plant operation (direct payment of corporate taxes and indirect contribution of payroll taxes) are beneficial and offset the additional demands on local community services (education, police, fire protection, water and wastewater, etc.) within the four-county Region of Influence. No other projects that involve in-migration of a large workforce have been identified in the area. Cumulative socioeconomic impacts are therefore SMALL.

As described in Section 5.8, the impacts of operation to socioeconomic resources are SMALL. PSEG is not aware of any other large projects that may alter or change socioeconomic resources in Salem County or the other counties crossed by the West Macro-Corridor. Therefore, the incremental impacts from NRC-authorized activities are SMALL, and no further mitigation is warranted.

10.5.2.5 Human Health

The new plant releases small quantities of radionuclides to the environment. Gaseous effluent activity releases and liquid effluent activity releases are given in Tables 5.4-1 and 5.4-2

respectively. Values for gaseous effluent releases and liquid effluent releases from the new plant are taken from SSAR Tables 1.3-7, and 1.3-8 respectively. These values are multiplied by two to account for the possibility of dual units.

It should be noted that the doses from the new plant are higher than from the existing HCGS and SGS units because doses from the existing units are based on actual site measurements, compared to the conservatively calculated, theoretical doses from the new plant. 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). This combines to a total of 309 person-rem. The maximum annual occupational dose from the new plant in combination with that from the existing SGS and HCGS at the PSEG Site is less than the 40 CFR 190 criteria (Table 5.4-10). Overall, the cumulative impacts to workers from occupational radiation doses are SMALL.

The fuel cycle specific to a new plant at the PSEG Site contributes to the cumulative impacts of fuel production, storage and disposal for all nuclear units in the United States. The cumulative impacts of the fuel cycle for the existing reactors are SMALL and the impacts from the addition of two new units do not change that conclusion. Fuel and waste transportation impacts from two new units are SMALL, and do not significantly increase the cumulative impacts of transportation of nuclear reactor fuel and wastes.

As described in Sections 5.4, 5.6, and 5.7, the impacts of radiation and the uranium fuel cycle as a result of operations are SMALL. PSEG is not aware of any other large projects that may adversely affect human health in Salem County or the other counties crossed by the West Macro-Corridor. Therefore, the incremental impacts from NRC-authorized activities are SMALL, and no further mitigation is warranted.

10.5.3 CONCLUSION

In conclusion, the impacts from the new plant construction and operation at the PSEG Site do not contribute significantly to existing or future cumulative impacts to the vicinity or the region.

10.5.4 REFERENCES

10.5-1 U.S. Army Corps of Engineers, *Delaware River Main Stem and Channel Deepening Project*, *Environmental Assessment.* Philadelphia, PA., 2009.