ENVIRONMENTAL REPORT

CHAPTER 7

IMPACTS OF POSTULATED ACCIDENTS INVOLVING RADIOACTIVE MATERIALS

7.0 IMPACTS OF POSTULATED ACCIDENTS INVOLVING RADIOACTIVE MATERIALS

7.1 DESIGN BASIS ACCIDENTS

Design basis accidents (DBAs) are events that are not expected to occur, but are evaluated to demonstrate the adequacy of the plant design since the consequences of their occurrence have the potential for radioactive material to be released to the environment. DBAs having a potential for radiological releases to the environment are identified in Section 7.1, Appendix A of NUREG-1555 (NRC, 1999) and are listed in Table 7.1-1 along with DBAs applicable for the U.S. EPR. The DBAs are based on Chapter 15 of NUREG-0800 (NRC, 2007) and Regulatory Guide 1.183 (NRC, 2000).

Sources of radioactivity are generated within the reactor core. Radioactivity releases are dependent on the specific accident and may be released from the primary coolant, from the secondary coolant, and from the core if the accident involves fuel failures. Design input used in the DBA radiological consequences evaluations for the U.S. EPR follows the Alternative Source Term Methodology outlined in Regulatory Guide 1.183 (NRC, 2000). The design basis primary and secondary coolant source term activity concentrations for the U.S. EPR are provided in Table 7.1-2 and Table 7.1-3, respectively. Table 7.1-4 lists the design basis source term inventories for the core.

Primary and secondary coolant concentrations are based on the proposed U.S. EPR Technical Specification limits for halogens and noble gases, the American National Standards Institute/ American Nuclear Society (ANSI/ANS)-18.1 Standard (ANS, 1999) for activation products and tritium, and 0.25% fuel defects for remaining radionuclides. For certain accidents (i.e., Steam System Piping Failures and Steam Generator Tube Rupture), the radiological consequences analyses account for iodine spiking which causes the concentration of various radioactive iodines in the primary coolant to significantly increase to levels described in Table 7.1-2. The iodine appearance rates (i.e., rates at which iodine isotopes are transferred from the core to the primary coolant via assumed fuel cladding defects and accumulate within the coolant) used in DBA analyses for the U.S. EPR were based on a conservative Reactor Coolant System letdown purification flow rate. Referring to Table 7.1-3, no secondary coolant noble gas source term is applicable since noble gas leakage from the Reactor Coolant System is assumed to enter the steam phase directly. Design basis core source terms were determined for a power level of 4,612 MWt, which is equivalent to the rated core thermal power of 4,590 MWt plus 22 MWt (approximately 1/2% of rated thermal power) to account for heat balance measurement uncertainty. Core inventories are bounding for U-235 fuel enrichments ranging between two and five percent and burnups up to 62,000 MWd/MTU.

For each of the accident scenarios listed in Table 7.1-1, it is postulated that some quantity of radioactivity is released at the accident location inside a plant building and eventually released into the environment. Radiological consequences of these accidents depend on the type and amount of radioactivity released and meteorological conditions. Potential consequences are assessed to demonstrate that environmental impacts, quantified in doses to individuals at the exclusion area boundary (EAB) distance of 0.5 mi (0.8 km) and the low population zone (LPZ) distance of 1.5 mi (2.4km), meet regulatory dose acceptance criteria.

The accident doses are expressed as total effective dose equivalent (TEDE). For each applicable DBA, TEDE/accident doses are calculated based on time-dependent activities released to the environment. Dose receptor variables include the exposure interval, the atmospheric dispersion of the activity during transport from the release point to the EAB and LPZ, the breathing rate of an individual at the EAB and LPZ, and dose conversion factors for the inhalation and external exposure pathways. In accordance with Section C.4.1.5 of Regulatory Guide 1.183 (NRC, 2000), the period of most adverse release of radioactive materials to the environment was assumed to occur coincident with the period of most unfavorable atmospheric dispersion. Except for atmospheric dispersion, the other variables are independent of the Calvert Cliffs Nuclear Power Plant (CCNPP) site and specific to the U.S. EPR design.

CCNPP site-specific atmospheric dispersion characteristics are provided in Section 2.7. CCNP site-specific atmospheric dispersion factors (X /Qs) are provided in ER Section 2.7. The 50th percentileX /Q values for CCNPP were based on meteorological data collected onsite over a 7 year period (2000 to 2006) and are shown in Table 7.1-5. For the EAB, the postulated DBA doses and X/Q values are calculated for a 2-hr interval. For the LPZ, doses and X/Q values are calculated for the accident duration (up to 30 days).

For the DBAs applicable to the U.S. EPR, the time-dependent releases to the atmosphere are presented in Table 7.1-14 through Table 7.1-23. The time-dependent postulated TEDE doses at the CCNPP EAB and LPZ are provided in Table 7.1-6 to Table 7.1-12, and an overall summary is presented in Table 7.1-13. It is seen that all doses are below the dose acceptance criteria.

7.1.1 References

ANS, 1999. Radioactive Source Term for Normal Operation for Light Water Reactors, ANSI/ ANS-18.1, American National Standards Institute/American Nuclear Society, 1999.

NRC, 1999 Environmental Standard Review Plan, NUREG-1555, Nuclear Regulatory Commission, October 1999.

NRC, 2000. Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors, Regulatory Guide 1.183, Nuclear Regulatory Commission, July 2000.

NRC, 2007. Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants, NUREG-0800, Nuclear Regulatory Commission, March 2007.

Table 7.1-1— Design Basis Accidents
(Page 1 of 2)

NUREG-1555 DBA Description	U.S. EPR DBA Description	Remarks
Radiological Consequences of Main Steam Line Failures Outside Containment of a PWR	Steam System Piping Failures	Following the guidance provided in Section 15.0.3 of NUREG-0800 and Regulatory Guide 1.183, the limiting accident for the U.S. EPR was determined to be a double-ended guillotine break of a main steam line in one of the Safeguards Buildings.
Feedwater System Pipe Breaks Inside and Outside Containment (PWR)	Not applicable	For the U.S. EPR, the consequences of the steam system piping failures were determined to bound those for the feedwater system system line breaks.
Reactor Coolant Pump Rotor Seizure	Reactor Coolant Pump Locked Rotor Accident	For the U.S. EPR, this postulated accident scenario is based on Section 15.0.3 of NUREG-0800 and the Alternate Source Term Methodology in Appendix G of Regulatory Guide 1.183.
Reactor Coolant Pump Shaft Break	Reactor Coolant Pump Shaft Break	This postulated accident scenario is based on Section 15.3.3 of NUREG-0800. U.S EPR radiological consequences are the same as those for the locked rotor accident.
Radiological Consequences of Control Rod Drop Accident (BWR)	Not Applicable	The U.S. EPR is a pressurized water reactor.
Radiological Consequences of the Failure of Small Lines Carrying Primary Coolant Outside Containment	Failure of Small Lines Carrying Primary Coolant Outside Containment	Based on the guidance in Section 15.6.2 of NUREG-0800, the limiting accident scenario for the U.S. EPR was determined to be a double-ended guillotine break in the Fuel Building.
Radiological Consequences of Steam Generator Tube Failures (PWR)	Steam Generator Tube Rupture	The analysis was based on guidance in Section 15.0.3 of NUREG-0800 and in Regulatory Guide 1.183 and incorporated the clarifications provided in NRC Regulatory Issue Summary 2006-04, Section 9, namely, the inclusion of the alkalis (in addition to the halogens and noble gases). Two alternative accident scenarios were postulated: A Steam Generator Tube Rupture (SGTR) with a pre-accident iodine spike and a SGTR with a concurrent iodine spike.
Radiological Consequences of a Design Basis Loss of Coolant Accident Including Containment Leakage Contribution	Loss of Coolant Accidents resulting from a Spectrum of Postulated Piping Breaks within the Reactor Coolant Pressure Boundary	For the U.S. EPR, a STARDOSE analysis was performed to determine the EAB and LPZ cloud immersion and inhalation doses at the EAB and LPZ for Loss of Coolant Accidents using the Alternate Source Term Methodology.
Radiological Consequences of a Design Basis Loss of Coolant Accident: Leakage from Engineered Safety Feature Components Outside Containment	Loss of Coolant Accidents resulting from a Spectrum of Postulated Piping Breaks within the Reactor Coolant Pressure Boundary	For the U.S. EPR, a STARDOSE analysis was performed to determine the EAB and LPZ cloud immersion and inhalation doses at the EAB and LPZ for Loss of Coolant Accidents using the Alternate Source Term Methodology.

Table 7.1-1— Design Basis Accidents
(Page 2 of 2)

NUREG-1555 DBA Description	U.S. EPR DBA Description	Remarks
Radiological Consequences of a Design Basis Loss of Coolant Accident: Leakage from Main Steam Isolation Valve Leakage Control System (BWR)	Not Applicable	The U.S. EPR is a pressurized water reactor.
Radiological Consequences of Fuel Handling Accidents	Fuel Handling Accident	The postulated accident scenario followed the guidance in Section 15.0.3 of NUREG-0800 and in Regulatory Guide 1.183, and was postulated to occur in either an open Containment or in the Fuel Building.
Not Applicable	Rod Ejection Accident	The analysis was based on the guidance in Section 15.0.3 of NUREG-0800 and in Regulatory Guide 1.183. The recent NRC concern regarding the fission-product gap inventory for reactivity-induced accidents and the interim acceptance criteria and guidance, were also considered.

Table 7.1-2— U.S. EPR Design Basis Primary Coolant Activity

(Page 1 of 2)

Radionuclide	Activity µCi/gm (Bq/gm)	Radionuclide	Activity µCi/gm (Bq/gm)
Noble Gases			
Kr-83m	1.28E-01 (4.74E+03)	Kr-85m	5.71E-01 (2.11E+04)
Kr-85	5.31E+00 (1.96E+05)	Kr-87	3.26E-01 (1.21E+04)
Kr-88	1.03 E+00 (3.81E+04)	Kr-89	2.42E-02 (8.95E+02)
Xe-131m	1.08E+00 (4.00E+04)	Xe-133m	1.35E+00 (5.00E+04)
Xe-133	9.47E+01 (3.50E+06)	Xe-135m	1.95E-01 (7.22E+03)
Xe-135	3.40E+00 (1.26E+05)	Xe-137	4.57E-02 (1.69E+03)
Xe-138	1.64E-01 (6.07E+03)		
Halogens			
Br-83	3.16E-02 (1.17E+03)	Br-84	1.67E-02 (6.18E+02)
Br-85	2.01E-03 (7.44E+01)	I-129	4.59E-08 (1.70E-03)
I-130	4.97E-02 (1.84E+03)	I-131	7.43E-01 (2.75E+04)
I-132	3.71E-01 (1.37E+04)	I-133	1.25E+00 (4.63E+04)
I-134	2.40E-01 (8.88E+03)	I-135	7.90E-01 (2.92E+04)
Alkalis			
Rb-86m	5.32E-07 (1.97E-02)	Rb-86	3.66E-03 (1.35E+02)
Rb-88	1.02E+00 (3.77E+04)	Rb-89	4.72E-02 (1.75E+03)
Cs-134	4.18E-01 (1.55E+04)	Cs-136	1.00E-01 (3.70E+03)
Cs-137	1.60E-01 (5.92E+03)	Cs-138	2.35E-01 (8.07E+03)
Tellurium Group			
Sb-125	1.56E-06 (5.77E-02)	Sb-127	6.99E-06 (2.59E-01)
Sb-129	8.53E-06 (3.16E-01)	Te-127m	6.19E-04 (2.29E+01)
Te-127	3.05E-03 (1.13E+02)	Te-129m	1.79E-03 (6.62E+01)
Te-129	3.00E-03 (1.11E+02)	Te-131m	4.36E-03 (1.61E+02)
Te-131	3.01E-03 (1.11E+02)	Te-132	4.70E-02 (1.74E+03)
Te-134	6.80E-03 (2.52E+02)		
Barium/Strontium Group			
Sr-89	6.35E-04 (2.35E+01)	Sr-90	4.32E-05 (1.60E+00)
Sr-91	1.02E-03 (3.77E+01)	Sr-92	1.73E-04 (6.40E+00)
Ba-137m	1.50E-01 (5.55E+03)	Ba-139	2.30E-02 (8.51E+02)
Ba-140	6.74E-04 (2.49E+01)		
Noble Metals			
Mo-99	1.21E-01 (4.48E+03)	Tc-99m	5.24E-02 (1.94E+03)
Ru-103	1.00E-04 (3.70E+00)	Ru-105	1.47E-04 (5.44E+00)
Ru-106	5.83E-05 (2.16E+00)	Rh-103m	8.85E-05 (3.27E+00)
Rh-105	6.62E-05 (2.45E+00)	Rh-106	5.84E-05 (2.16E+00)
Cerium Group			
Ce-141	9.12E-05 (3.37E+00)	Ce-143	7.96E-05 (2.95E+00)
Ce-144	6.93E-05 (2.56E+00)	Pu-238	5.97E-07 (2.21E-02)

Table 7.1-2— U.S. EPR Design Basis Primary Coolant Activity
(Page 2 of 2)

Radionuclide	Activity µCi/gm (Bq/gm)	Radionuclide	Activity µCi/gm (Bq/gm)
Pu-239	2.51E-08 (9.29E-04)	Pu-240	5.72E-08 (2.12E-03)
Pu-241	1.03E-05 (3.81E-01)	Np-239	1.41E-03 (5.22E+01)
Lanthanides			
Y-90	1.03E-05 (3.81E-01)	Y-91m	5.23E-04 (1.94E+01)
Y-91	8.10E-05 (3.00E+00)	Y-92	1.41E-04 (5.22E+00)
Y-93	6.50E-05 (2.41E+00)	Zr-95	9.31E-05 (3.44E+00)
Zr-97	7.37E-05 (2.73E+00)	Nb-95	9.35E-05 (3.46E+00)
Ag-110m	9.87E-07 (3.65E+00)	Ag-110	4.72E-08 (1.75E-03)
La-140	1.76E-04 (6.51E+00)	La-141	5.77E-05 (2.13E+00)
La-142	3.38E-05 (1.25E+00)	Pr-143	9.20E-05 (3.40E+00)
Pr-144	6.94E-05 (2.57E+00)	Nd-147	3.77E-05 (1.39E+00)
Am-241	1.18E-08 (4.37E-04)	Cm--242	5.35E-06 (1.98E-01)
Cm--244	2.83E-06 (1.05E-01)		
Activation Products			
Na-24	3.7E-02 (1.37E+03)	Cr-51	2.0E-03 (7.40E+01)
Mn-54	1.0E-03 (3.70E+01)	Fe-55	7.6E-04 (2.81E+01)
Fe-59	1.9E-04 (7.03E+00)	Co-58	2.9E-03 (1.07E+02)
Co-60	3.4E-04 (1.26E+01)	Zn-65	3.2E-04 (1.18E+01)
W-187	1.8E-03 (6.66E+01)		
Tritium			
H-3	1.0E+00 (3.70E+04)		

Key:

µCi/gm - microcuries per gram
Bq/gm - Becquerels per gram

Notes:

a. This table lists the design basis source term activity and the magnitude of source terms for offsite releases for the U.S. EPR primary coolant.

b. Following an accident, iodine spiking causes the concentration of radioactive iodines I-131 through I-135 to significantly increase.

Table 7.1-3— U.S. EPR Design Basis Secondary Coolant Activity
(Page 1 of 2)

Radionuclide	Activity µCi/gm (Bq/gm)	Radionuclide	Activity µCi/gm (Bq/gm)
Halogens			
Br-83	1.61E-03 (5.96E+01)	Br-84	3.05E-04 (1.13E+01)
Br-85	3.93E-06 (1.45E-01)	I-129	4.81E-09 (1.78E-04)
I-130	4.33E-03 (1.60E+02)	I-131	7.67E-02 (2.84E+03)
I-132	2.27E-02 (8.40E+02)	I-133	1.17E-01 (4.33E+03)
I-134	6.68E-03 (2.47E+02)	I-135	5.99E-02 (2.22E+03)
Alkalis			
Rb-86m	3.99E-12 (1.48E-07)	Rb-86	7.27E-06 (2.69E-01)
Rb-88	1.26E-04 (4.66E+00)	Rb-89	5.02E-06 (1.86E-01)
Cs-134	8.38E-04 (3.10E+01)	Cs-136	1.98E-04 (7.33E+00)
Cs-137	3.21E-04 (1.19E+01)	Cs-138	5.00E-05 (1.85E+00)
Tellurium Group			
Sb-125	1.74E-09 (6.44E-05)	Sb-127	7.60E-09 (2.81E-04)
Sb-129	6.01E-09 (2.22E-04)	Te-127m	6.89E-07 (2.55E-02)
Te-127	2.82E-06 (1.04E-01)	Te-129m	1.99E-06 (7.36E-02)
Te-129	1.94E-06 (7.18E-02)	Te-131m	4.48E-06 (1.66E-01)
Te-131	1.33E-06 (4.92E-02)	Te-132	5.07E-05 (1.88E+00)
Te-134	1.64E-06 (6.07E+00)		
Barium/Strontium Group			
Sr-89	7.16E-07 (2.64E-02)	Sr-90	4.81E-08 (1.78E-03)
Sr-91	9.01E-07 (3.33E-02)	Sr-92	1.00E-07 (3.70E-03)
Ba-137m	3.01E-04 (1.11E+01)	Ba-139	1.03E-05 (3.81E-01)
Ba-140	7.45E-07 (2.76E-02)		
Noble Metals			
Mo-99	1.30E-04 (4.81E+00)	Tc-99m	7.47E-05 (2.76E+00)
Ru-103	1.11E-07 (4.11E-03)	Ru-105	1.09E-07 (4.03E-03)
Ru-106	6.49E-08 (2.40E-03)	Rh-103m	9.97E-08 (3.69E-03)
Rh-105	7.58E-08 (2.80E-03)	Rh-106	6.49E-08 (2.40E-03)
Cerium Group			
Ce-141	1.01E-07 (3.74E-03)	Ce-143	8.24E-08 (3.05E-03)
Ce-144	7.72E-08 (2.86E-03)	Pu-238	6.65E-10 (2.46E-05)
Pu-239	2.80E-11 (1.04E-06)	Pu-240	6.37E-11 (2.36E-06)
Pu-241	1.15E-08 (4.26E-04)	Np-239	1.50E-06 (5.55E-02)
Lanthanides			
Y-90	1.29E-08 (4.77E-04)	Y-91m	5.38E-07 (1.99E-02)
Y-91	9.17E-08 (3.39E-03)	Y-92	1.33E-07 (4.92E-03)
Y-93	5.81E-08 (2.15E-03)	Zr-95	1.04E-07 (3.85E-03)
Zr-97	7.15E-08 (2.65E-03)	Nb-95	1.04E-07 (3.85E-03)
Ag-110m	1.10E-09 (4.07E-05)	Ag-110	1.47E-11 (5.44E-07)

Table 7.1-3— U.S. EPR Design Basis Secondary Coolant Activity
(Page 2 of 2)

Radionuclide	Activity µCi/gm (Bq/gm)	Radionuclide	Activity µCi/gm (Bq/gm)
La-140	2.28E-07 (8.44E-03)	La-141	4.06E-08 (1.50E-03)
La-142	1.51E-08 (5.59E-04)	Pr-143	1.02E-07 (3.77E-03)
Pr-144	7.72E-08 (2.86E-03)	Nd-147	4.16E-08 (1.54E-03)
Am-241	1.32E-11 (4.88E-07)	Cm-242	5.96E-09 (2.21E-04)
Cm-244	3.15E-09 (1.17E-04)		
Activation Products			
Na-24	3.53E-05 (1.31E+00)	Cr-51	2.22E-06 (8.21E-02)
Mn-54	1.11E-06 (4.11E-02)	Fe-55	8.47E-07 (3.13E-02)
Fe-59	2.11E-07 (7.81E-03)	Co-58	3.23E-06 (1.20E-01)
Co-60	3.79E-07 (1.40E-02)	Zn-65	3.56E-07 (1.32E-02)
W-187	1.81E-06 (6.70E-02)		
Tritium			
H-3	1.0E-03 (3.70E+01)		

Key:
µCi/gm - microcuries per gram
Bq/gm - Becquerels per gram
Notes:
a This table lists the design basis source term activity and the magnitude of source terms for offsite releases for the U.S. EPR secondary coolant.
b Noble gases are not applicable since they are assumed to enter the steam phase.

Table 7.1-4— U.S. EPR Bounding Core Inventory [a,b,c]

(Page 1 of 2)

Radionuclide	Inventory Ci (Bq)	Radionuclide	Inventory Ci (Bq)
Noble Gases			
Kr-83m	1.96E+07 (7.25E+17)	Kr-85m	4.50E+07 (1.67E+18)
Kr-85	2.10E+06 (7.77E+16)	Kr-87	9.02E+07 (3.34E+18)
Kr-88	1.28E+08 (4.74E+18)	Kr-89	1.61E+08 (5.96E+18)
Xe-131m	1.54E+06 (5.70E+16)	Xe-133m	8.92E+06 (3.30E+17)
Xe-133	2.89E+08 (1.07E+19)	Xe-135m	5.49E+07 (2.03E+18)
Xe-135	9.26E+07 (3.43E+18)	Xe-137	2.52E+08 (9.32E+18)
Xe-138	2.45E+08 (9.07E+18)		
Halogens			
Br-83	1.96E+07 (7.25E+17)	Br-84	3.62E+07 (1.34E+18)
Br-85	4.45E+07 (1.65E+18)	I-129	8.33E+00 (3.08E+11)
I-130	1.32E+07 (4.88E+17)	I-131	1.39E+08 (5.14E+18)
I-132	2.01E+08 (7.44E+18)	I-133	2.90E+08 (1.07E+19)
I-134	3.18E+08 (1.18E+19)	I-135	2.69E+08 (9.95E+18)
Alkalis			
Rb-86m	5.53E+04 (2.05E+15)	Rb-86	5.80E+05 (2.15E+16)
Rb-88	1.29E+08 (4.77E+18)	Rb-89	1.67E+08 (6.18E+18)
Cs-134	6.48E+07 (2.40E+18)	Cs-136	1.61E+07 (5.96E+17)
Cs-137	2.47E+07 (9.14E+17)	Cs-138	2.69E+08 (9.95E+18)
Tellurium Group			
Sb-125	3.83E+06 (1.42E+17)	Sb-127	1.80E+07 (6.66E+17)
Sb-129	4.85E+07 (1.79E+18)	Te-127m	2.43E+06 (8.99E+16)
Te-127	1.79E+07 (6.62E+17)	Te-129m	7.08E+06 (2.62E+17)
Te-129	4.78E+07 (1.77E+18)	Te-131m	2.04E+07 (7.55E+17)
Te-131	1.24E+08 (4.59E+18)	Te-132	1.98E+08 (7.33E+18)
Te-134	2.50E+08 (9.25E+18)		
Barium/Strontium Group			
Sr-89	1.61E+08 (5.96E+18)	Sr-90	1.69E+07 (6.25E+17)
Sr-91	2.07E+08 (7.66E+18)	Sr-92	2.14E+08 (7.92E+18)
Ba-137m	2.34E+07 (8.66E+17)	Ba-139	2.62E+08 (9.69E+18)
Ba-140	2.52E+08 (9.32E+18)		
Noble Metals			
Mo-99	2.59E+08 (9.58E+18)	Tc-99m	2.27E+08 (8.40E+18)
Ru-103	2.42E+08 (8.95E+18)	Ru-105	1.96E+08 (7.25E+18)
Ru-106	1.43E+08 (5.29E+18)	Rh-103m	2.18E+08 (8.07E+18)
Rh-105	1.75E+08 (6.48E+18)	Rh-106	1.58E+08 (5.85E+18)
Cerium Group			
Ce-141	2.24E+08 (8.29E+18)	Ce-143	2.28E+08 (8.44E+18)
Ce-144	1.70E+08 (6.29E+18)	Pu-238	1.46E+06 (5.40E+16)

Table 7.1-4— U.S. EPR Bounding Core Inventory (a,b,c)
(Page 2 of 2)

Radionuclide	Inventory Ci (Bq)	Radionuclide	Inventory Ci (Bq)
Pu-239	6.14E+04 (2.27E+15)	Pu-240	1.40E+05 (5.18E+15)
Pu-241	2.53E+07 (9.36E+17)	Np-239	3.82E+09 (1.41E+20)
Lanthanides			
Y-90	1.79E+07 (6.62E+17)	Y-91m	1.20E+08 (4.44E+18)
Y-91	1.96E+08 (7.25E+18)	Y-92	2.14E+08 (7.92E+18)
Y-93	2.34E+08 (8.66E+18)	Zr-95	2.29E+08 (8.47E+18)
Zr-97	2.43E+08 (8.99E+18)	Nb-95	2.29E+08 (8.47E+18)
Ag-110m	2.42E+06 (8.95E+16)	Ag-110	7.15E+07 (2.65E+18)
La-140	2.54E+08 (9.40E+18)	La-141	2.41E+08 (8.92E+18)
La-142	2.35E+08 (8.70E+18)	Pr-143	2.26E+08 (8.36E+18)
Pr-144	1.72E+08 (6.36E+18)	Nd-147	9.44E+07 (3.49E+18)
Am-241	2.88E+04 (1.07E+15)	Cm-242	1.31E+07 (4.85E+17)
Cm-244	6.94E+06 (2.57E+17)		

Key:
Ci - curies
Bq - Becquerels
Notes:
a This table lists the design basis source term inventories for radiological consequences for the U.S. EPR core.
b Core inventories are bounding for U-235 fuel enrichment ranging between 2% and 5% and burnups up to 62,000 MWd/MTU.
c The design basis power level is 4,612 MWt.

Table 7.1-5— 50th Percentile CCNPP Site Atmospheric Dispersion Factors

Time Interval (hrs)	Atmosheric Dispersion Factor (sec/m^3) (Nominal, 50% Meteorology)	
	EAB (Worst 2-hr)	LPZ (0 to 30 days)
	LOCA	
0 to 1.5	n/a	1.181E-05
1.5 to 3.5[a]	8.079E-05	1.527E-05
3.5 to 8	n/a	1.181E-05
8 to 24		9.391E-06
24 to 96		6.607E-06
96 to 720		3.987E-06
	All Other Accidents	
0 to 2	8.079E-05	1.527E-05
2 to 8	n/a	1.181E-05
8 to 24		9.391E-06
24 to 96		6.607E-06
96 to 720		3.987E-06

a. In accordance with Regulatory Guide 1.183 (Section 4.1.5), the period of most adverse release of radioactive materials to the environment was assumed to occur coincident with the period of most unfavorable atmospheric dispersion.

Table 7.1-6— Steam System Piping Failure

Time	Site TEDE Dose (rem/Sv)	
	EAB	LPZ
	Pre-Existing Iodine S ike	
0-2 hr	1.96E-02/1.96E-04	3.71E-03/3.71E-05
2-8 hr		1.58E-03/1.58E-05
8-24 hr		9.10E-05/9.10E-05
24-96 hr		0.00E+00/0.00E+00
96-720 hr		0.00E+00/0.00E+00
Total	1.96E-02/1.96E-04	5.38E-03/5.38E-05
Limit	25/0.25	25/0.25
	Accident-Initiated Iodine Spike	
0-2 hr	2.17E-02/2.17E-04	4.11E-03/4.11E-05
2-8 hr		1.25E-02/1.25E-04
8-24 hr		1.30E-03/1.30E-05
24-96 hr		0.00E+00/0.00E+00
96-720 hr		0.00E+00/0.00E+00
Total	2.17E-02/2.17E-04	1.80E-02/1.80E-04
Limit	2.5/0.025	2.5/0.025
	Accidental-Induced 3.3% Fuel Rod Clad Failure	
0-2 hr	4.26E-01/4.26E-03	8.05E-02/8.05E-04
2-8 hr		1.41E-01/1.41E-03
8-24 hr		8.62E-03/8.62E-05
24-96 hr		0.00E+00/0.00E+00
96-720 hr		0.00E+00/0.00E+00
Total	4.26E-01/4.26E-03	2.30E-01/2.30E-03
Limit	25/0.25	25/0.25
	Accident-Induced 0.58% Fuel Overheat	
0-2 hr	4.72E-01/4.72E-03	8.92E-02/8.92E-04
2-8 hr		1.44E-01/1.44E-03
8-24 hr		8.47E-03/8.47E-05
24-96 hr		0.00E+00/0.00E+00
96-720 hr		0.00E+00/0.00E+00
Total	4.72E-01/4.72E-03	2.42E-01/2.42E-03
Limit	25/0.25	25/0.25

Table 7.1-7— Reactor Coolant Pump Locked Rotor Accident / Broken Shaft

Time	Site TEDE Dose (rem/Sv)	
	EAB	LPZ
0-2 hr	1.82E-01 / 1.82E-03	3.43E-02 / 3.43E-04
2-8 hr		4.13E-02 / 4.13E-04
8-24 hr		0.00E+00 / 0.00E+00
24-96 hr		0.00E+00 / 0.00E+00
96-720 hr		0.00E+00 / 0.00E+00
Total	1.82E-01 / 1.82E-03	7.56E-02 / 7.56E-04
Limit	2.5 / 0.025	2.5 / 0.025

Table 7.1-8— Failure of Small Lines Carrying Primary Coolant Outside Containment[1]

Time	Site TEDE Dose (rem/Sv)	
	EAB	LPZ
0-2 hr	1.45E-01/1.45E-03	2.75E-02/2.75E-04
2-8 hr		0.00E+00/0.00E+00
8-24 hr		0.00E+00/0.00E+00
24-96 hr		0.00E+00/0.00E+00
96-720 hr		0.00E+00/0.00E+00
Total	1.45E-01/1.45E-03	2.75E-02/2.75E-04
Limit	2.5/0.025	2.5/0.025

1. The Nuclear Sampling System Line Break (1/4" line) bounds the Chemical and Volume Control System Line Break (6" line) for the EAB and LPZ.

Table 7.1-9— Steam Generator Tube Rupture

Time	Site TEDE Dose (rem/Sv)	
	EAB	LPZ
	Pre-Existing Iodine S ike	
0-2 hr	8.93E-02/8.93E-04	1.69E-02/1.69E-04
2-8 hr		3.24E-03/3.24E-05
8-24 hr		2.48E-03/2.48E-05
24-96 hr		1.16E-03/1.16E-05
96-720 hr		5.07E-03/5.07E-05
Total	8.93E-02/8.93E-04	2.88E-02/2.88E-04
Limit	25/0.25	25/0.25
	Accident-Initiated Iodine Spike	
0-2 hr	5.90E-02/5.90E-04	1.11E-02/1.11E-04
2-8 hr		2.35E-03/2.35E-05
8-24 hr		2.83E-03/2.83E-05
24-96 hr		7.13E-03/7.13E-05
96-720 hr		4.61E-02/4.61E-04
Total	5.90E-02/5.90E-04	6.96E-02/6.96E-04

Table 7.1-10— Loss of Coolant Accident

Time	Site TEDE Dose (rem/Sv)	
	EAB	LPZ
0-1.5 hr		4.52E-02/4.52E-04
1.5-3.5	1.01E+00/1.01E-02	1.91E-01/1.91E-03
3.5-8 hr		2.39E-01/2.39E-03
8-24 hr		3.13E-01/3.13E-03
24-96 hr		2.00E-01/2.00E-03
96-720 hr		1.57E-01/1.57E-03
Total	1.01E+00/1.01E-02	1.14E+00/1.14E-02
Limit	25/0.25	25/0.25

Table 7.1-11— Fuel Handling Accident

Time	Site TEDE Dose (rem/Sv)	
	EAB	LPZ
0-2 hr	4.54E-01/4.54E-03	8.58E-02/8.58E-04
2-8 hr		2.62E-03/2.62E-05
8-24 hr		1.66E-03/1.66E-05
24-96 hr		3.42E-04/3.42E-06
96-720 hr		7.27E-06/7.27E-08
Total	4.54E-01/4.54E-03	9.04E-02/9.04E-04
Limit	6.3/0.063	6.3/0.063

Table 7.1-12— Rod Ejection Accident

Time	Site TEDE Dose (rem/Sv)	
	EAB	LPZ
0-2 hr	4.57E-01/4.57E-03	8.63E-02/8.63E-04
2-8 hr		2.19E-01/2.19E-03
8-24 hr		0.00E+00/0.00E+00
24-96 hr		0.00E+00/0.00E+00
96-720 hr		0.00E+00/0.00E+00
Total	4.57E-01/4.57E-03	3.05E-01/3.05E-03
Limit	6.3/0.063	6.3/0.063

Table 7.1-13— Summary of DBA Radiological Consequences of Offsite Receptors From CCNPP Unit 3

Design Basis Accident	EAB TEDE Dose(rem / Sv)	LPZ TEDE Dose(rem / Sv)	Regulatory TEDE Dose Acceptance Criteria (rem / Sv)
Steam System Piping Failures			
Pre-accident Iodine Spike	2.0E-02/2.0E-04	5.4E-03/5.4E-05	25 / 0.25
Concurrent Iodine Spike	2.2E-02/2.2E-04	1.8/1.8E-04	2.5 / 0.025
3.3% Fuel Rod Clad Failure	4.3E-01/4.3E-03	2.3E-01/2.3E-03	25 / 0.25
0.58% Fuel Overheat	4.7E-01/4.7E-03	2.4E-01/2.4E-03	25 / 0.25
Reactor Coolant Pump Locked Rotor Accident / Broken Shaft (9.5% clad failure)	1.8E-01/1.8E-03	7.6E-02/7.6E-04	2.5 / 0.025
Failure of Small Lines Carrying Primary Coolant Outside Containment	1.5E-01/1.5E-03	2.8E-02/2.8E-04	2.5 / 0.025
Steam Generator Tube Rupture			
Pre-accident Iodine Spike	8.9E-01/8.9E-03	2.9E-02/2.9E-04	25 / 0.25
Concurrent Iodine Spike	5.9E-01/5.9E-03	7.0E-02/7.0E-04	2.5 / 0.025
LOCA	1.0E+00/1.0E-02	1.1E+00/1.1E-02	25 / 0.25
Fuel Handling Accident	4.5E-01/4.5E-03	9.0E-02/9.0E-04	6.3 / 0.063
Rod Ejection Accident (36.7% clad failure)	4.6E-01/4.6E-03	3.1E-01/3.1E-03	6.3 / 0.063

Key:
EAB – Exclusion Area Boundary
LPZ – Low Population Zone
TEDE – Total effective dose equivalent

Table 7.1-14— Radionuclide Releases to Atmosphere for Main Steam Line Break with Pre-Accident Iodine Spike

(Page 1 of 2)

Nuclide	Releases to Atmosphere (Ci) During Specified Time Intervals (hrs)							
	0 to 2		2 to 8		8 to 24		Total	
	Ci	Bq	Ci	Bq	Ci	Bq	Ci	Bq
Kr-83m	2.167E-02	8.018E+08	2.145E-02	7.937E+08	3.182E-04	1.177E+07	4.344E-02	1.607E+09
Kr-85m	1.115E-01	4.126E+09	1.858E-01	6.875E+09	4.350E-03	1.610E+08	3.016E-01	1.116E+10
Kr-85	1.205E+00	4.459E+10	3.613E+00	1.337E+11	1.505E-01	5.569E+09	4.969E+00	1.839E+11
Kr-87	4.505E-02	1.667E+09	2.194E-02	8.118E+08	9.099E-05	3.367E+06	6.709E-02	2.482E+09
Kr-88	1.849E-01	6.841E+09	2.258E-01	8.355E+09	3.674E-03	1.359E+08	4.144E-01	1.533E+10
Kr-89	2.093E-04	7.744E+06	8.419E-16	3.115E-05	1.370E-50	5.069E-40	2.093E-04	7.744E+06
Xe-131m	2.446E-01	9.050E+09	7.271E-01	2.690E+10	3.027E-02	1.120E+09	1.002E+00	3.707E+10
Xe-133m	3.042E-01	1.126E+10	8.850E-01	3.275E+10	3.985E-02	1.474E+09	1.229E+00	4.547E+10
Xe-133	2.140E+01	7.918E+11	6.307E+01	2.334E+12	2.646E+00	9.790E+10	8.711E+01	3.223E+12
Xe-135m	3.843E-01	1.422E+10	8.821E-01	3.264E+10	8.834E-02	3.269E+09	1.355E+00	5.014E+10
Xe-135	9.137E-01	3.381E+10	3.733E+00	1.381E+11	4.540E-01	1.680E+10	5.100E+00	1.887E+11
Xe-137	4.777E-04	1.767E+07	1.767E-13	6.538E-03	2.237E-42	8.277E-32	4.777E-04	1.767E+07
Xe-138	6.324E-03	2.340E+08	1.790E-05	6.623E+05	9.525E-14	3.524E-03	6.341E-03	2.346E+08
Br-83	2.522E-01	9.331E+09	4.130E-03	1.528E+08	7.641E-05	2.827E+06	2.564E-01	9.487E+09
Br-84	4.771E-02	1.765E+09	4.524E-05	1.674E+06	7.550E-09	2.794E+02	4.775E-02	1.767E+09
Br-85	6.133E-04	2.269E+07	1.092E-18	4.040E-08	1.546E-56	5.720E-46	6.133E-04	2.269E+07
I-129	7.539E-07	2.789E+04	3.757E-08	1.390E+03	1.301E-09	4.814E+01	7.928E-07	2.933E+04
I-130	6.787E-01	2.511E+10	2.685E-02	9.935E+08	8.749E-04	3.237E+07	7.064E-01	2.614E+10
I-131	1.516E+01	5.609E+11	8.621E+00	3.190E+11	1.226E+00	4.536E+10	2.501E+01	9.254E+11
I-132	4.788E+00	1.772E+11	1.069E+00	3.955E+10	4.889E-02	1.809E+09	5.906E+00	2.185E+11
I-133	2.350E+01	8.695E+11	1.244E+01	4.603E+11	1.602E+00	5.927E+10	3.754E+01	1.389E+12
I-134	1.620E+00	5.994E+10	1.135E-01	4.200E+09	5.052E-04	1.869E+07	1.734E+00	6.416E+10
I-135	1.246E+01	4.610E+11	5.510E+00	2.039E+11	5.515E-01	2.041E+10	1.852E+01	6.852E+11
Rb-86m	1.353E-09	5.006E+01	1.255E-45	4.644E-35	0.000E+00	0.000E+00	1.353E-09	5.006E+01
Rb-86	1.398E-03	5.173E+07	7.207E-04	2.667E+07	1.024E-04	3.789E+06	2.221E-03	8.218E+07

Table 7.1-14— Radionuclide Releases to Atmosphere for Main Steam Line Break with Pre-Accident Iodine Spike
(Page 2 of 2)

Nuclide	Releases to Atmosphere (Ci) During Specified Time Intervals (hrs)							
	0 to 2		2 to 8		8 to 24		Total	
	Ci	Bq	Ci	Bq	Ci	Bq	Ci	Bq
Rb-88	1.915E-01	7.086E+09	2.517E-01	9.313E+09	4.103E-03	1.518E+08	4.474E-01	1.655E+10
Rb-89	1.838E-03	6.801E+07	3.266E-06	1.208E+05	1.619E-13	5.990E-03	1.841E-03	6.812E+07
Cs-134	1.609E-01	5.953E+09	8.300E-02	3.071E+09	1.185E-02	4.385E+08	2.557E-01	9.461E+09
Cs-136	3.808E-02	1.409E+09	1.963E-02	7.263E+08	2.782E-03	1.029E+08	6.048E-02	2.238E+09
Cs-137	6.160E-02	2.279E+09	3.177E-02	1.175E+09	4.536E-03	1.678E+08	9.791E-02	3.623E+09
Cs-138	2.051E-02	7.589E+08	1.254E-03	4.640E+07	1.886E-07	6.978E+03	2.177E-02	8.055E+08
Sr-89	7.189E-07	2.660E+04	2.557E-06	9.461E+04	3.082E-07	1.140E+04	3.584E-06	1.326E+05
Ba-137m	5.786E-02	2.141E+09	3.006E-02	1.112E+09	4.291E-03	1.588E+08	9.220E-02	3.411E+09
Total	8.386E+01	3.103E+12	1.016E+02	3.759E+12	6.875E+00	2.544E+11	1.923E+02	7.115E+12

Table 7.1-15— Radionuclide Releases to Atmosphere for Main Steam Line Break with Accident-Induced (Coincident) Iodine Spike

(Page 1 of 2)

Nuclide	Releases to Atmosphere (Ci) During Specified Time Intervals (hrs)							
	0 to 2		2 to 8		8 to 24		Total	
	Ci	Bq	Ci	Bq	Ci	Bq	Ci	Bq
Kr-83m	2.167E-02	8.018E+08	2.145E-02	7.937E+08	3.182E-04	1.177E+07	4.344E-02	1.607E+09
Kr-85m	1.115E-01	4.126E+09	1.858E-01	6.875E+09	4.350E-03	1.610E+08	3.016E-01	1.116E+10
Kr-85	1.205E+00	4.459E+10	3.613E+00	1.337E+11	1.505E-01	5.569E+09	4.969E+00	1.839E+11
Kr-87	4.505E-02	1.667E+09	2.194E-02	8.118E+08	9.099E-05	3.367E+06	6.709E-02	2.482E+09
Kr-88	1.849E-01	6.841E+09	2.258E-01	8.355E+09	3.674E-03	1.359E+08	4.144E-01	1.533E+10
Kr-89	2.093E-04	7.744E+06	8.419E-16	3.115E-05	1.370E-50	5.069E-40	2.093E-04	7.744E+06
Xe-131m	2.446E-01	9.050E+09	7.308E-01	2.704E+10	3.188E-02	1.180E+09	1.007E+00	3.726E+10
Xe-133m	3.045E-01	1.127E+10	9.837E-01	3.640E+10	8.092E-02	2.994E+09	1.369E+00	5.065E+10
Xe-133	2.140E+01	7.918E+11	6.448E+01	2.386E+12	3.237E+00	1.198E+11	8.912E+01	3.297E+12
Xe-135m	7.205E-01	2.666E+10	1.136E+01	4.203E+11	2.616E+00	9.679E+10	1.470E+01	5.439E+11
Xe-135	1.023E+00	3.785E+10	1.721E+01	6.368E+11	5.434E+00	2.011E+11	2.367E+01	8.758E+11
Xe-137	4.777E-04	1.767E+07	1.767E-13	6.538E-03	2.237E-42	8.277E-32	4.777E-04	1.767E+07
Xe-138	6.324E-03	2.340E+08	1.790E-05	6.623E+05	9.525E-14	3.524E-03	6.341E-03	2.346E+08
Br-83	2.522E-01	9.331E+09	4.130E-03	1.528E+08	7.641E-05	2.827E+06	2.564E-01	9.487E+09
Br-84	4.771E-02	1.765E+09	4.524E-05	1.674E+06	7.550E-09	2.794E+02	4.775E-02	1.767E+09
Br-85	6.133E-04	2.269E+07	1.092E-18	4.040E-08	1.546E-56	5.720E-46	6.133E-04	2.269E+07
I-129	7.539E-07	2.789E+04	3.757E-08	1.390E+03	1.301E-09	4.814E+01	7.928E-07	2.933E+04
I-130	6.787E-01	2.511E+10	2.685E-02	9.935E+08	8.749E-04	3.237E+07	7.064E-01	2.614E+10
I-131	1.627E+01	6.020E+11	6.254E+01	2.314E+12	1.557E+01	5.761E+11	9.438E+01	3.492E+12
I-132	8.145E+00	3.014E+11	3.962E+01	1.466E+12	6.683E+00	2.473E+11	5.445E+01	2.015E+12
I-133	2.653E+01	9.816E+11	1.129E+02	4.177E+12	2.685E+01	9.935E+11	1.663E+02	6.153E+12
I-134	5.642E+00	2.088E+11	2.468E+01	9.132E+11	2.899E+00	1.073E+11	3.322E+01	1.229E+12
I-135	1.595E+01	5.902E+11	7.814E+01	2.891E+12	1.675E+01	6.198E+11	1.108E+02	4.100E+12
Rb-86m	1.353E-09	5.006E+01	1.255E-45	4.644E-35	0.000E+00	0.000E+00	1.353E-09	5.006E+01
Rb-86	1.398E-03	5.173E+07	7.207E-04	2.667E+07	1.024E-04	3.789E+06	2.221E-03	8.218E+07

Table 7.1-15— Radionuclide Releases to Atmosphere for Main Steam Line Break with Accident-Induced (Coincident) Iodine Spike

(Page 2 of 2)

Nuclide	Releases to Atmosphere (Ci) During Specified Time Intervals (hrs)							
	0 to 2		2 to 8		8 to 24		Total	
	Ci	**Bq**	*Ci*	**Bq**	*Ci*	**Bq**	*Ci*	**Bq**
Rb-88	1.915E-01	7.086E+09	2.517E-01	9.313E+09	4.103E-03	1.518E+08	4.474E-01	1.655E+10
Rb-89	1.838E-03	6.801E+07	3.266E-06	1.208E+05	1.619E-13	5.990E-03	1.841E-03	6.812E+07
Cs-134	1.609E-01	5.953E+09	8.300E-02	3.071E+09	1.185E-02	4.385E+08	2.557E-01	9.461E+09
Cs-136	3.808E-02	1.409E+09	1.963E-02	7.263E+08	2.782E-03	1.029E+08	6.048E-02	2.238E+09
Cs-137	6.160E-02	2.279E+09	3.177E-02	1.175E+09	4.536E-03	1.678E+08	9.791E-02	3.623E+09
Cs-138	2.051E-02	7.589E+08	1.254E-03	4.640E+07	1.886E-07	6.978E+03	2.177E-02	8.055E+08
Sr-89	7.189E-07	2.660E+04	2.557E-06	9.461E+04	3.082E-07	1.140E+04	3.584E-06	1.326E+05
Ba-137m	5.786E-02	2.141E+09	3.006E-02	1.112E+09	4.291E-03	1.588E+08	9.220E-02	3.411E+09
Total	9.932E+01	3.675E+12	4.172E+02	1.544E+13	8.034E+01	2.973E+12	5.968E+02	2.208E+13

Table 7.1-16— Radionuclide Releases to Atmosphere for Main Steam Line Break with Accident-Induced 3.3% Clad Failure and 0.58% Fuel Overheat

(Page 1 of 3)

	Releases to Atmosphere During Specified Time Intervals (hrs)							
	0 to 2		2 to 8		8 to 24		Total	
Nuclide	Ci	Bq	Ci	Bq	Ci	Bq	Ci	Bq
Kr-83m	3.280E+01	1.214E+12	3.559E+01	1.317E+12	1.238E+00	4.581E+10	6.963E+01	2.576E+12
Kr-85m	8.444E+01	3.124E+12	1.407E+02	5.206E+12	3.320E+00	1.228E+11	2.285E+02	8.455E+12
Kr-85	1.031E+01	3.815E+11	3.093E+01	1.144E+12	1.288E+00	4.766E+10	4.253E+01	1.574E+12
Kr-87	1.192E+02	4.410E+12	5.806E+01	2.148E+12	2.408E-01	8.910E+09	1.775E+02	6.568E+12
Kr-88	2.202E+02	8.147E+12	2.688E+02	9.946E+12	4.376E+00	1.619E+11	4.934E+02	1.826E+13
Kr-89	1.332E+01	4.928E+11	5.359E-11	1.983E+00	8.719E-46	3.226E-35	1.332E+01	4.928E+11
Xe-131m	3.583E+00	1.326E+11	1.068E+01	3.952E+11	4.523E-01	1.674E+10	1.472E+01	5.446E+11
Xe-133m	1.946E+01	7.200E+11	5.604E+01	2.073E+12	2.403E+00	8.891E+10	7.790E+01	2.882E+12
Xe-133	6.466E+02	2.392E+13	1.908E+03	7.060E+13	8.055E+01	2.980E+12	2.635E+03	9.750E+13
Xe-135m	4.150E+01	1.536E+12	4.615E+01	1.708E+12	4.800E+00	1.776E+11	9.245E+01	3.421E+12
Xe-135	1.998E+02	7.393E+12	5.351E+02	1.980E+13	3.532E+01	1.307E+12	7.702E+02	2.850E+13
Xe-137	2.515E+01	9.306E+11	9.302E-09	3.442E+02	1.178E-37	4.359E-27	2.515E+01	9.306E+11
Xe-138	9.017E+01	3.336E+12	2.552E-01	9.442E+09	1.358E-09	5.025E+01	9.042E+01	3.346E+12
Br-83	1.094E+01	4.048E+11	9.155E+00	3.387E+11	4.542E-01	1.681E+10	2.055E+01	7.604E+11
Br-84	1.069E+01	3.955E+11	5.777E-01	2.137E+10	1.566E-04	5.794E+06	1.126E+01	4.166E+11
Br-85	1.663E+00	6.153E+10	2.161E-13	7.996E-03	3.269E-51	1.210E-40	1.663E+00	6.153E+10
I-129	6.476E-06	2.396E+05	1.488E-05	5.506E+05	2.258E-06	8.355E+04	2.362E-05	8.739E+05
I-130	9.312E+00	3.445E+11	1.780E+01	6.586E+11	2.217E+00	8.203E+10	2.933E+01	1.085E+12
I-131	1.643E+02	6.079E+12	3.897E+02	1.442E+13	5.846E+01	2.163E+12	6.125E+02	2.266E+13
I-132	1.121E+02	4.148E+12	8.941E+01	3.308E+12	4.225E+00	1.563E+11	2.057E+02	7.611E+12
I-133	2.124E+02	7.859E+12	4.391E+02	1.625E+13	5.933E+01	2.195E+12	7.109E+02	2.630E+13
I-134	1.242E+02	4.595E+12	2.356E+01	8.717E+11	1.065E-01	3.941E+09	1.479E+02	5.472E+12
I-135	1.789E+02	6.619E+12	2.877E+02	1.064E+13	2.996E+01	1.109E+12	4.966E+02	1.837E+13
Rb-86m	1.764E-03	6.527E+07	2.996E-39	1.109E-28	0.000E+00	0.000E+00	1.764E-03	6.527E+07

Table 7.1-16— Radionuclide Releases to Atmosphere for Main Steam Line Break with Accident-Induced 3.3% Clad Failure and 0.58% Fuel Overheat

(Page 2 of 3)

	Releases to Atmosphere During Specified Time Intervals (hrs)							
	0 to 2		2 to 8		8 to 24		Total	
Nuclide	Ci	Bq	Ci	Bq	Ci	Bq	Ci	Bq
Rb-86	9.539E-01	3.529E+10	2.456E+00	9.087E+10	3.714E-01	1.374E+10	3.781E+00	1.399E+11
Rb-88	2.406E+02	8.902E+12	2.999E+02	1.110E+13	4.885E+00	1.807E+11	5.454E+02	2.018E+13
Rb-89	8.269E+01	3.060E+12	2.451E-01	9.069E+09	1.281E-08	4.740E+02	8.293E+01	3.068E+12
Cs-134	1.069E+02	3.955E+12	2.768E+02	1.024E+13	4.209E+01	1.557E+12	4.258E+02	1.575E+13
Cs-136	2.650E+01	9.805E+11	6.805E+01	2.518E+12	1.026E+01	3.796E+11	1.048E+02	3.878E+12
Cs-137	4.081E+01	1.510E+12	1.057E+02	3.911E+12	1.607E+01	5.946E+11	1.626E+02	6.016E+12
Cs-138	2.696E+02	9.975E+12	2.276E+01	8.421E+11	4.151E-03	1.536E+08	2.923E+02	1.082E+13
Sr-89	5.497E-02	2.034E+09	1.946E-01	7.200E+09	2.451E-02	9.069E+08	2.741E-01	1.014E+10
Ba-137m	3.860E+01	1.428E+12	1.000E+02	3.700E+12	1.520E+01	5.624E+11	1.538E+02	5.691E+12
Total	3.138E+03	1.161E+14	5.224E+03	1.933E+14	3.776E+02	1.397E+13	8.739E+03	3.233E+14
Kr-83m	1.098E+02	4.063E+12	1.038E+02	3.841E+12	2.549E+00	9.431E+10	2.162E+02	7.999E+12
Kr-85m	2.957E+02	1.094E+13	4.928E+02	1.823E+13	1.158E+01	4.285E+11	8.001E+02	2.960E+13
Kr-85	1.721E+01	6.368E+11	5.163E+01	1.910E+12	2.150E+00	7.955E+10	7.099E+01	2.627E+12
Kr-87	4.179E+02	1.546E+13	2.035E+02	7.530E+12	8.440E-01	3.123E+10	6.223E+02	2.303E+13
Kr-88	7.737E+02	2.863E+13	9.445E+02	3.495E+13	1.537E+01	5.687E+11	1.733E+03	6.412E+13
Kr-89	4.684E+01	1.733E+12	1.884E-10	6.971E+00	3.065E-45	1.134E-34	4.684E+01	1.733E+12
Xe-131m	1.197E+01	4.429E+11	3.560E+01	1.317E+12	1.483E+00	5.487E+10	4.905E+01	1.815E+12
Xe-133m	6.769E+01	2.505E+12	1.938E+02	7.171E+12	8.011E+00	2.964E+11	2.695E+02	9.972E+12
Xe-133	2.213E+03	8.188E+13	6.514E+03	2.410E+14	2.708E+02	1.002E+13	8.997E+03	3.329E+14
Xe-135m	1.112E+02	4.114E+12	8.124E+01	3.006E+12	8.435E+00	3.121E+11	2.008E+02	7.430E+12
Xe-135	6.807E+02	2.519E+13	1.677E+03	6.205E+13	8.537E+01	3.159E+12	2.443E+03	9.039E+13
Xe-137	8.839E+01	3.270E+12	3.271E-08	1.210E+03	4.140E-37	1.532E-26	8.839E+01	3.270E+12
Xe-138	3.178E+02	1.176E+13	8.992E-01	3.327E+10	4.786E-09	1.771E+02	3.187E+02	1.179E+13
Br-83	1.904E+01	7.045E+11	1.609E+01	5.953E+11	7.982E-01	2.953E+10	3.592E+01	1.329E+12

Table 7.1-16— Radionuclide Releases to Atmosphere for Main Steam Line Break with Accident-Induced 3.3% Clad Failure and 0.58% Fuel Overheat
(Page 3 of 3)

	Releases to Atmosphere During Specified Time Intervals (hrs)							
	0 to 2		2 to 8		8 to 24		Total	
Nuclide	Ci	Bq	Ci	Bq	Ci	Bq	Ci	Bq
Br-84	1.875E+01	6.938E+11	1.015E+00	3.756E+10	2.752E-04	1.018E+07	1.976E+01	7.311E+11
Br-85	2.922E+00	1.081E+11	3.798E-13	1.405E-02	5.745E-51	2.126E-40	2.922E+00	1.081E+11
I-129	1.081E-05	4.000E+05	2.613E-05	9.668E+05	3.967E-06	1.468E+05	4.091E-05	1.514E+06
I-130	1.585E+01	5.865E+11	3.127E+01	1.157E+12	3.897E+00	1.442E+11	5.102E+01	1.888E+12
I-131	1.792E+02	6.630E+12	4.277E+02	1.582E+13	6.411E+01	2.372E+12	6.709E+02	2.482E+13
I-132	1.943E+02	7.189E+12	1.571E+02	5.813E+12	7.425E+00	2.747E+11	3.588E+02	1.328E+13
I-133	3.595E+02	1.330E+13	7.712E+02	2.853E+13	1.043E+02	3.859E+12	1.235E+03	4.570E+13
I-134	2.175E+02	8.048E+12	4.141E+01	1.532E+12	1.872E-01	6.926E+09	2.591E+02	9.587E+12
I-135	3.073E+02	1.137E+13	5.054E+02	1.870E+13	5.265E+01	1.948E+12	8.654E+02	3.202E+13
Rb-86m	1.290E-03	4.773E+07	2.191E-39	8.107E-29	0.000E+00	0.000E+00	1.290E-03	4.773E+07
Rb-86	7.010E-01	2.594E+10	1.804E+00	6.675E+10	2.727E-01	1.009E+10	2.777E+00	1.027E+11
Rb-88	6.770E+02	2.505E+13	1.053E+03	3.896E+13	1.716E+01	6.349E+11	1.747E+03	6.464E+13
Rb-89	9.740E+01	3.604E+12	3.763E-01	1.392E+10	1.278E-08	4.729E+02	9.778E+01	3.618E+12
Cs-134	7.845E+01	2.903E+12	2.031E+02	7.515E+12	3.087E+01	1.142E+12	3.124E+02	1.156E+13
Cs-136	1.947E+01	7.204E+11	4.995E+01	1.848E+12	7.537E+00	2.789E+11	7.696E+01	2.848E+12
Cs-137	2.990E+01	1.106E+12	7.740E+01	2.864E+12	1.177E+01	4.355E+11	1.191E+02	4.407E+12
Cs-138	4.164E+02	1.541E+13	5.014E+01	1.855E+12	5.701E-03	2.109E+08	4.666E+02	1.726E+13
Sr-89	7.331E-02	2.712E+09	2.692E-01	9.960E+09	2.321E-02	8.588E+08	3.657E-01	1.353E+10
Ba-137m	2.829E+01	1.047E+12	7.327E+01	2.711E+12	1.113E+01	4.118E+11	1.127E+02	4.170E+12
Total	7.814E+03	2.891E+14	1.376E+04	5.091E+14	7.187E+02	2.659E+13	2.229E+04	8.247E+14

Table 7.1-17— Radionuclide Releases to Atmosphere for Pump Locked Rotor Accident (LRA) with Accident-Induced 9.5% Clad Failure

	Releases to Atmosphere During Specified Time Intervals (hrs)					
	0 to 2		2 to 8		Total	
Nuclide	Ci	Bq	Ci	Bq	Ci	Bq
Kr-83m	6.864E+01	2.540E+12	5.405E+01	2.000E+12	1.227E+02	4.540E+12
Kr-85m	1.905E+02	7.049E+12	3.030E+02	1.121E+13	4.935E+02	1.826E+13
Kr-85	2.146E+01	7.940E+11	6.173E+01	2.284E+12	8.319E+01	3.078E+12
Kr-87	2.742E+02	1.015E+13	1.254E+02	4.640E+12	3.996E+02	1.479E+13
Kr-88	5.001E+02	1.850E+13	5.806E+02	2.148E+13	1.081E+03	4.000E+13
Kr-89	3.803E+01	1.407E+12	1.158E-10	4.285E+00	3.803E+01	1.407E+12
Xe-131m	7.701E+00	2.849E+11	2.195E+01	8.122E+11	2.966E+01	1.097E+12
Xe-133m	4.324E+01	1.600E+12	1.182E+02	4.373E+12	1.615E+02	5.976E+12
Xe-133	1.423E+03	5.265E+13	4.010E+03	1.484E+14	5.433E+03	2.010E+14
Xe-135m	5.836E+01	2.159E+12	1.167E+01	4.318E+11	7.003E+01	2.591E+12
Xe-135	4.279E+02	1.583E+13	9.442E+02	3.494E+13	1.372E+03	5.076E+13
Xe-137	7.127E+01	2.637E+12	2.011E-08	7.441E+02	7.127E+01	2.637E+12
Xe-138	2.288E+02	8.466E+12	5.516E-01	2.041E+10	2.293E+02	8.484E+12
Br-83	4.263E+00	1.577E+11	2.041E+00	7.552E+10	6.304E+00	2.332E+11
Br-84	6.306E+00	2.333E+11	8.774E-02	3.246E+09	6.394E+00	2.366E+11
Br-85	2.332E+00	8.628E+10	2.497E-14	9.239E-04	2.332E+00	8.628E+10
I-129	2.293E-06	8.484E+04	3.969E-06	1.469E+05	6.262E-06	2.317E+05
I-130	3.307E+00	1.224E+11	4.570E+00	1.691E+11	7.877E+00	2.914E+11
I-131	5.682E+01	2.102E+12	1.029E+02	3.807E+12	1.597E+02	5.909E+12
I-132	4.404E+01	1.629E+12	1.982E+01	7.333E+11	6.386E+01	2.363E+12
I-133	7.514E+01	2.780E+12	1.144E+02	4.233E+12	1.896E+02	7.015E+12
I-134	6.060E+01	2.242E+12	4.122E+00	1.525E+11	6.472E+01	2.395E+12
I-135	6.439E+01	2.382E+12	7.163E+01	2.650E+12	1.360E+02	5.032E+12
Rb-86m	2.540E-03	9.398E+07	3.391E-40	1.255E-29	2.540E-03	9.398E+07
Rb-86	3.151E-01	1.166E+10	6.410E-01	2.372E+10	9.561E-01	3.538E+10
Rb-88	4.415E+02	1.634E+13	6.471E+02	2.394E+13	1.089E+03	4.029E+13
Rb-89	8.974E+01	3.320E+12	1.757E-01	6.501E+09	8.992E+01	3.327E+12
Cs-134	3.527E+01	1.305E+12	7.231E+01	2.675E+12	1.076E+02	3.981E+12
Cs-136	8.757E+00	3.240E+11	1.775E+01	6.568E+11	2.651E+01	9.809E+11
Cs-137	1.347E+01	4.984E+11	2.761E+01	1.022E+12	4.108E+01	1.520E+12
Cs-138	2.872E+02	1.063E+13	2.755E+01	1.019E+12	3.147E+02	1.164E+13
Sr-89	3.289E-02	1.217E+09	1.374E-01	5.084E+09	1.702E-01	6.297E+09
Ba-137m	1.008E+01	3.730E+11	2.612E+01	9.664E+11	3.620E+01	1.339E+12
Total	4.557E+03	1.686E+14	7.371E+03	2.727E+14	1.193E+04	4.414E+14

Table 7.1-18— Radionuclide Releases to Atmosphere for Design-Basis Small Line Break - Rupture of 1/4"NSS Sampling Line Outside Primary Containment

Nuclide	Total Release to Atmosphere (Ci) [0 - 2 hr]	
	CI	Bq
Kr-83m	1.653E+00	6.116E+10
Kr-85m	7.066E+00	2.614E+11
Kr-85	6.827E+01	2.526E+12
Kr-87	3.672E+00	1.359E+11
Kr-88	1.247E+01	4.614E+11
Kr-89	4.810E-02	1.780E+09
Xe-131m	1.389E+01	5.139E+11
Xe-133m	1.750E+01	6.475E+11
Xe-133	1.219E+03	4.510E+13
Xe-135m	1.652E+02	6.112E+12
Xe-135	6.941E+01	2.568E+12
Xe-137	1.093E-01	4.044E+09
Xe-138	1.111E+00	4.111E+10
Br-83	1.514E-01	5.602E+09
Br-84	6.319E-02	2.338E+09
Br-85	1.447E-03	5.354E+07
I-129	2.360E-07	8.732E+03
I-130	2.521E-01	9.328E+09
I-131	9.400E+01	3.478E+12
I-132	1.132E+02	4.188E+12
I-133	1.828E+02	6.764E+12
I-134	1.347E+02	4.984E+12
I-135	1.502E+02	5.557E+12
Rb-86	1.881E-02	6.960E+08
Rb-88	5.174E+00	1.914E+11
Rb-89	1.458E-01	5.395E+09
Cs-134	2.150E+00	7.955E+10
Cs-136	5.140E-01	1.902E+10
Cs-137	8.228E-01	3.044E+10
Cs-138	1.032E+00	3.818E+10
Sr-89	2.485E-05	9.195E+05
Ba-137m	7.775E-01	2.877E+10
Total	2.27E+03	8.399E+13

Table 7.1-19— Radionuclide Releases to Atmosphere for SGTR with Pre-Accident Spike

(Page 1 of 2)

	Releases to Atmosphere During Specified Time Intervals (hrs)											
	0 to 2		2 to 8		8 to 24		24 to 96		96 to 720		Total	
Nuclide	Ci	Bq	Ci	Bq	Ci	Bq	Ci	Bq	Ci	Bq	Ci	Bq
Kr-83m	5.579E+01	2.064E+12	5.208E+01	1.927E+12	1.113E+01	4.118E+11	1.110E-01	4.107E+09	1.024E-10	3.789E+00	1.191E+02	4.407E+12
Kr-85m	2.745E+01	1.016E+12	9.737E-02	3.603E+09	5.647E-02	2.089E+09	5.168E-03	1.912E+08	7.391E-08	2.735E+03	2.761E+01	1.022E+12
Kr-85	2.693E+02	9.964E+12	1.875E+00	6.938E+10	4.878E+00	1.805E+11	2.172E+01	8.036E+11	1.734E+02	6.416E+12	4.711E+02	1.743E+13
Kr-87	1.365E+01	5.051E+11	1.170E-02	4.329E+08	4.390E-04	1.624E+07	7.132E-08	2.639E+03	6.326E-25	2.341E-14	1.366E+01	5.054E+11
Kr-88	4.786E+01	1.771E+12	1.186E-01	4.388E+09	3.368E-02	1.246E+09	6.881E-04	2.546E+07	1.565E-11	5.791E-01	4.801E+01	1.776E+12
Kr-89	1.260E-01	4.662E+09	4.744E-16	1.755E-05	2.768E-50	1.024E-39	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.260E-01	4.662E+09
Xe-131m	5.483E+01	2.029E+12	7.018E-01	2.597E+10	1.810E+00	6.697E+10	7.458E+00	2.759E+11	3.116E+01	1.153E+12	9.596E+01	3.551E+12
Xe-133m	7.072E+01	2.617E+12	7.102E+00	2.628E+11	1.379E+01	5.102E+11	2.108E+01	7.800E+11	4.983E+00	1.844E+11	1.177E+02	4.355E+12
Xe-133	4.829E+03	1.787E+14	1.262E+02	4.669E+12	2.600E+02	9.620E+12	5.499E+02	2.035E+13	6.459E+02	2.390E+13	6.411E+03	2.372E+14
Xe-135m	1.530E+03	5.661E+13	3.263E+03	1.207E+14	3.062E+03	1.133E+14	7.187E+02	2.659E+13	4.064E-01	1.504E+10	8.574E+03	3.172E+14
Xe-135	4.299E+02	1.591E+13	5.069E+02	1.876E+13	4.845E+02	1.793E+13	1.206E+02	4.462E+12	1.232E-01	4.558E+09	1.542E+03	5.705E+13
Xe-137	2.887E-01	1.068E+10	9.932E-14	3.675E-03	4.492E-42	1.662E-31	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.887E-01	1.068E+10
Xe-138	3.434E+00	1.271E+11	9.959E-06	3.685E+05	2.041E-13	7.552E-03	8.199E-34	3.034E-23	0.000E+00	0.000E+00	3.434E+00	1.271E+11
Br-83	2.004E+00	7.415E+10	2.840E-03	1.051E+08	7.849E-04	2.904E+07	1.620E-05	5.994E+05	4.395E-14	1.626E-03	2.008E+00	7.430E+10
Br-84	5.904E-01	2.184E+10	4.270E-05	1.580E+06	1.939E-08	7.174E+02	4.027E-17	1.490E-06	1.788E-57	6.616E-47	5.904E-01	2.184E+10
Br-85	6.852E-04	2.535E+07	1.190E-18	4.403E-08	2.448E-56	9.058E-46	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.852E-04	2.535E+07
I-129	3.454E-06	1.278E+05	1.964E-08	7.267E+02	8.140E-08	3.012E+03	1.077E-06	3.985E+04	4.192E-05	1.551E+06	4.655E-05	1.722E+06
I-130	3.616E+00	1.338E+11	1.503E-02	5.561E+08	3.374E-02	1.248E+09	5.191E-02	1.921E+09	2.304E-03	8.525E+07	3.719E+00	1.376E+11
I-131	5.578E+01	2.064E+12	3.103E-01	1.148E+10	1.236E+00	4.573E+10	1.376E+01	5.091E+11	1.542E+02	5.705E+12	2.253E+02	8.336E+12
I-132	2.339E+01	8.654E+11	3.417E-02	1.264E+09	8.312E-03	3.075E+08	1.407E-04	5.206E+06	1.667E-13	6.168E-03	2.343E+01	8.669E+11
I-133	9.220E+01	3.411E+12	4.337E-01	1.605E+10	1.242E+00	4.595E+10	3.997E+00	1.479E+11	9.448E-01	3.496E+10	9.882E+01	3.656E+12
I-134	1.140E+01	4.218E+11	3.079E-03	1.139E+08	3.155E-05	1.167E+06	2.442E-10	9.035E+00	1.584E-34	5.861E-24	1.140E+01	4.218E+11
I-135	5.584E+01	2.066E+12	1.805E-01	6.679E+09	2.463E-01	9.113E+09	1.167E-01	4.318E+09	1.685E-04	6.235E+06	5.639E+01	2.086E+12
Rb-86	4.589E-03	1.698E+08	2.766E-05	1.023E+06	1.086E-04	4.018E+06	1.305E-03	4.829E+07	2.814E-02	1.041E+09	3.417E-02	1.264E+09
Rb-88	1.105E+00	4.089E+10	1.286E-03	4.758E+07	6.410E-04	2.372E+07	2.976E-05	1.101E+06	2.261E-12	8.366E-02	1.107E+00	4.096E+10

Table 7.1-19— Radionuclide Releases to Atmosphere for SGTR with Pre-Accident Spike

(Page 2 of 2)

	Releases to Atmosphere During Specified Time Intervals (hrs)											
	0 to 2		2 to 8		8 to 24		24 to 96		96 to 720		Total	
Nuclide	**Ci**	**Bq**	**Ci**	**Bq**	**Ci**	**Bq**	**Ci**	**Bq**	**Ci**	**Bq**	**Ci**	**Bq**
Rb-89	1.257E-02	4.651E+08	4.677E-08	1.730E+03	4.331E-15	1.602E-04	1.140E-33	4.218E-23	0.000E+00	0.000E+00	1.257E-02	4.651E+08
Cs-134	5.246E-01	1.941E+10	3.196E-03	1.183E+08	1.275E-02	4.718E+08	1.648E-01	6.098E+09	6.259E+00	2.316E+11	6.964E+00	2.577E+11
Cs-136	1.253E-01	4.636E+09	7.520E-04	2.782E+07	2.931E-03	1.084E+08	3.415E-02	1.264E+09	5.875E-01	2.174E+10	7.507E-01	2.778E+10
Cs-137	2.008E-01	7.430E+09	1.224E-03	4.529E+07	4.884E-03	1.807E+08	6.322E-02	2.339E+09	2.436E+00	9.013E+10	2.706E+00	1.001E+11
Cs-138	1.397E-01	5.169E+09	9.813E-06	3.631E+05	5.129E-09	1.898E+02	1.405E-17	5.199E-07	2.046E-57	7.570E-47	1.397E-01	5.169E+09
Ba-137m	1.883E-01	6.967E+09	1.148E-03	4.248E+07	4.579E-03	1.694E+08	5.927E-02	2.193E+09	2.284E+00	8.451E+10	2.537E+00	9.387E+10
Total	7.580E+03	2.805E+14	3.959E+03	1.465E+14	3.841E+03	1.421E+14	1.458E+03	5.395E+13	1.023E+03	3.785E+13	1.786E+04	6.608E+14

Table 7.1-20— Radionuclide Releases to Atmosphere for SGTR with Accident-Induced (Coincident) Iodine Spike

(Page 1 of 2)

	Releases to Atmosphere During Specified Time Intervals (hrs)											
	0 to 2		2 to 8		8 to 24		24 to 96		96 to 720		Total	
Nuclide	Ci	Bq	Ci	Bq	Ci	Bq	Ci	Bq	Ci	Bq	Ci	Bq
Kr-83m	5.286E+01	1.956E+12	6.506E+01	2.407E+12	2.614E+01	9.672E+11	5.395E-01	1.996E+10	1.229E-09	4.547E+01	1.446E+02	5.350E+12
Kr-85m	2.938E+01	1.087E+12	2.475E-01	9.158E+09	2.560E-01	9.472E+09	2.342E-02	8.665E+08	3.350E-07	1.240E+04	2.990E+01	1.106E+12
Kr-85	2.693E+02	9.964E+12	1.875E+00	6.938E+10	4.878E+00	1.805E+11	2.172E+01	8.036E+11	1.734E+02	6.416E+12	4.711E+02	1.743E+13
Kr-87	1.365E+01	5.051E+11	1.170E-02	4.329E+08	4.390E-04	1.624E+07	7.132E-08	2.639E+03	6.326E-25	2.341E-14	1.366E+01	5.054E+11
Kr-88	4.786E+01	1.771E+12	1.186E-01	4.388E+09	3.368E-02	1.246E+09	6.881E-04	2.546E+07	1.565E-11	5.791E-01	4.801E+01	1.776E+12
Kr-89	1.260E-01	4.662E+09	4.744E-16	1.755E-05	2.768E-50	1.024E-39	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.260E-01	4.662E+09
Xe-131m	5.476E+01	2.026E+12	5.269E-01	1.950E+10	1.550E+00	5.735E+10	9.473E+00	3.505E+11	8.667E+01	3.207E+12	1.530E+02	5.661E+12
Xe-133m	6.924E+01	2.562E+12	4.025E+00	1.489E+11	1.188E+01	4.396E+11	4.107E+01	1.520E+12	2.417E+01	8.943E+11	1.504E+02	5.565E+12
Xe-133	4.808E+03	1.779E+14	8.294E+01	3.069E+12	2.349E+02	8.691E+12	9.134E+02	3.380E+13	1.558E+03	5.765E+13	7.597E+03	2.811E+14
Xe-135m	9.009E+02	3.333E+13	2.273E+03	8.410E+13	2.859E+03	1.058E+14	1.054E+03	3.900E+13	1.262E+00	4.669E+10	7.088E+03	2.623E+14
Xe-135	3.154E+02	1.167E+13	3.712E+02	1.373E+13	6.204E+02	2.295E+13	3.471E+02	1.284E+13	1.427E+00	5.280E+10	1.655E+03	6.124E+13
Xe-137	2.887E-01	1.068E+10	9.932E-14	3.675E-03	4.492E-42	1.662E-31	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.887E-01	1.068E+10
Xe-138	3.434E+00	1.271E+11	9.959E-06	3.685E+05	2.041E-13	7.552E-03	8.199E-34	3.034E-23	0.000E+00	0.000E+00	3.434E+00	1.271E+11
Br-83	3.105E+00	1.149E+11	2.064E-02	7.637E+08	3.304E-02	1.222E+09	1.187E-03	4.392E+07	4.062E-12	1.503E-01	3.159E+00	1.169E+11
Br-84	3.844E+00	1.422E+11	4.306E-03	1.593E+08	7.921E-04	2.931E+07	7.298E-12	2.700E-01	4.404E-52	1.629E-41	3.849E+00	1.424E+11
Br-85	7.119E-01	2.634E+10	4.381E-05	1.621E+06	6.904E-07	2.554E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.120E-01	2.634E+10
I-129	1.942E-06	7.185E+04	3.838E-08	1.420E+03	4.662E-07	1.725E+04	9.049E-06	3.348E+05	3.973E-04	1.470E+07	4.088E-04	1.513E+07
I-130	2.679E+00	9.912E+10	3.998E-02	1.479E+09	3.041E-01	1.125E+10	6.765E-01	2.503E+10	3.436E-02	1.271E+09	3.734E+00	1.382E+11
I-131	3.199E+01	1.184E+12	6.194E-01	2.292E+10	7.305E+00	2.703E+11	1.192E+02	4.410E+12	1.500E+03	5.550E+13	1.659E+03	6.138E+13
I-132	3.721E+01	1.377E+12	2.421E-01	8.958E+09	3.626E-01	1.342E+10	1.103E-02	4.081E+08	1.671E-11	6.183E-01	3.782E+01	1.399E+12
I-133	6.155E+01	2.277E+12	1.022E+00	3.781E+10	9.383E+00	3.472E+11	4.389E+01	1.624E+12	1.163E+01	4.303E+11	1.275E+02	4.718E+12
I-134	4.170E+01	1.543E+12	9.438E-02	3.492E+09	3.336E-02	1.234E+09	7.756E-07	2.870E+04	6.711E-31	2.483E-20	4.183E+01	1.548E+12
I-135	5.032E+01	1.862E+12	6.126E-01	2.267E+10	3.161E+00	1.170E+11	2.185E+00	8.085E+10	3.747E-03	1.386E+08	5.629E+01	2.083E+12
Rb-86	4.589E-03	1.698E+08	2.766E-05	1.023E+06	1.086E-04	4.018E+06	1.305E-03	4.829E+07	2.814E-02	1.041E+09	3.417E-02	1.264E+09
Rb-88	1.105E+00	4.089E+10	1.286E-03	4.758E+07	6.410E-04	2.372E+07	2.976E-05	1.101E+06	2.261E-12	8.366E-02	1.107E+00	4.096E+10

Table 7.1-20— Radionuclide Releases to Atmosphere for SGTR with Accident-Induced (Coincident) Iodine Spike

(Page 2 of 2)

	Releases to Atmosphere During Specified Time Intervals (hrs)											
	0 to 2		2 to 8		8 to 24		24 to 96		96 to 720		Total	
Nuclide	Ci	Bq	Ci	Bq	Ci	Bq	Ci	Bq	Ci	Bq	Ci	Bq
Rb-89	1.257E-02	4.651E+08	4.677E-08	1.730E+03	4.331E-15	1.602E-04	1.140E-33	4.218E-23	0.000E+00	0.000E+00	1.257E-02	4.651E+08
Cs-134	5.246E-01	1.941E+10	3.196E-03	1.183E+08	1.275E-02	4.718E+08	1.648E-01	6.098E+09	6.259E+00	2.316E+11	6.964E+00	2.577E+11
Cs-136	1.253E-01	4.636E+09	7.520E-04	2.782E+07	2.931E-03	1.084E+08	3.415E-02	1.264E+09	5.875E-01	2.174E+10	7.507E-01	2.778E+10
Cs-137	2.008E-01	7.430E+09	1.224E-03	4.529E+07	4.884E-03	1.807E+08	6.322E-02	2.339E+09	2.436E+00	9.013E+10	2.706E+00	1.001E+11
Cs-138	1.397E-01	5.169E+09	9.813E-06	3.631E+05	5.129E-09	1.898E+02	1.405E-17	5.199E-07	2.046E-57	7.570E-47	1.397E-01	5.169E+09
Ba-137m	1.883E-01	6.967E+09	1.148E-03	4.248E+07	4.579E-03	1.694E+08	5.927E-02	2.193E+09	2.284E+00	8.451E+10	2.537E+00	9.387E+10
Total	6.801E+03	2.516E+14	2.802E+03	1.037E+14	3.780E+03	1.399E+14	2.554E+03	9.450E+13	3.368E+03	1.246E+14	1.930E+04	7.141E+14

Table 7.1-21— Radionuclide Releases to Atmosphere for Design Basis LOCA
(Page 1 of 4)

	Releases to Atmosphere During Specified Time Intervals (hrs)													
	0 to 1.5		1.5 to 3.5		3.5 to 8		8 to 24		24 to 96		96 to 720		Total	
Nuclide	Ci	Bq	Ci	Bq	Ci	Bq	Ci	Bq	Ci	Bq	Ci	Bq	Ci	Bq
Kr-83m	7.297E+02	2.700E+13	2.751E+03	1.018E+14	4.641E+03	1.717E+14	4.187E+03	1.549E+14	1.072E+02	3.966E+12	3.150E-07	1.166E+04	1.242E+04	4.595E+14
Kr-85m	1.709E+03	6.323E+13	6.303E+03	2.332E+14	8.876E+03	3.284E+14	8.074E+03	2.987E+14	3.703E+02	1.370E+13	5.366E-03	1.985E+08	2.533E+04	9.372E+14
Kr-85	1.126E+02	4.166E+12	4.307E+02	1.594E+13	9.847E+02	3.643E+13	3.497E+03	1.294E+14	7.845E+03	2.903E+14	6.661E+04	2.465E+15	7.948E+04	2.941E+15
Kr-87	2.224E+03	8.229E+13	4.925E+03	1.822E+14	2.337E+03	8.647E+13	2.199E+02	8.136E+12	1.791E-02	6.627E+08	1.613E-19	5.968E-09	9.706E+03	3.591E+14
Kr-88	4.382E+03	1.621E+14	1.434E+04	5.306E+14	1.548E+04	5.728E+14	7.580E+03	2.805E+14	7.766E+01	2.873E+12	1.794E-06	6.638E+04	4.186E+04	1.549E+15
Kr-89	9.523E+00	3.524E+11	3.044E-06	1.126E+05	1.461E-17	5.406E-07	3.346E-43	1.238E-32	0.000E+00	0.000E+00	0.000E+00	0.000E+00	9.523E+00	3.524E+11
Xe-131m	7.277E+01	2.692E+12	3.151E+02	1.166E+13	7.225E+02	2.673E+13	2.650E+03	9.805E+13	8.448E+03	3.126E+14	8.304E+04	3.072E+15	9.525E+04	3.524E+15
Xe-133m	4.023E+02	1.489E+13	1.806E+03	6.682E+13	4.148E+03	1.535E+14	1.551E+04	5.739E+14	3.840E+04	1.421E+15	2.689E+04	9.949E+14	8.716E+04	3.225E+15
Xe-133	1.326E+04	4.906E+14	5.898E+04	2.182E+15	1.353E+05	5.006E+15	4.923E+05	1.822E+16	1.172E+06	4.336E+16	2.331E+06	8.625E+16	4.202E+06	1.555E+17
Xe-135m	1.676E+03	6.201E+13	1.283E+04	4.747E+14	5.187E+04	1.919E+15	1.495E+05	5.532E+15	6.371E+04	2.357E+15	8.257E+01	3.055E+12	2.797E+05	1.035E+16
Xe-135	4.390E+03	1.624E+14	2.130E+04	7.881E+14	5.958E+04	2.204E+15	2.402E+05	8.887E+15	1.708E+05	6.320E+15	9.095E+02	3.365E+13	4.971E+05	1.839E+16
Xe-137	2.238E+01	8.281E+11	1.730E-04	6.401E+06	7.545E-14	2.792E-03	4.529E-35	1.676E-24	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.238E+01	8.281E+11
Xe-138	6.229E+02	2.305E+13	9.854E+01	3.646E+12	3.005E-01	1.112E+10	5.518E-07	2.042E+04	1.111E-27	4.111E-17	0.000E+00	0.000E+00	7.217E+02	2.670E+13
Br-83	3.714E+00	1.374E+11	7.476E+00	2.766E+11	5.922E+00	2.191E+11	1.578E+00	5.839E+10	9.943E-03	3.679E+08	7.939E-12	2.937E-01	1.870E+01	6.919E+11
Br-84	3.206E+00	1.186E+11	1.399E+00	5.176E+10	1.010E-01	3.737E+09	2.106E-04	7.792E+06	1.010E-13	3.737E-03	1.200E-54	4.440E-44	4.706E+00	1.741E+11
Br-85	7.005E-01	2.592E+10	3.783E-10	1.400E+01	1.011E-22	3.741E-12	3.330E-51	1.232E-40	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.005E-01	2.592E+10
I-129	2.143E-06	7.929E+04	6.460E-06	2.390E+05	1.204E-05	4.455E+05	2.778E-05	1.028E+06	8.971E-05	3.319E+06	6.739E-04	2.493E+07	8.120E-04	3.004E+07
I-130	3.160E+00	1.169E+11	8.910E+00	3.297E+11	1.395E+01	5.162E+11	1.919E+01	7.100E+11	9.181E+00	3.397E+11	1.557E-01	5.761E+09	5.455E+01	2.018E+12
I-131	3.558E+01	1.316E+12	1.070E+02	3.959E+12	1.971E+02	7.293E+12	4.395E+02	1.626E+13	1.216E+03	4.499E+13	3.310E+03	1.225E+14	5.305E+03	1.963E+14
I-132	3.928E+01	1.453E+12	8.453E+01	3.128E+12	8.515E+01	3.151E+12	8.672E+01	3.209E+12	1.646E+02	6.090E+12	1.700E+02	6.290E+12	6.303E+02	2.332E+13
I-133	7.134E+01	2.640E+12	2.071E+02	7.663E+12	3.479E+02	1.287E+13	5.859E+02	2.168E+13	5.389E+02	1.994E+13	5.089E+01	1.883E+12	1.802E+03	6.667E+13
I-134	4.192E+01	1.551E+12	4.308E+01	1.594E+12	1.043E+01	3.859E+11	2.466E-01	9.124E+09	4.949E-07	1.831E+04	8.736E-32	3.232E-21	9.568E+01	3.540E+12
I-135	6.120E+01	2.264E+12	1.615E+02	5.976E+12	2.183E+02	8.077E+12	2.005E+02	7.419E+12	3.195E+01	1.182E+12	1.584E-02	5.861E+08	6.735E+02	2.492E+13
Rb-86m	2.457E-04	9.091E+06	8.331E-31	3.082E-20	2.805E-66	1.038E-55	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.457E-04	9.091E+06
Rb-86	1.268E-01	4.692E+09	3.249E-01	1.202E+10	5.175E-01	1.915E+10	6.158E-01	2.278E+10	1.784E-01	6.601E+09	3.473E-02	1.285E+09	1.798E+00	6.653E+10

Table 7.1-21— Radionuclide Releases to Atmosphere for Design Basis LOCA

(Page 2 of 4)

	Releases to Atmosphere During Specified Time Intervals (hrs)													
	0 to 1.5		1.5 to 3.5		3.5 to 8		8 to 24		24 to 96		96 to 720		Total	
Nuclide	Ci	Bq	Ci	Bq	Ci	Bq	Ci	Bq	Ci	Bq	Ci	Bq	Ci	Bq
Rb-88	6.288E+01	2.327E+12	1.545E+02	5.717E+12	1.636E+02	6.053E+12	8.009E+01	2.963E+12	8.460E-01	3.130E+10	1.980E-08	7.326E+02	4.619E+02	1.709E+13
Rb-89	1.126E+01	4.166E+11	5.235E-01	1.937E+10	1.960E-03	7.252E+07	4.966E-09	1.837E+02	5.198E-29	1.923E-18	0.000E+00	0.000E+00	1.178E+01	4.359E+11
Cs-134	1.418E+01	5.247E+11	3.636E+01	1.345E+12	5.818E+01	2.153E+12	7.012E+01	2.594E+12	2.128E+01	7.874E+11	5.202E+00	1.925E+11	2.053E+02	7.596E+12
Cs-136	3.511E+00	1.299E+11	9.004E+00	3.331E+11	1.431E+01	5.295E+11	1.694E+01	6.268E+11	4.810E+00	1.780E+11	8.548E-01	3.163E+10	4.943E+01	1.829E+12
Cs-137	5.419E+00	2.005E+11	1.389E+01	5.139E+11	2.223E+01	8.225E+11	2.679E+01	9.912E+11	8.142E+00	3.013E+11	2.002E+00	7.407E+10	7.848E+01	2.904E+12
Cs-138	4.511E+01	1.669E+12	2.603E+01	9.631E+11	1.839E+00	6.804E+10	3.106E-03	1.149E+08	3.645E-13	1.349E-02	3.186E-55	1.179E-44	7.298E+01	2.700E+12
Sb-125	7.674E-02	2.839E+09	3.605E-01	1.334E+10	5.787E-01	2.141E+10	6.973E-01	2.580E+10	2.117E-01	7.833E+09	5.185E-02	1.918E+09	1.977E+00	7.315E+10
Sb-127	3.566E-01	1.319E+10	1.658E+00	6.135E+10	2.602E+00	9.627E+10	2.947E+00	1.090E+11	7.152E-01	2.646E+10	6.814E-02	2.521E+09	8.347E+00	3.088E+11
Sb-129	8.062E-01	2.983E+10	3.074E+00	1.137E+11	3.076E+00	1.138E+11	1.172E+00	4.336E+10	1.262E-02	4.669E+08	9.903E-09	3.664E+02	8.142E+00	3.013E+11
Te-127m	5.087E-02	1.882E+09	2.290E-01	8.473E+09	3.677E-01	1.360E+10	4.432E-01	1.640E+10	1.345E-01	4.977E+09	3.221E-02	1.192E+09	1.257E+00	4.651E+10
Te-127	3.679E-01	1.361E+10	1.678E+00	6.209E+10	2.678E+00	9.909E+10	3.139E+00	1.161E+11	8.103E-01	2.998E+10	9.679E-02	3.581E+09	8.769E+00	3.245E+11
Te-129m	1.475E-01	5.458E+09	6.643E-01	2.458E+10	1.065E+00	3.941E+10	1.276E+00	4.721E+10	3.779E-01	1.398E+10	8.132E-02	3.009E+09	3.612E+00	1.336E+11
Te-129	9.137E-01	3.381E+10	3.758E+00	1.390E+11	4.244E+00	1.570E+11	2.219E+00	8.210E+10	2.610E-01	9.657E+09	5.294E-02	1.959E+09	1.145E+01	4.237E+11
Te-131m	4.117E-01	1.523E+10	1.808E+00	6.690E+10	2.706E+00	1.001E+11	2.700E+00	9.990E+10	4.296E-01	1.590E+10	9.844E-03	3.642E+08	8.066E+00	2.984E+11
Te-131	4.731E-01	1.750E+10	6.764E-01	2.503E+10	6.180E-01	2.287E+10	6.079E-01	2.249E+10	9.670E-02	3.578E+09	2.216E-03	8.199E+07	2.474E+00	9.154E+10
Te-132	4.076E+00	1.508E+11	1.819E+01	6.730E+11	2.841E+01	1.051E+12	3.181E+01	1.177E+12	7.423E+00	2.747E+11	6.147E-01	2.274E+10	9.053E+01	3.350E+12
Te-134	1.637E+00	6.057E+10	2.306E+00	8.532E+10	2.992E-01	1.107E+10	1.926E-03	7.126E+07	2.642E-11	9.775E-01	1.491E-43	5.517E-33	4.244E+00	1.570E+11
Sr-89	1.295E+00	4.792E+10	6.070E+00	2.246E+11	9.727E+00	3.599E+11	1.167E+01	4.318E+11	3.484E+00	1.289E+11	7.831E-01	2.897E+10	3.303E+01	1.222E+12
Sr-90	1.352E-01	5.002E+09	6.346E-01	2.348E+10	1.019E+00	3.770E+10	1.228E+00	4.544E+10	3.731E-01	1.380E+10	9.176E-02	3.395E+09	3.481E+00	1.288E+11
Sr-91	1.523E+00	5.635E+10	6.489E+00	2.401E+11	8.369E+00	3.097E+11	5.720E+00	2.116E+11	3.029E-01	1.121E+10	1.462E-04	5.409E+06	2.240E+01	8.288E+11
Sr-92	1.273E+00	4.710E+10	4.299E+00	1.591E+11	3.300E+00	1.221E+11	7.207E-01	2.667E+10	1.556E-03	5.757E+07	1.220E-12	4.514E-02	9.594E+00	3.550E+11
Ba-137m	4.246E+00	1.571E+11	1.310E+01	4.847E+11	2.103E+01	7.781E+11	2.535E+01	9.380E+11	7.702E+00	2.850E+11	1.894E+00	7.008E+10	7.332E+01	2.713E+12
Ba-139	1.252E+00	4.632E+10	2.933E+00	1.085E+11	1.185E+00	4.385E+10	7.377E-02	2.729E+09	2.809E-06	1.039E+05	3.953E-23	1.463E-12	5.444E+00	2.014E+11
Ba-140	2.011E+00	7.441E+10	9.409E+00	3.481E+11	1.500E+01	5.550E+11	1.775E+01	6.568E+11	5.031E+00	1.861E+11	8.876E-01	3.284E+10	5.008E+01	1.853E+12
Mo-99	6.680E-01	2.472E+10	1.185E+00	4.385E+10	1.843E+00	6.819E+10	2.036E+00	7.533E+10	4.535E-01	1.678E+10	3.193E-02	1.181E+09	6.218E+00	2.301E+11

Table 7.1-21— Radionuclide Releases to Atmosphere for Design Basis LOCA

(Page 3 of 4)

	Releases to Atmosphere During Specified Time Intervals (hrs)													
	0 to 1.5		1.5 to 3.5		3.5 to 8		8 to 24		24 to 96		96 to 720		Total	
Nuclide	**Ci**	**Bq**	**Ci**	**Bq**	**Ci**	**Bq**	**Ci**	**Bq**	**Ci**	**Bq**	**Ci**	**Bq**	**Ci**	**Bq**
Tc-99m	4.054E-01	1.500E+10	1.062E+00	3.929E+10	1.685E+00	6.235E+10	1.916E+00	7.089E+10	4.358E-01	1.612E+10	3.075E-02	1.138E+09	5.535E+00	2.048E+11
Ru-103	2.419E-01	8.950E+09	1.134E+00	4.196E+10	1.816E+00	6.719E+10	2.175E+00	8.048E+10	6.463E-01	2.391E+10	1.417E-01	5.243E+09	6.155E+00	2.277E+11
Ru-105	1.639E-01	6.064E+09	6.263E-01	2.317E+10	6.347E-01	2.348E+10	2.485E-01	9.195E+09	2.881E-03	1.066E+08	3.096E-09	1.146E+02	1.676E+00	6.201E+10
Ru-106	1.433E-01	5.302E+09	6.720E-01	2.486E+10	1.079E+00	3.992E+10	1.299E+00	4.806E+10	3.939E-01	1.457E+10	9.568E-02	3.540E+09	3.683E+00	1.363E+11
Rh-103 m	2.180E-01	8.066E+09	1.022E+00	3.781E+10	1.637E+00	6.057E+10	1.961E+00	7.256E+10	5.827E-01	2.156E+10	1.277E-01	4.725E+09	5.549E+00	2.053E+11
Rh-105	1.753E-01	6.486E+09	8.191E-01	3.031E+10	1.284E+00	4.751E+10	1.375E+00	5.088E+10	2.453E-01	9.076E+09	7.574E-03	2.802E+08	3.907E+00	1.446E+11
Rh-106	1.433E-01	5.302E+09	6.720E-01	2.486E+10	1.079E+00	3.992E+10	1.299E+00	4.806E+10	3.939E-01	1.457E+10	9.568E-02	3.540E+09	3.683E+00	1.363E+11
Ce-141	4.504E-02	1.666E+09	2.100E-01	7.770E+09	3.363E-01	1.244E+10	4.027E-01	1.490E+10	1.191E-01	4.407E+09	2.551E-02	9.439E+08	1.139E+00	4.214E+10
Ce-143	4.473E-02	1.655E+09	2.032E-01	7.518E+09	3.060E-01	1.132E+10	3.105E-01	1.149E+10	5.212E-02	1.928E+09	1.426E-03	5.276E+07	9.179E-01	3.396E+10
Ce-144	3.421E-02	1.266E+09	1.595E-01	5.902E+09	2.560E-01	9.472E+09	3.085E-01	1.141E+10	9.342E-02	3.457E+09	2.261E-02	8.366E+08	8.743E-01	3.235E+10
Np-239	7.573E-01	2.802E+10	3.479E+00	1.287E+11	5.379E+00	1.990E+11	5.860E+00	2.168E+11	1.242E+00	4.595E+10	7.389E-02	2.734E+09	1.679E+01	6.212E+11
Pu-238	2.937E-04	1.087E+07	1.371E-03	5.073E+07	2.200E-03	8.140E+07	2.652E-03	9.812E+07	8.060E-04	2.982E+07	1.984E-04	7.341E+06	7.522E-03	2.783E+08
Pu-239	1.236E-05	4.573E+05	5.767E-05	2.134E+06	9.263E-05	3.427E+06	1.118E-04	4.137E+06	3.413E-05	1.263E+06	8.458E-06	3.129E+05	3.171E-04	1.173E+07
Pu-240	2.817E-05	1.042E+06	1.315E-04	4.866E+06	2.110E-04	7.807E+06	2.543E-04	9.409E+06	7.729E-05	2.860E+06	1.901E-05	7.034E+05	7.212E-04	2.668E+07
Pu-241	5.110E-03	1.891E+08	2.385E-02	8.825E+08	3.828E-02	1.416E+09	4.613E-02	1.707E+09	1.402E-02	5.187E+08	3.446E-03	1.275E+08	1.308E-01	4.840E+09
Y-90	3.140E-03	1.162E+08	2.339E-02	8.654E+08	6.936E-02	2.566E+09	1.818E-01	6.727E+09	1.423E-01	5.265E+09	7.603E-02	2.813E+09	4.961E-01	1.836E+10
Y-91m	5.663E-01	2.095E+10	3.441E+00	1.273E+11	5.191E+00	1.921E+11	3.634E+00	1.345E+11	1.924E-01	7.119E+09	9.288E-05	3.437E+06	1.302E+01	4.817E+11
Y-91	1.652E-02	6.112E+08	8.019E-02	2.967E+09	1.426E-01	5.276E+09	2.021E-01	7.478E+09	7.064E-02	2.614E+09	1.656E-02	6.127E+08	5.286E-01	1.956E+10
Y-92	3.112E-01	1.151E+10	2.236E+00	8.273E+10	3.968E+00	1.468E+11	2.181E+00	8.070E+10	2.160E-02	7.992E+08	1.599E-09	5.916E+01	8.719E+00	3.226E+11
Y-93	1.749E-02	6.471E+08	7.414E-02	2.743E+09	9.685E-02	3.583E+09	6.832E-02	2.528E+09	3.943E-03	1.459E+08	2.631E-06	9.735E+04	2.607E-01	9.646E+09
Zr-95	1.861E-02	6.886E+08	8.589E-02	3.178E+09	1.377E-01	5.095E+09	1.654E-01	6.120E+09	4.955E-02	1.833E+09	1.135E-02	4.200E+08	4.685E-01	1.733E+10
Zr-97	1.877E-02	6.945E+08	8.243E-02	3.050E+09	1.169E-01	4.325E+09	1.014E-01	3.752E+09	1.051E-02	3.889E+08	5.726E-05	2.119E+06	3.300E-01	1.221E+10
Nb-95	1.862E-02	6.889E+08	8.599E-02	3.182E+09	1.380E-01	5.106E+09	1.664E-01	6.157E+09	5.053E-02	1.870E+09	1.232E-02	4.558E+08	4.719E-01	1.746E+10
La-140	6.044E-02	2.236E+09	4.868E-01	1.801E+10	1.509E+00	5.583E+10	3.941E+00	1.458E+11	2.736E+00	1.012E+11	9.057E-01	3.351E+10	9.639E+00	3.566E+11

Table 7.1-21— Radionuclide Releases to Atmosphere for Design Basis LOCA

(Page 4 of 4)

	Releases to Atmosphere During Specified Time Intervals (hrs)													
	0 to 1.5		1.5 to 3.5		3.5 to 8		8 to 24		24 to 96		96 to 720		Total	
Nuclide	**Ci**	**Bq**	**Ci**	**Bq**	**Ci**	**Bq**	**Ci**	**Bq**	**Ci**	**Bq**	**Ci**	**Bq**	**Ci**	**Bq**
La-141	1.590E-02	5.883E+08	5.866E-02	2.170E+09	5.613E-02	2.077E+09	1.940E-02	7.178E+08	1.590E-04	5.883E+06	3.935E-11	1.456E+00	1.502E-01	5.557E+09
La-142	1.132E-02	4.188E+08	2.986E-02	1.105E+09	1.382E-02	5.113E+08	1.118E-03	4.137E+07	1.026E-07	3.796E+03	7.220E-23	2.671E-12	5.612E-02	2.076E+09
Pr-143	1.844E-02	6.823E+08	8.551E-02	3.164E+09	1.384E-01	5.121E+09	1.698E-01	6.283E+09	5.241E-02	1.939E+09	1.030E-02	3.811E+08	4.748E-01	1.757E+10
Pr-144	3.272E-02	1.211E+09	1.590E-01	5.883E+09	2.560E-01	9.472E+09	3.085E-01	1.141E+10	9.343E-02	3.457E+09	2.261E-02	8.366E+08	8.722E-01	3.227E+10
Nd-147	7.658E-03	2.833E+08	3.525E-02	1.304E+09	5.615E-02	2.078E+09	6.621E-02	2.450E+09	1.857E-02	6.871E+08	3.127E-03	1.157E+08	1.870E-01	6.919E+09
Am-241	2.343E-06	8.669E+04	1.083E-05	4.007E+05	1.740E-05	6.438E+05	2.105E-05	7.789E+05	6.475E-06	2.396E+05	1.695E-06	6.272E+04	5.978E-05	2.212E+06
Cm-242	1.065E-03	3.941E+07	4.917E-03	1.819E+08	7.889E-03	2.919E+08	9.495E-03	3.513E+08	2.870E-03	1.062E+08	6.862E-04	2.539E+07	2.692E-02	9.960E+08
Cm-244	5.651E-04	2.091E+07	2.610E-03	9.657E+07	4.190E-03	1.550E+08	5.049E-03	1.868E+08	1.534E-03	5.676E+07	3.772E-04	1.396E+07	1.432E-02	5.298E+08
Total	3.005E+04	1.112E+15	1.250E+05	4.625E+15	2.852E+05	1.055E+16	9.254E+05	3.424E+16	1.463E+06	5.413E+16	2.512E+06	9.294E+16	5.341E+06	1.976E+17

Table 7.1-22— Radionuclide Releases to Atmosphere for Fuel Handling Accident

Nuclide	Releases to Atmosphere (Ci) During Specified Time Intervals (hrs)											
	0 to 2		2 to 8		8 to 24		24 to 96		96 to 720		Total	
	Ci	Bq	Ci	Bq	Ci	Bq	Ci	Bq	Ci	Bq	Ci	Bq
Kr-83m	1.437E+00	5.317E+10	2.129E-01	7.877E+09	4.404E-02	1.629E+09	4.294E-04	1.589E+07	3.665E-13	1.356E-02	1.694E+00	6.268E+10
Kr-85m	7.810E+01	2.890E+12	3.881E-01	1.436E+10	4.693E-08	1.736E+03	1.678E-26	6.209E-16	0.000E+00	0.000E+00	7.849E+01	2.904E+12
Kr-85	1.471E+03	5.443E+13	9.977E+00	3.691E+11	3.052E-06	1.129E+05	1.296E-23	4.795E-13	0.000E+00	0.000E+00	1.481E+03	5.480E+13
Kr-87	2.330E-04	8.621E+06	5.290E-07	1.957E+04	6.148E-15	2.275E-04	4.260E-36	1.576E-25	0.000E+00	0.000E+00	2.335E-04	8.640E+06
Kr-88	1.016E+01	3.759E+11	4.220E-02	1.561E+09	2.983E-09	1.104E+02	2.549E-28	9.431E-18	0.000E+00	0.000E+00	1.020E+01	3.774E+11
Xe-131m	5.637E+02	2.086E+13	1.475E+01	5.458E+11	2.813E+01	1.041E+12	1.084E+02	4.011E+12	3.282E+02	1.214E+13	1.043E+03	3.859E+13
Xe-133m	2.609E+03	9.653E+13	8.098E+01	2.996E+12	1.193E+02	4.414E+12	1.540E+02	5.698E+12	1.538E+01	5.691E+11	2.979E+03	1.102E+14
Xe-133	9.442E+04	3.494E+15	1.533E+03	5.672E+13	1.684E+03	6.231E+13	2.174E+03	8.044E+13	2.171E+02	8.033E+12	1.000E+05	3.700E+15
Xe-135m	1.089E+03	4.029E+13	1.975E+03	7.308E+13	1.834E+03	6.786E+13	4.211E+02	1.558E+13	2.219E-01	8.210E+09	5.319E+03	1.968E+14
Xe-135	1.407E+04	5.206E+14	7.705E+02	2.851E+13	6.412E+02	2.372E+13	1.472E+02	5.446E+12	7.759E-02	2.871E+09	1.563E+04	5.783E+14
Xe-138	1.825E-39	6.753E-29	3.471E-44	1.284E-33	2.388E-58	8.836E-48	4.092E-96	1.514E-85	0.000E+00	0.000E+00	1.825E-39	6.753E-29
Br-83	1.610E-03	5.957E+07	6.097E-06	2.256E+05	3.273E-13	1.211E-02	1.343E-32	4.969E-22	0.000E+00	0.000E+00	1.616E-03	5.979E+07
Br-84	2.046E-18	7.570E-08	1.009E-21	3.733E-11	1.206E-31	4.462E-21	4.188E-58	1.550E-47	0.000E+00	0.000E+00	2.047E-18	7.574E-08
I-129	1.459E-05	5.398E+05	9.898E-08	3.662E+03	3.028E-14	1.120E-03	1.286E-31	4.758E-21	0.000E+00	0.000E+00	1.469E-05	5.435E+05
I-130	3.363E+00	1.244E+11	2.038E-02	7.541E+08	4.453E-09	1.648E+02	7.713E-27	2.854E-16	0.000E+00	0.000E+00	3.383E+00	1.252E+11
I-131	3.443E+02	1.274E+13	2.319E+00	8.580E+10	6.942E-07	2.569E+04	2.784E-24	1.030E-13	0.000E+00	0.000E+00	3.466E+02	1.282E+13
I-132	1.118E-02	4.137E+08	4.139E-05	1.531E+06	2.076E-12	7.681E-02	7.100E-32	2.627E-21	0.000E+00	0.000E+00	1.122E-02	4.151E+08
I-133	1.615E+02	5.976E+12	1.025E+00	3.793E+10	2.567E-07	9.498E+03	6.398E-25	2.367E-14	0.000E+00	0.000E+00	1.625E+02	6.013E+12
I-134	8.997E-10	3.329E+01	1.249E-12	4.621E-02	3.325E-21	1.230E-10	4.528E-44	1.675E-33	0.000E+00	0.000E+00	9.009E-10	3.333E+01
I-135	1.282E+01	4.743E+11	7.041E-02	2.605E+09	1.148E-08	4.248E+02	9.113E-27	3.372E-16	0.000E+00	0.000E+00	1.289E+01	4.769E+11
Rb-88	4.884E+00	1.807E+11	4.672E-02	1.729E+09	3.332E-09	1.233E+02	2.846E-28	1.053E-17	0.000E+00	0.000E+00	4.931E+00	1.824E+11
Cs-138	6.206E-40	2.296E-29	1.019E-42	3.770E-32	1.379E-52	5.102E-42	6.210E-79	2.298E-68	0.000E+00	0.000E+00	6.216E-40	2.300E-29
Total	1.148E+05	4.248E+15	4.388E+03	1.624E+14	4.307E+03	1.594E+14	3.005E+03	1.112E+14	5.610E+02	2.076E+13	1.271E+05	4.703E+15

Table 7.1-23— Radionuclide Releases to Atmosphere for Rod Ejection Accident (REA) with Accident-Induced 36.7% Clad Failure

	Releases to Atmosphere (Ci) During Specified Time Intervals (hrs)					
	0 to 2		2 to 8		Total	
Nuclide	Ci	Bq	Ci	Bq	Ci	Bq
Kr-83m	6.655E+02	2.462E+13	5.477E+02	2.026E+13	1.213E+03	4.488E+13
Kr-85m	1.872E+03	6.926E+13	3.118E+03	1.154E+14	4.990E+03	1.846E+14
Kr-85	1.026E+02	3.796E+12	3.074E+02	1.137E+13	4.100E+02	1.517E+13
Kr-87	2.651E+03	9.809E+13	1.290E+03	4.773E+13	3.941E+03	1.458E+14
Kr-88	4.894E+03	1.811E+14	5.970E+03	2.209E+14	1.086E+04	4.018E+14
Kr-89	2.967E+02	1.098E+13	1.193E-09	4.414E+01	2.967E+02	1.098E+13
Xe-131m	7.443E+01	2.754E+12	2.209E+02	8.173E+12	2.953E+02	1.093E+13
Xe-133m	4.246E+02	1.571E+13	1.209E+03	4.473E+13	1.633E+03	6.042E+13
Xe-133	1.390E+04	5.143E+14	4.078E+04	1.509E+15	5.467E+04	2.023E+15
Xe-135m	4.932E+02	1.825E+13	8.973E+01	3.320E+12	5.829E+02	2.157E+13
Xe-135	4.202E+03	1.555E+14	9.607E+03	3.555E+14	1.381E+04	5.110E+14
Xe-137	5.606E+02	2.074E+13	2.073E-07	7.670E+03	5.606E+02	2.074E+13
Xe-138	2.009E+03	7.433E+13	5.684E+00	2.103E+11	2.015E+03	7.456E+13
Br-83	3.270E+00	1.210E+11	1.566E+01	5.794E+11	1.893E+01	7.004E+11
Br-84	1.892E+00	7.000E+10	6.754E-01	2.499E+10	2.567E+00	9.498E+10
Br-85	2.564E-02	9.487E+08	1.917E-13	7.093E-03	2.564E-02	9.487E+08
I-129	2.042E-06	7.555E+04	3.009E-05	1.113E+06	3.213E-05	1.189E+06
I-130	2.985E+00	1.104E+11	3.487E+01	1.290E+12	3.786E+01	1.401E+12
I-131	3.385E+01	1.252E+12	4.915E+02	1.819E+13	5.254E+02	1.944E+13
I-132	3.305E+01	1.223E+12	1.520E+02	5.624E+12	1.851E+02	6.849E+12
I-133	6.775E+01	2.507E+12	8.692E+02	3.216E+13	9.369E+02	3.467E+13
I-134	2.896E+01	1.072E+12	3.175E+01	1.175E+12	6.071E+01	2.246E+12
I-135	5.703E+01	2.110E+12	5.471E+02	2.024E+13	6.042E+02	2.236E+13
Rb-86m	4.849E-06	1.794E+05	1.306E-39	4.832E-29	4.849E-06	1.794E+05
Rb-86	1.683E-01	6.227E+09	2.480E+00	9.176E+10	2.648E+00	9.798E+10
Rb-88	4.004E+03	1.481E+14	6.652E+03	2.461E+14	1.066E+04	3.944E+14
Rb-89	2.983E+02	1.104E+13	1.662E+00	6.149E+10	2.999E+02	1.110E+13
Cs-134	1.887E+01	6.982E+11	2.796E+02	1.035E+13	2.985E+02	1.104E+13
Cs-136	4.672E+00	1.729E+11	6.863E+01	2.539E+12	7.330E+01	2.712E+12
Cs-137	7.195E+00	2.662E+11	1.067E+02	3.948E+12	1.139E+02	4.214E+12
Cs-138	1.765E+03	6.531E+13	2.733E+02	1.011E+13	2.038E+03	7.541E+13
Sr-89	2.739E-01	1.013E+10	1.163E+00	4.303E+10	1.437E+00	5.317E+10
Ba-137m	6.794E+00	2.514E+11	1.009E+02	3.733E+12	1.077E+02	3.985E+12
Total	3.848E+04	1.424E+15	7.277E+04	2.692E+15	1.113E+05	4.118E+15

7.2 SEVERE ACCIDENTS

This section evaluates the potential environmental impacts of severe accidents on the Calvert Cliffs Nuclear Power Plant (CCNPP) site from the proposed U.S. EPR plant. The environmental impacts from a postulated severe accident have been estimated using CCNPP site-specific data to demonstrate acceptability for a Combined License (COL) Application.

Severe accidents are defined as accidents with substantial damage to the reactor core and degradation of containment systems. Because the probability of a severe accident is very low for the U.S. EPR, such accidents are not part of the design basis for the plant. However, the Nuclear Regulatory Commission (NRC) requires, in its Policy Statement on Severe Reactor Accidents Regarding Future Designs and Existing Plants (FR, 1985), the completion of a probabilistic risk assessment (PRA) for severe accidents for new reactor designs. This requirement is codified in regulation 10 CFR 52.47, Contents of Applications.

A PRA was completed for the U.S. EPR as part of the application for design certification. This section presents the applicable results of the probabilistic risk assessment and includes site-specific characteristics of the CCNPP site and impacts of a severe accident over the entire life cycle. The purpose of this report is to identify the severe accident offsite radiological impacts, demonstrate that the impacts are acceptable, and support the severe accident mitigation alternatives analyses in Section 7.3.

7.2.1 Methodology

7.2.1.1 Offsite Consequences

The probabilistic risk assessment for the U.S. EPR established containment event trees that define the possible end states of the containment following an accident sequence. The end states are grouped into five broad categories as follows:

1. Containment intact, isolated and not bypassed (RC 101)
2. Containment bypassed (RC701, 702, 802)
3. Containment not isolated (isolation failure) (RC 201-206)
4. Early failures (excluding not isolated and bypassed) (RC 301-304, 401-404)
5. Late containment failures (RC 501-504, 602)

Using the Electric Power Research Institute code Modular Accident Analysis Program (MAAP), 23 release consequence (RC) categories are assigned to represent all potential severe accident release scenarios. The release categories are described in Table 7.2-1. An accident frequency (release category frequency) is assigned to each of the 23 categories, and these are shown in Table 7.2-3. The results from the U.S. EPR base case are applicable to CCNPP Unit 3.

The NRC code MACCS2 (Sandia, 1997) was used to model the environmental consequences of the severe accidents. MACCS2 was developed specifically for NRC to evaluate severe accidents at nuclear power plants. The exposure pathways modeled include external exposure to the passing plume, external exposure to 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 also evaluates the extent of contamination. The meteorology data used in the analysis was 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 expected number of early fatalities, expected number of latent cancer fatalities, and collective whole body dose from a severe accident to the year 2050 population within a 50-mile radius of the plant. Economic costs were also determined, including the costs associated with short-term relocation of people, decontamination of property and equipment, and interdiction of food supplies.

MACCS2 requires five input files: MET, SITE, ATMOS, EARLY, and CHRONC. 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 site-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, which uses actual CCNPP meteorological monitoring data from the years 1995 through 2004 and a site characteristics file, which uses site-specific population data, land usage, watershed index, and regions.

7.2.1.2 Population Data

Several sources of historical and projected population data were referenced before deciding on appropriate data, including SECPOP1990, SECPOP2000, and 2030 projected data. These data included the 50-mile region surrounding the CCNPP 3 site.

Population growth rate was first determined by comparing SECPOP1990 and SECPOP2000 data, which were each adjusted to include transient population. This resulted in an exponential growth rate of 1.103 per decade. For comparison, population growth rate was also determined by comparing the SECPOP2000 data with the 2030 data. This resulted in an exponential growth rate of 1.146 per decade. The 1.146 per decade rate was chosen as it produces higher populations and more conservative severe accident consequence results.

There are several plausible year 2000 population distributions that could be used in this analysis, including the SECPOP2000 data, and the 2030 data (which is descaled to the year 2000 using the 1.146 per decade exponential growth rate from above). The 2030 descaled data was chosen to represent the 2000 population distribution, because a severe accident was shown to have more severe affects on this population.

In summary, the 2000 population distribution is modeled by taking the 2030 population distribution data, and descaling it by a growth rate of 1.146 per decade. The population growth rate is modeled as 1.146 per decade. Populations at any point in time are then modeled by scaling the assumed 2000 population by the assumed population growth rate.

The consequences of a severe accident at CCNPP Unit 3 were determined using 2050 population. The population for 2050 was chosen because CCNPP Unit 3 has an expected start-up date of 2015 and operating life of 60 years. Recognizing that consequences increase with time (i.e., increasing population), a time-averaged consequence can be estimated by looking at the midpoint of the U.S. EPR operational life, 2045. To be conservative, this was rounded up to 2050. As a sensitivity case, the endpoint of the U.S. EPR operational life, 2075, round up to 2080, is also evaluated. The 2080 population was not checked for realistic results, such as unattainable population densities and is believed to be overly conservative due to the projection of a conservative growth rate over a time period of 80 years.

7.2.1.3 Risk Calculation

Release heights vary, depending on the event sequence, ranging from ground level to the top of the containment annulus. The time window for the analysis is 24 hours following core damage.

The results of the MACCS2 calculations and accident frequency information were used to determine risk. The sum of all release category frequencies is the core damage frequency and includes internal and external initiating events. External events include internal fire events and internal flood events. Risk is the set of accident sequences, their respective frequencies and their respective consequences. Risk is often more simply quantified as the sum of the products of accident sequence frequencies and consequences. The consequence can be radiation dose or economic cost. Therefore, risk can be reported as a combination of person-rem per year and dollars per year.

7.2.2 Consequences to Population Groups

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

The current U.S. nuclear fleet has an exceptional safety record. Through evolutionary and innovative design, the U.S. EPR has enhanced the ability to both prevent potential core damage events and to mitigate them should they occur. A list of example U.S. EPR design features which reduce plant risk is provided below.

- Increased redundancy and separation
- Four safety trains including four EFW divisions
- Separate power divisions for each safety train, each with dedicated battery division and EDG
- Two divisions each have a backup alternate ac diesel generator for SBO-type scenario
- State-of-the-art digital I&C
- Stand-still Seal System for backup to RCP seals
- Main Feedwater System with Startup and Shutdown System
- In-containment refueling water storage tank to eliminate transfer to long term recirculation
- Two, dedicated severe accident battery divisions
- Dedicated severe accident depressurization valves to prevent high pressure melt scenarios which can challenge containment due to postulated direct containment heating

- Containment combustible gas control system, including passive autocatalytic recombiners and gas mixing system
- Core stabilization system
- Passive cooling of molten core debris
- Active spray for environmental control of the containment atmosphere
- Active recirculation cooling of the molten core debris and containment atmosphere

The core damage frequency (CDF) is a measure of the impacts of potential accidents. CDF is estimated using PRA modeling which evaluates how changes to the reactor or auxiliary systems can change the severity of the accident. The CDF for the U.S. EPR is less than the CDFs for the current U.S. nuclear fleet.

7.2.2.1 Air Pathways

The potential severe accidents for the U.S. EPR were grouped into 23 release categories based on their similarity of characteristics. Each release category was assigned a set of characteristics representative of the elements of that class. Each release category was analyzed with MACCS2 to estimate population dose, number of early and latent fatalities, cost, and farm land requiring decontamination. The analysis assumed that 95 percent of the population was evacuated following declaration of a general emergency.

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

7.2.2.2 Surface Water Pathways

Population can be exposed to radiation when airborne radioactivity is deposited onto surface water. The exposure pathway can be 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-mile population from drinking water is 7.02 E-03 person-rem per year for the U.S. EPR and for CCNPP Unit 3. This value is the sum of all 23 release categories.

Surface water pathways involving swimming, fishing, and boating are not modeled by MACCS2. Surface water bodies within the 50-mile region of the CCNPP site include the Chesapeake Bay, Patuxent River, Potomac River, and other smaller bodies of water. The NRC evaluated doses from the aquatic food pathway (fishing) for the current nuclear fleet discharging to various bodies of water (including the existing CCNPP Units 1 and 2 on Chesapeake Bay) in NUREG-1437, the Generic Environmental Impact Statement for License Renewal of Nuclear Plants (NRC, 1996). The NRC evaluation concluded that with interdiction, the risk associated with the aquatic food pathway is found to be 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 (which includes CCNPP Units 1 and 2). Because the U.S. EPR atmospheric pathway doses are significantly lower that those of the current U.S. nuclear fleet, the doses from surface water sources would be consistently lower for the U.S. EPR and for CCNPP Unit 3, as well.

7.2.2.3 Groundwater Pathways

Population can also receive a dose from groundwater pathways. Radioactivity released during an accident can enter groundwater that serves as a source of drinking water or irrigation, or can move through an aquifer that eventually discharges to surface water. The consequences of a radioactive spill not associated with an accident in COL application FSAR Section 2.4.13 have been evaluated and it has been determined that if radioactive liquids were released directly to groundwater, all isotopes would be below maximum permissible concentrations before they reached the unnamed stream identified as Branch 2 and the Chesapeake Bay.

NUREG-1437 also evaluated the groundwater pathway dose, based on the analysis in NUREG-0440 (NRC, 1978), the Liquid Pathway Generic Study (LPGS). NUREG-0440 analyzed a core meltdown that contaminated groundwater that subsequently contaminated surface water. However, NUREG-0440 did not analyze direct drinking of groundwater 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 were one or more orders of magnitude less than those attributed to the atmospheric pathway. NUREG-1437 compared potential contamination at representative sites, two of which (Hope Creek and Indian Point) were estuary sites similar to the CCNPP site. The conclusion for those sites is that the uninterdicted population doses are significantly less than the NUREG-0440 generic site. The proposed location for CCNPP Unit 3 has the same groundwater characteristics as the location of the existing units and the CDF for the U.S. EPR is lower than that of the existing units. Therefore, the doses from the U.S. EPR and CCNPP Unit 3 groundwater pathway would be smaller than from the existing CCNPP Units 1 and 2.

7.2.3 Conclusions

The total calculated dose-risk to the 50-mile, year 2050 estimated population from airborne releases from a U.S. EPR reactor at CCNPP is expected to be approximately 0.35 person-rem per year (Table 7.2-3). The fraction of core inventory assumed to be released in each of the release categories is also included in Table 7.2-2. The number of persons exposed to doses greater than 2 Sv (200 rem) and 0.25 Sv (25 rem) are 3.59E-05 and 4.56E-04, respectively. It must be noted that these populations exceeding a dose are only calculated by MACCS2 for the early phase of an accident, the long-term dose that could be accumulated is not included in this result.

The U.S. EPR dose-risk at the CCNPP site is less than the population risk for all current reactors that have undergone license renewal, and less than that for the five reactors analyzed in NUREG-1150 (NRC, 1990). As reported in NUREG-1811 (NRC, 2006), the lowest dose-risk reported for reactors currently undergoing license renewal is 0.55 person-rem per year.

The qualitative analysis indicates that risk from the surface water and groundwater pathways is small. As discussed in Section 7.2.2.2, risks from surface water contamination from an accident at the CCNPP site are comparable to the risk from atmospheric pathway. The risk from atmospheric pathway from an U.S. EPR severe accident is small compared to currently licensed units, therefore the risk from surface water contamination is small compared with the atmospheric pathway of the current U.S. nuclear fleet. As discussed in Section 7.2.2.3, the risk of groundwater contamination from a U.S. EPR severe accident is also significantly less than the risk from currently licensed reactors. Additionally, interdiction could substantially reduce the groundwater pathway risks.

For comparison, as reported in ER Section 5.4, the total collective dose from normal operations is expected to be 5.7 person-rem per year for CCNPP Unit 3 (based on liquid and gaseous effluent for the projected 50-mile population for year 2080). As previously described, dose-risk is dose times frequency. Normal operation has a frequency of one. Therefore, the dose-risk for normal operation is 5.7 person-rem per year. Comparing this value to the severe accident dose-risk of approximately 0.52 person-rem per year (2080 conservative estimate) indicates that the dose risk from severe accidents is approximately 9 percent of dose risk from normal operations.

The probability-weighted number of cancer fatalities from a severe accident for the U.S. EPR at CCNPP is reported in Table 7.2-3 as 2.2E-04 per year. The lifetime probability of an individual dying from any cancer is 2.3 E-01 (NCHS, 2007).

7.2.4 References

FR, 1985. NRC Policy Statement on Severe Reactor Accidents Regarding Future Designs and Existing Plants, 50 FR 32138, Nuclear Regulatory Commission, August 8, 1985.

NCHS, 2007. "Table C, Percentage of total deaths, death rates, age-adjusted death rates for 2004, percentage change in age-adjusted death rates from 2003 to 2004 and ratio of age-adjusted death rates by race and sex for the 15 leading causes of death for the total population in 2004: United States," National Vital Statistics Report, Vol. 55, No. 19, dated August 21, 2007, National Center for Health Statistics. Available online at http://www.cdc.gov/nchs/data/nvsr/nvsr55/nvsr55_19.pdf, accessed December 8, 2007.

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

NRC, 1978. Liquid Pathway Generic Study, NUREG 0440, Nuclear Regulatory Commission, February 1978.

NRC, 1990. Severe Accident Risks: An Assessment for Five U.S. Nuclear Power Plants, NUREG-1150, Nuclear Regulatory Commission, December 1990.

NRC, 1996. Generic Environmental Impact Statement for License Renewal of Nuclear Plants, NUREG-1437, Vol. 1, Nuclear Regulatory Commission, May 1996.

NRC, 2006. Environmental Impact Statement for an Early Site Permit (ESP) at the North Anna ESP Site, NUREG-1811, Nuclear Regulatory Commission, December 2006.

Table 7.2-1— Release Category Descriptions

Release Category	Description
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 molten core-concrete interaction (MCCI), melt not flooded ex-vessel, with containment spray
RC203	Containment fails before vessel breach due to isolation failure, melt released from vessel, with MCCI, melt not flooded ex-vessel, without containment spray
RC204	Containment fails before vessel breach due to isolation failure, melt released from vessel, without MCCI, melt flooded ex-vessel with containment spray
RC205	Containment failures before vessel breach due to isolation failure, melt released from vessel, without MCCI, melt flooded ex-vessel without containment spray
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 spray
RC302	Containment fails before vessel breach due to containment rupture, with MCCI, melt not flooded ex-vessel, without containment spray
RC303	Containment fails before vessel breach due to containment rupture, without MCCI, melt flooded ex-vessel, with containment spray
RC304	Containment fails before vessel breach due to containment rupture, without MCCI, melt flooded ex-vessel, without containment spray
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 spray
RC502	Long term containment failure during and after debris quench due to rupture, with MCCI, without debris flooding, without containment spray
RC503	Long term containment failure during and after debris quench due to rupture, without MCCI, with debris flooding, with containment spray
RC504	Long term containment failure during and after debris quench due to rupture, without MCCI, with debris flooding, without containment spray
RC602	Long term containment failure due to basemat failure, without debris flooding, without containment spray
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— Source Term Release Fractions

RELEASE CATEGORY	XE/KR	I	Cs	Te	Sr	Ru	La	Ce	Ba
RC101	8.8E-3	2.4E-5	2.0E-5	5.3E-5	8.5E-6	4.4E-5	2.8E-7	7.3E-7	2.4E-5
RC201	3.6E-1	1.0E-1	9.5E-2	7.6E-3	7.8E-5	1.1E-3	3.4E-6	1.7E-5	4.1E-4
RC202	7.9E-1	2.3E-2	1.5E-2	2.0E-2	2.4E-4	3.4E-3	1.9E-5	6.8E-5	2.4E-3
RC203	8.9E-1	5.3E-2	2.8E-2	1.6E-1	1.4E-4	6.8E-3	1.5E-5	2.4E-4	2.2E-3
RC204	9.5E-1	2.8E-2	1.6E-2	3.6E-2	1.7E-4	5.3E-3	1.4E-5	6.2E-5	3.2E-3
RC205	9.8E-1	5.7E-2	3.6E-2	9.3E-2	4.0E-3	9.8E-3	3.0E-4	5.3E-4	6.1E-3
RC206	1.9E-1	5.6E-3	5.0E-3	9.0E-3	1.2E-3	7.3E-3	5.5E-5	1.8E-4	4.2E-3
RC301	7.9E-1	2.3E-2	1.5E-2	2.0E-2	2.4E-4	3.4E-3	1.9E-5	6.8E-5	2.4E-3
RC302	8.9E-1	5.3E-2	2.8E-2	1.6E-1	1.4E-4	6.8E-3	1.5E-5	2.4E-4	2.2E-3
RC303	9.5E-1	2.8E-2	1.6E-2	3.6E-2	1.7E-4	5.3E-3	1.4E-5	6.2E-5	3.2E-3
RC304	9.8E-1	5.7E-2	3.6E-2	9.3E-2	4.0E-3	9.8E-3	3.0E-4	5.3E-4	6.1E-3
RC401	8.0E-1	4.6E-3	2.3E-3	3.4E-3	2.7E-3	1.5E-3	8.0E-5	3.4E-4	5.2E-3
RC402	9.7E-1	2.0E-2	1.0E-2	1.2E-2	3.8E-3	2.1E-3	1.1E-4	4.9E-4	7.3E-3
RC403	8.0E-1	4.6E-3	2.3E-3	3.4E-3	2.7E-3	1.5E-3	8.0E-5	3.4E-4	5.2E-3
RC404	9.7E-1	2.0E-2	1.0E-2	1.2E-2	3.8E-3	2.1E-3	1.1E-4	4.9E-4	7.3E-3
RC501	9.9E-1	7.7E-4	4.0E-4	1.7E-2	7.4E-6	4.4E-5	2.2E-7	7.0E-7	2.4E-5
RC502	9.9E-1	7.7E-4	4.0E-4	1.7E-2	7.4E-6	4.4E-5	2.2E-7	7.0E-7	2.4E-5
RC503	1.0E+0	4.1E-4	6.9E-5	5.1E-5	8.5E-6	4.4E-5	2.8E-7	7.3E-7	2.4E-5
RC504	1.0E+0	4.1E-4	6.9E-5	5.1E-5	8.5E-6	4.4E-5	2.8E-7	7.3E-7	2.4E-5
RC602	9.9E-1	7.7E-4	4.0E-4	1.7E-2	7.4E-6	4.4E-5	2.2E-7	7.0E-7	2.4E-5
RC701	1.1E-1	4.2E-3	4.4E-3	6.9E-3	6.0E-4	4.8E-3	2.2E-5	1.1E-4	2.7E-3
RC702	1.1E-1	8.4E-2	8.7E-2	1.4E-1	1.2E-2	9.6E-2	4.5E-4	2.2E-3	5.4E-2
RC802	9.8E-1	7.1E-1	6.9E-1	6.4E-1	1.3E-1	5.7E-1	3.9E-3	2.2E-2	3.8E-1

Table 7.2-3— U.S. EPR Severe Accidents Analysis

		Number of Fatalities (per Year)		Environmental Risk			
Release Category	**Release Category Frequency (per year)**	**Early Fatalities**	**Late Cancers**	**Population Dose Risk (person-rem per year)**	**Cost (dollars per year)**	**Land Requiring Decontamination (acres per year)**	**Water Ingestion Dose (rem within 50 miles)**
RC101	3.39E-07	0.00E+00	6.64E-06	1.28E-02	3.10E+00	2.31E-04	5.59E-05
RC201	4.98E-10	9.76E-12	9.96E-07	2.11E-03	4.49E+00	5.22E-05	1.22E-04
RC202	4.00E-14	0.00E+00	7.00E-11	1.45E-07	1.48E-04	5.37E-09	1.97E-09
RC203	8.45E-14	2.77E-15	2.48E-09	4.84E-06	5.40E-03	1.38E-07	7.61E-08
RC204	2.41E-11	2.55E-15	4.80E-08	9.52E-05	9.78E-02	3.31E-06	1.23E-06
RC205	4.10E-10	3.51E-13	1.38E-06	2.60E-03	3.39E+00	6.86E-05	4.88E-05
RC206	1.64E-08	5.48E-09	2.56E-05	4.28E-02	3.61E+01	1.29E-03	6.10E-04
RC301	1.63E-12	0.00E+00	2.85E-09	5.92E-06	6.03E-03	2.19E-07	8.04E-08
RC302	1.51E-11	4.95E-14	4.44E-08	8.65E-05	9.65E-02	2.47E-06	1.36E-06
RC303	2.29E-09	2.43E-13	4.56E-06	9.05E-03	9.30E+00	3.15E-04	1.17E-04
RC304	1.76E-08	1.51E-11	5.93E-05	1.12E-01	1.46E+02	2.94E-03	2.09E-03
RC401	1.38E-11	0.00E+00	1.14E-08	2.40E-05	1.63E-02	8.29E-07	1.56E-07
RC402	2.75E-10	0.00E+00	4.18E-07	8.91E-04	9.02E-01	3.52E-05	1.08E-05
RC403	6.82E-10	0.00E+00	5.63E-07	1.19E-03	8.05E-01	4.10E-05	7.71E-06
RC404	1.35E-08	0.00E+00	2.05E-05	4.37E-02	4.43E+01	1.73E-03	5.29E-04
RC501	2.65E-13	0.00E+00	3.68E-11	8.00E-08	5.75E-06	6.09E-09	3.29E-10
RC502	1.11E-10	0.00E+00	1.54E-08	3.35E-05	2.41E-03	2.55E-06	1.38E-07
RC503	3.65E-10	0.00E+00	7.81E-09	1.69E-05	5.00E-04	3.34E-07	6.83E-08
RC504	1.19E-07	0.00E+00	2.55E-06	5.52E-03	1.63E-01	1.09E-04	2.23E-05
RC602	3.61E-10	0.00E+00	5.02E-08	1.09E-04	7.83E-03	8.30E-06	4.48E-07
RC701	1.02E-08	0.00E+00	1.24E-05	2.22E-02	1.85E+01	7.74E-04	2.45E-04
RC702	5.37E-09	2.66E-08	6.82E-05	7.52E-02	8.59E+01	1.02E-03	2.55E-03
RC802	2.64E-10	1.54E-08	1.86E-05	1.67E-02	1.01E+01	4.40E-05	6.02E-04
Total	**5.26E-07**	**4.75E-08**	**2.22E-04**	**3.47E-01**	**3.63E+02**	**8.67E-03**	**7.02E-03**

7.3 SEVERE ACCIDENT MITIGATION ALTERNATIVES

The purpose of the severe accident mitigation alternatives (SAMA) analysis is to review and evaluate both design and non-hardware (i.e., operation and maintenance programs) alternatives that could significantly reduce the radiological risk from a postulated severe accident by preventing core damage and significant releases from the containment. The U.S. EPR Design Certification Environmental Report (U.S. EPR DC ER) (AREVA, 2009) for the U.S. EPR submitted by AREVA NP evaluated both design and non-hardware alternatives.

The primary focus of the U.S. EPR DC ER was the severe accident mitigation design alternatives (SAMDA). However, non-hardware alternatives were identified in the analysis and will be addressed when the plant design is finalized and processes and procedures are being developed for the U.S. EPR. The conclusions drawn in the U.S. EPR DC ER are applicable to CCNPP Unit 3.

7.3.1 SAMDA Analysis Methodology

The methodology used to develop a comprehensive list of U.S. EPR SAMDA candidates, define the screening criteria used to categorize the SAMDA candidates, and perform the cost-benefit evaluation is summarized in this section based on the U.S. EPR DC ER (AREVA, 2009) for the U.S. EPR.

The comprehensive list of SAMDA candidates was developed for the U.S. EPR by reviewing industry documents for generic PWR enhancements and considering plant-specific enhancements. The SAMDA candidates were defined as enhancements to the U.S. EPR plant that have the potential to prevent core damage and significant releases from the containment. The primary industry document supporting the development of U.S. EPR generic PWR SAMDA candidates was NEI 05-01 (NEI, 2005).

The top 100 U.S. EPR Level 1 PRA cutsets were evaluated to identify plant-specific modifications for inclusion in the comprehensive list of SAMDA candidates. The top 100 cutsets represent approximately 50 percent of the total core damage frequency (CDF) for the U.S. EPR. The percentage of contribution to the total CDF for each cutset below the top 100 was minimal. Therefore, these cutsets were not likely contributors for identification of cost beneficial enhancements for the U.S. EPR design.

An extensive evaluation of the top 100 cutsets was completed in order to establish that all possible design alternatives for the U.S. EPR were addressed. Through the evaluation, numerous U.S. EPR specific operator actions and hardware-based SAMDA candidates were developed. The U.S. EPR DC ER (AREVA, 2009) provides a detailed list of the SAMDA candidates for the U.S. EPR. The SAMDA candidates identified in the U.S. EPR DC ER are applicable to CCNPP Unit 3.

The top 100 Large Release Frequency (LRF) cutsets were also evaluated to identify those modifications that would reduce the likelihood of occurrence of the significant containment challenges. This population of cutsets specifically excluded the contribution to LRF of the core damage sequences due to Main Steam Line Break (MSLB) inside containment with main feedwater unisolated, as this sequence was determined not to lead to core damage or LRF. This exclusion ensures that the overly conservative treatment of an event does not reduce the importance of other containment failure mechanisms. The top 100 cutsets represent approximately 50 percent of the total U.S. EPR LRF. The percentage contribution to the total LRF for each cutset below the top 100 was minimal. Therefore, these cutsets were not likely contributors for identification of cost beneficial enhancements for the U.S. EPR design.

Consistent with current regulatory guidance and industry practice, all risk significant design alternatives for the U.S. EPR plant have been addressed by detailed evaluation of the top 100 CDF and top 100 LRF cutsets to identify plant-specific modifications for inclusion in the comprehensive list of U.S. EPR SAMDA candidates. Through the evaluation of the top 100 CDF cutsets, numerous U.S. EPR-specific operator actions and hardware-based SAMDA candidates were developed. When evaluating the top 100 LRF cutsets, no additional SAMDA candidates were identified. The U.S. EPR DC ER (AREVA, 2009) provides a detailed list of the SAMDA candidates for the U.S. EPR-plant. The SAMDA candidates identified in the U.S. EPR DC ER (AREVA, 2009) are applicable to CCNPP Unit 3.

The SAMDA candidates developed for the U.S. EPR design were qualitatively screened using seven categories. The intent of the screening is to identify the candidates for further risk-benefit calculation. For each SAMDA candidate, a screening criteria and basis for screening was identified to justify the implementation or exclusion of the SAMDA candidate in the U.S. EPR. The seven categories used during the screening process included:

- Not applicable. The SAMDA candidates were identified to determine which are definitely not applicable to the U.S. EPR. Potential enhancements that are not considered applicable to the U.S. EPR are those developed for systems specifically associated with boiling water reactors (BWR) or with specific PWR equipment that is not in the U.S. EPR design.
- Already implemented. The SAMDA candidates were reviewed to ensure that the U.S. EPR design does not already include features recommended by a particular SAMDA candidate. Also, the intent of a particular SAMDA candidate may have been fulfilled by another design feature or modification. In these cases the SAMDA candidates are already implemented in the U.S. EPR plant design. If a SAMDA candidate has already been implemented at the plant, it is not retained.
- Combined. If one SAMDA candidate is similar to another SAMDA candidate, and can be combined with that candidate to develop a more comprehensive or plant-specific SAMDA candidate, only the combined SAMDA candidate is retained for screening.
- Excessive implementation cost. If a SAMDA candidate requires extensive changes that will obviously exceed the maximum benefit, even without an implementation cost estimate and therefore incurs an excessive implementation cost, it is not retained.
- Very low benefit. If a SAMDA candidate is related to a non-risk significant system for which change in reliability is known to have negligible impact on the risk profile, it is deemed to have a very low benefit and is not retained.
- Not required for design certification. Evaluation of any potential procedural or surveillance action SAMDA candidates are not appropriate until the plant design is finalized and the plant procedures are being developed. Therefore, if a SAMDA candidate is related to any of these enhancements, it is not retained for this analysis.
- Considered for further evaluation. If a particular SAMDA candidate was not categorized by any of the preceding categories, then the SAMDA candidate is considered for further evaluation and subject to a cost-benefit analysis.

The screening categories were chosen based on guidance from NEI 05-01. The U.S. EPR DC ER contains a detailed description of each of the categories. The screening categories are applicable to CCNPP Unit 3.

The SAMDA candidates categorized as "Not required for design certification" in the AREVA NP Environmental Report Standard Design Certification were re-evaluated for CCNPP Unit 3. These SAMDA candidates were re-evaluated using the screening methodology in AREVA NP Environmental Report Standard Design Certification. An additional screening category called "Not a design alternative" was used to capture any SAMDA candidate not related to the plant design. This category included SAMDA candidates related to procedure modifications, training, or surveillance. If a SAMDA candidate is related to any of these enhancements, it is not retained for this analysis.

After the screening process was completed, the SAMDA candidates that were placed in the Considered for Further Evaluation category would require a cost-benefit evaluation. The cost-benefit evaluation of each SAMDA candidate would determine the cost of implementing the specific SAMDA candidate with the maximum averted cost risk from the implementation of the specific SAMDA candidate. The maximum averted cost risk, typically referred to as the maximum benefit, equates to the cost obtained by the elimination of all severe accident risk.

7.3.2 Severe Accident Cost Impact and Maximum Benefit for CCNPP Unit 3

The severe accident impact is determined by summing the occupational exposure cost, on-site cost, public exposure, and off-site property damage. The methodologies provided in NEI 05-01 (NEI, 2005) and NUREG/BR-1084 (NRC, 1997) were used as guidance. The principal inputs to the calculations were the CDF, 2,000 dollars per person-rem (NRC, 1997), licensing period of 60 years, 7% best estimate discount rate (NEI, 2005) and 3% upper bound discount rate (NEI, 2005). The maximum benefit calculation performed in the U.S. EPR DC ER used the whole body dose and economic impact from U.S. EPR Level 3 PRA analysis, which was based on population data from 2000. The maximum benefit calculation for CCNPP Unit 3 uses the economic impact and whole body dose for a 2050 population (Table 7.3-1). The point estimate and mean value CDF (with 2008 replacement power costs) for severe accident impact for CCNPP Unit 3 is also shown in Table 7.3-1.

The severe accident impact cost calculated in Table 7.3-1 accounts for the risk of internal events, internal flooding, and internal fires. To determine the total cost of severe accident risk the contribution of external events (e.g., seismic risk, as other external event contributors are small) needs to be included. Assuming that fire risk is the dominant contributor to external events risk, the seismic risk contribution was conservatively accounted for by assuming that it is equivalent to the internal fire risk. A scaling factor was calculated by dividing the internal fire CDF (1 .76 E-07 per year) by the total CDF (5 .26 E-07 per year) resulting in an increase of 33 percent (AREVA, 2009).

Increasing the severe accident impact by 33 percent includes the seismic risk and is the maximum benefit for CCNPP Unit 3. The maximum benefit for CCNPP Unit 3 based on the point estimate CDF with 2008 replacement power costs is $79,824.

The percentage contributions of each hazards group are slightly different for the mean value CDF. Therefore, seismic risk based on the mean value CDF is assumed to be 28 percent of the total mean value CDF. The resulting maximum benefit on the mean value CDF would be $107,261.

7.3.3 Sensitivity Studies

Sensitivity cases were performed to investigate the sensitivity of the results to certain parameters in the CCNPP Unit 3 SAMDA analysis. A total of five sensitivity benefit calculations were performed for both the point estimate and mean value CDF with 2008 replacement power costs. Below is a brief description of the sensitivity cases.

- The first case investigated the sensitivity of the base case to the discount rate by assuming a lower discount rate of three percent. The method to calculate the present value of replacement power for a single event is discussed in U.S. EPR DC ER (AREVA, 2009).
- The second case investigated the sensitivity of the base case to the discount rate by assuming a lower discount rate of five percent.
- The third case investigated the sensitivity of the base case to the on-site dose estimates. For the base case analysis, an immediate and long-term on-site dose to plant personnel following a severe accident is 3,300 rem and 20,000 rem, respectively. Therefore, this sensitivity case used the recommended high estimate dose values of 14,000 rem and 30,000 rem for immediate and long-term dose on-site, respectively, as suggested in NUREG/BR-0184 (NRC, 1997).
- The fourth case investigated the sensitivity of the base case to the total on-site cleanup cost. For the base case analysis, the total on-site cleanup cost following a severe accident is taken to be $1,500,000. Therefore, this analysis assumed a high estimated on-site cleanup cost of $2,000,000 as suggested in NUREG/BR-0184 (NRC, 1997).
- The fifth case also investigated the sensitivity of the increase in the replacement power cost for the U.S. EPR design. This sensitivity case projected that the cost of replacement power would double between 2008 and 2015. This would result in electricity cost of 24 cents/kw-h in 2015 based on the assumption that the cost of electricity in 2008 is 12 cents/kw-h. The inflation rate for this sensitivity case was calculated using the method outlined in the U.S. EPR DC ER (AREVA, 2009).

Table 7.3-2 and Table 7.3-3 provide the calculated benefit it for the point estimate and mean value CDF with 2008 replacement power cost sensitivity cases discussed above.

7.3.4 Results and Summary

A total of 167 SAMDA candidates developed from industry and U.S. EPR documents were evaluated in the U.S. EPR DC ER completed by AREVA NP. The basis for screening is provided in detail for each SAMDA candidate in the U.S. EPR DC ER. Below is a summary of the results of the SAMDA analysis performed for the U.S. EPR and is applicable to CCNPP Unit 3.

- Twenty-five SAMDA candidates were not applicable to the U.S. EPR design.
- Sixty-nine SAMDA candidates were already implemented into the U.S. EPR design either as suggested in the SAMDA or an equivalent replacement that fulfilled the intent of the SAMDA. These SAMDA candidates are summarized in Table 7.3-4.
- Four SAMDA candidates were combined with another SAMDA because they had the same intent.
- Forty-three SAMDA candidates were categorized as not not a design alternative because they were related to a procedural or surveillance action. Evaluation of any potential administrative SAMDA candidates (i.e., those candidates related to procedures and training) is not appropriate until the plant design is finalized and plant

administrative processes, procedures and training program are being developed. However, the plant administrative processes, procedures, and training program will be developed to address appropriate maintenance and use of the U.S. EPR design features which have been credited with the reduction of risk associated with postulated severe accidents. As such, appropriate administrative controls on plant operations will be incorporated into the CCNPP Unit 3 management systems as part of the initial administrative processes, procedures and training program development process.

- One SAMDA candidate was categorized as very low benefit.
- Twenty-five SAMDA candidates were categorized as excessive implementation cost.
- None of the SAMDA candidates were categorized as consider for further evaluation.

The low probability of core damage events in the U.S. EPR coupled with reliable severe accident mitigation features provide significant protection to the public and the environment. Specific severe accident mitigation design alternatives from previous industry studies, and from U.S. EPR probabilistic risk assessment (PRA) insights, were measured against broad acceptance criteria in the U.S. EPR DC ER (AREVA, 2009). Since none of the SAMDA candidates were categorized as considered for further evaluation, a cost-benefit analysis (i.e., risk reduction, value impact ratios) was not required for the U.S. EPR SAMDA analysis. The overall conclusion of the U.S. EPR SAMDA analysis is that no additional plant modifications are cost beneficial to implement due to the robust design of the U.S. EPR with respect to prevention and mitigation of severe accidents. The maximum benefit from the U.S. EPR DC ER was reevaluated for CCNPP Unit 3. The detailed analysis and conclusions in the U.S. EPR DC ER remain applicable for CCNPP Unit 3.

7.3.5 References

AREVA, 2009. "AREVA NP Environmental Report Standard Design Certification," ANP-10290, Revision 1, AREVA NP, September 2009.

NEI, 2005. "Severe Accident Mitigation Alternatives (SAMA) Analysis, Guidance Document," NEI 05-01, Revision A, Nuclear Energy Institute November 2005.

NRC, 1997. "Regulatory Analysis Technical Evaluation Handbook," NUREG/BR-1084, Nuclear Regulatory Commission, January 1997.

Table 7.3-1— Severe Accident Cost Impact for CCNPP Unit 3

	Point Estimate CDF (7% Discount Rate and 2008 Replacement Power Costs)	Mean CDF (7% Discount Rate and 2008 Replacement Power Costs)
Averted Occupational Exposure (AREVA, 2009)	$264	$368
Averted On-site Costs (AREVA, 2009)	$44,880	$62,663
Averted Public Exposure	$9,766	$13,635
Averted Off-site Property Damage Costs	$5,108	$7,132
Severe Accident Impact Internal Events, Internal Flooding, Internal Fire	$60,018	$83,798
Maximum Benefit Internal Events, Internal Flooding, Internal Fire, Seismic	**$79,824**	**$107,261**

Table 7.3-2— Maximum Benefit for Sensitivity Cases (Point Estimate CDF)

Case	Sensitivity Case 1: Discount Rate 3%	Sensitivity Case 2: Discount Rate 5%	Sensitivity Case 3: High Estimate Dose (On-Site)	Sensitivity Case 4: High On-Site Cleanup Costs	Sensitivity Case 5: Increase Replacement Power Costs via Inflation for 2015 Dollars
Immediate Dose Savings (On-site)	$97	$66	$209	$49	$49
Long Term Dose Savings (On-site)	$510	$317	$322	$215	$215
Total Accident Related Occupational Exposure **(AOE)**	$607	$384	$531	$264	$264
Cleanup/Decontamination Savings (On-site)	$19,110	$13,053	$8,045	$10,727	$8,045
Replacement Power Savings (On-site)	$129,243	$62,524	$36,835	$36,835	$73,675
Averted Costs of On-site Property Damage **(AOSC)**	$148,353	$75,577	$44,880	$47,562	$81,720
Total On-site Benefit	**$148,960**	**$75,960**	**$45,411**	**$47,826**	**$81,984**
Averted Public Exposure **(APE)**	$19,309	$13,189	$9,766	$9,766	$9,766
Averted Offsite Damage Savings **(AOC)**	$10,100	$6,899	$5,108	$5,108	$5,108
Total Offsite Benefit	$29,409	$20,088	$14,874	$14,874	$14,874
Total Benefit (On-Slte + Offslte)	**$178,369**	**$96,048**	**$60,284**	**$62,699**	**$96,857**
Total Benefit (On-Slte + Offslte + External Events)	**$237,231**	**$127,744**	**$80,178**	**$83,390**	**$128,820**

Table 7.3-3— Maximum Benefit for Sensitivity Cases (Mean Value CDF)

Case	Sensitivity Case 1: Discount Rate 3%	Sensitivity Case 2: Discount Rate 5%	Sensitivity Case 3: High Estimate Dose (On-Site)	Sensitivity Case 4: High On-Site Cleanup Costs	Sensitivity Case 5: Increase Replacement Power Costs via Inflation for 2015 Dollars
Immediate Dose Savings (On-site)	$136	$93	$292	$69	$69
Long Term Dose Savings (On-site)	$712	$443	$449	$300	$300
Total Accident Related Occupational Exposure **(AOE)**	$847	$535	$741	$368	$368
Cleanup/Decontamination Savings (On-site)	$26,682	$18,225	$11,233	$14,977	$11,233
Replacement Power Savings (On-site)	$180,452	$87,298	$51,430	$51,430	$102,867
Averted Costs of On-site Property Damage **(AOSC)**	$207,134	$105,522	$62,663	$66,407	$114,100
Total On-site Benefit	**$207,981**	**$106,058**	**$63,404**	**$66,775**	**$114,468**
Averted Public Exposure **(APE)**	$26,960	$18,415	$13,635	$13,635	$13,635
Averted Offsite Damage Savings **(AOC)**	$14,102	$9,632	$7,132	$7,132	$7,132
Total Offsite Benefit	$41,062	$28,047	$20,767	$20,767	$20,767
Total Benefit (On-Slte + Offslte)	**$249,043**	**$134,105**	**$84,171**	**$87,542**	**$135,235**
Total Benefit (On-Slte + Offslte + External Events)	**$318,775**	**$171,654**	**$107,738**	**$112,054**	**$173,101**

Table 7.3-4— SAMDA Candidates - Already Implemented
(Page 1 of 2)

SAMDA ID	Potential Enhancement
AC/DC-01	Provide additional DC battery capacity.
AC/DC-03	Add additional battery charger or portable, diesel-driven battery charger to existing DC system.
AC/DC-04	Improve DC bus load shedding.
AC/DC-06	Provide additional DC power to the 120/240V vital AC system.
AC/DC-07	Add an automatic feature to transfer the 120V vital AC bus from normal to standby power.
AC/DC-09	Provide an additional diesel generator.
AC/DC-11	Improve 4.16 kV bus cross-tie ability.
AC/DC-14	Install a gas turbine generator.
AC/DC-16	Improve uninterruptible power supplies.
AC/DC-24	Bury off-site power lines.
AT-01	Add an independent boron injection system.
AT-02	Add a system of relief valves to prevent equipment damage from pressure spikes during an ATWS.
AT-07	Install motor generator set trip breakers in control room.
AT-08	Provide capability to remove power from the bus powering the control rods.
CB-01	Install additional pressure or leak monitoring instruments for detection of ISLOCAs.
CB-04	Install self-actuating containment isolation valves.
CB-10	Replace SGs with a new design.
CB-12	Install a redundant spray system to depressurize the primary system during an SGTR.
CB-14	Provide improved instrumentation to detect SGTR, such as Nitrogen-16 monitors.
CB-16	Install a highly reliable (closed loop) SG shell-side heat removal system that relies on natural circulation and stored water sources.
CB-20	Install relief valves in the CCWS.
CC-01	Install an independent active or passive high pressure injection system.
CC-04	Add a diverse low pressure injection system.
CC-05	Provide capability for alternate injection via diesel-driven fire pump.
CC-06	Improve ECCS suction strainers.
CC-07	Add the ability to manually align ECCS recirculation.
CC-10	Provide an in-containment reactor water storage tank.
CC-15	Replace two of the four electric safety injection pumps with diesel-powered pumps.
CC-17	Create a reactor coolant depressurization system.
CC-21	Modify the containment sump strainers to prevent plugging.
CP-01	Create a reactor cavity flooding system.
CP-03	Use the fire water system as a backup source for the containment spray system.
CP-07	Provide post-accident containment inerting capability.
CP-08	Create a large concrete crucible with heat removal potential to contain molten core debris.
CP-11	Increase depth of the concrete base mat or use an alternate concrete material to ensure melt-through does not occur.
CP-13	Construct a building to be connected to primary/secondary containment and maintained at a vacuum.
CP-17	Install automatic containment spray pump header throttle valves.
CP-20	Install a passive hydrogen control system.

Table 7.3-4— SAMDA Candidates - Already Implemented
(Page 2 of 2)

SAMDA ID	Potential Enhancement
CP-21	Erect a barrier that would provide enhanced protection of the containment walls (shell) from ejected core debris following a core melt scenario at high pressure.
CP-22	Install a secondary containment filtered ventilation.
CW-01	Add redundant DC control power for SW pumps.
CW-02	Replace ECCS pump motors with air-cooled motors.
CW-04	Add a SW pump.
CW-05	Enhance the screen wash system.
CW-06	Cap downstream piping of normally closed component cooling water drain and vent valves.
CW-10	Provide hardware connections to allow another essential raw cooling water system to cool charging pump seals.
CW-15	Use existing hydro test pump for RCP seal injection.
CW-16	Install improved RCP seals.
CW-17	Install an additional component cooling water pump.
EPR-01	Provide an additional SCWS train.
EPR-05	Add redundant pressure sensors to the pressurizer and SG.
FR-03	Install additional transfer and isolation switches.
FR-05	Enhance control of combustibles and ignition.
FW-01	Install a digital feed water upgrade.
FW-02	Create ability for emergency connection of existing or new water sources to feedwater and condensate systems.
FW-04	Add a motor-driven feedwater pump.
FW-07	Install a new condensate storage tank (auxiliary feedwater storage tank).
FW-11	Use fire water system as a backup for SG inventory.
FW-15	Replace existing pilot-operated relief valves with larger ones, such that only one is required for successful feed and bleed.
HV-01	Provide a redundant train or means of ventilation to the switch gear rooms.
HV-02	Add a diesel building high temperature alarm or redundant louver and thermostat.
HV-04	Add a switchgear room high temperature alarm.
HV-05	Create ability to switch EFW room fan power supply to station batteries in an SBO.
SR-01	Increase seismic ruggedness of plant components.
SR-02	Provide additional restraints for CO_2 tanks.
OT-01	Install digital large break LOCA protection system.

7.4 TRANSPORTATION ACCIDENTS

The NRC evaluated the environmental effects of transportation of fuel and waste for light water reactors in WASH-1238, "Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Plants" (AEC, 1972) and NUREG-75/038, "Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants, Supplement 1" (NRC, 1975) and found the impacts to be small. These NRC analyses provided the basis for Table S-4 in 10 CFR 51.52 (CFR, 2007) which summarizes the environmental impacts of transportation of fuel and radioactive wastes to and from a reference reactor.

10 CFR 51.52 requires that:

> Every environmental report prepared for ... a light-water-cooled nuclear power reactor... 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 in paragraph (b) of this section.

Table S-4 of 10 CFR 51.52 addresses two categories of environmental considerations: (1) normal conditions of transport and (2) accidents in transport.

The U.S. EPR design varies from the conditions of 10 CFR 51.52(a). Specifically,

- The reactor has a core thermal power level exceeding 3,800 MWth,
- The reactor fuel has a uranium-235 enrichment that may exceed 4% by weight,
- The uranium dioxide pellets are not encapsulated in Zircaloy rods,
- The average level of burnup of the irradiated fuel removed from the reactor will exceed 33,000 MWd/MTU.

Because the U.S. EPR varies from the conditions of 10 CFR51.52(a), a full description and analysis of transportation environmental impacts is required in accordance with 10 CFR 51.52(b). This section describes the environmental impact of postulated transportation accidents involving the shipment of radioactive materials including unirradiated (new) fuel, irradiated fuel, and radioactive waste as required by 10 CFR 51.52. The environmental impacts from the incident-free transportation of fuel and wastes to and from the new reactor is summarized in Section 5.11.

These evaluated impacts are compared to the respective impacts in 10 CFR 51.52 as shown in Table 7.4-1.

Radiological and non-radiological types of accident effects are analyzed. Two computer programs were used to perform this analysis. The TRAGIS (ORNL, 2003) computer code was used to determine the distance traveled by truck, the roads taken, and the population density along the routes. The RADTRAN 5.6 computer code was used to calculate population doses from the shipment (direct and effluent sources, not ingestion) given the routes defined by TRAGIS. The inputs to these codes are listed in Table 7.4-2 through Table 7.4-7and Table 7.4-9 through Table 7.4-11.

7.4.1 Radiological Impacts

The radiological impact population dose was calculated using the RADTRAN computer code. The population dose impact from postulated accidents associated with the transportation of unirradiated fuel, irradiated fuel, and radioactive waste are provided in Table 7.4-12. The dose impact from all postulated transportation accident sources is 2.0E-4 person-rem/year (2.0E-6 person-Sv/year).

7.4.1.1 Unirradiated (New) Fuel

The WASH-1238 analysis (AEC, 1972) of postulated accidents during the transportation of unirradiated fuel found accident impacts to be negligible. The analysis states "the impact on the environment from radiation in transportation accidents involving unirradiated (current) fuel is considered to be negligible."

Additionally, as noted in NUREG-1815 (NRC, 2006), accident frequencies are likely to be lower in the future than those used in the analysis in WASH-1238 (AEC, 1972) because traffic accident, injury, and fatality rates have fallen since the initial analyses were performed.

Finally, advanced fuel behaves like fuel evaluated in the analyses provided in WASH-1238 (AEC, 1972). Again as noted in NUREG-1815 (NRC, 2006), there is no significant difference in the consequences of accidents severe enough to result in a release of unirradiated fuel particles to the environment between advanced LWRs and previous-generation LWRs because the fuel form, cladding, and packaging are similar to those analyzed in WASH-1238 (AEC, 1972).

Based on this information, the dose impact from nuclides released from postulated accidents involving new fuel is assumed to be negligible when compared to dose impact from postulated irradiated fuel and radiation waste transportation accidents. Therefore, quantitative analysis of dose from new fuel accidents was not performed.

7.4.1.2 Irradiated Fuel

The dose impact from postulated accidents during the shipment of irradiated fuel was evaluated using the TRAGIS code (ORNL, 2003) to define appropriate routing and population density along the route. This information was used as input to the RADTRAN code with U.S. EPR-specific design information to calculate a postulated annual dose from irradiated fuel transportation accidents.

The evaluation model assumed that irradiated fuel will be shipped to the site of the proposed Yucca Mountain repository. The distance from the Calvert Cliffs Nuclear Plant (CCNPP) site to the proposed repository is 2,680 mi (4,313 km) based on a TRAGIS Highway Route Controlled Quantity (HRCQ) distance.

The model accident rate is the probability that an accident will occur during the trip along each route through each state. The route's average accident rate is the sum of the distance weighted accident rate through each state.

State-specific accident data from Table 4 of ANL/ESD/TM-150 (ANL, 1999) are shown in Table 7.4-4. Only the interstate data are used because the HRCQ route is mainly on Interstate roads.

The distance and demographic data for input to RADTRAN are listed in Table 7.4-2. The U.S. EPR average annual quantity of irradiated fuel shipped is assumed, consistent with

NUREG-1815 (NRC, 2006), to equal the average annual reload quantity. For the U.S. EPR this is 37.5 MTU of irradiated fuel per year (as provided in Section 5.11) to be shipped.

The source term in Table 7.4-3 is based on an equilibrium burnup of 52 GWd/MTU. The activity was decayed 5 years to account for the minimum decay period prior to shipment of irradiated fuel to the proposed geologic repository at Yucca Mountain, NV. The nuclides evaluated are those dominant nuclides described and listed in Appendix G of NUREG-1815 (NRC, 2006).

In addition to the source term assumed above, Cobalt-60 was used to represent fuel surface contamination and added at a level of 0.2 Ci/rod. This use of Cobalt-60 in the model was consistent with previously performed studies (SNL, 1991) (NRC, 2000) (DOE, 2002) that quantified fuel rod contamination levels and that concluded the maximum contribution from contamination is Cobalt-60. NUREG/CR-6672 estimated the maximum contamination from Cobalt-60 for PWR fuel at zero year decay is 0.168 Ci/rod (6.22E9 Bq/rod) (or approximately 0.2 Ci/rod (7.4E9 Bq/rod)). A U.S. EPR-specific calculation of Ci/rod was carried out that confirmed the 0.2 Ci/rod (7.4E9 Bq/rod) value was conservative.

The accident severity categories and related releases from Appendix G of NUREG-1815 (NRC, 2006) were used and are presented in Table 7.4-5. The model deposition velocities were consistent with Appendix E in DOE/EIS-0250 (DOE, 2002). The model severity fractions, release fractions, aerosol and respirable fractions are the conditional probabilities, given an accident occurs, for specific severity categories. The model severity and release fractions are for the 19 severity categories and the 5 chemical groups identified in NUREG-1815 (NRC, 2006), and are presented in Table 7.4-5. Gases are not deposited and have a 0.0 m/s deposition velocity. All other chemical groups are defined consistent with DOE/EIS-0250 (DOE, 2002) at 0.03 ft/s (0.01 m/s). Other RADTRAN parameters used were the default values from the RADCAT 2.3 User Guide (SNL, 2006), and from Appendix G of NUREG-1815 (NRC, 2006).

The evaluation determined that the dose impact from postulated transportation accidents involving irradiated fuel was 5.14E-06 person-rem/MTU (5.14E-08 person-Sv/MTU). Using the average annual reload requirements for a U.S. EPR of 37.5 MTU, the annual population dose impact is 1.9E-04 person-rem/year (1.9E-06 person-Sv/year) from postulated transportation accidents involving irradiated fuel.

7.4.1.3 Radioactive Waste

The population risk from radwaste transportation accidents is 7.3E-06 person-rem/yr (7.3E-08 person-Sv/year). This is the population dose for an accident divided by the mean number of years between accidents.

The TRAGIS computer code was used to calculate the routes, distances, and demographics along the route. It was conservatively assumed that all radwaste would be shipped to the farthest disposal repository in commercial mode. The route was from the plant to the Hanford site located in Washington State. It was along roads which allowed trucks and avoided ferry crossings. TRAGIS calculated the total one-way distance to be 2,733 mi (4,399 km). The distances through each state are listed in Table 7.4-11. The distances and population densities through the rural, suburban and urban settings are listed in Table 7.4-9 as well as the time spent stopped. These were all used as inputs to RADTRAN.

The RADTRAN computer code was used to calculate accident probability and population risk for the route. In an average year 1.99E+03Ci (7.37E+13Bq), is forecast to be shipped. This is described in Table 7.4-8and will involve 15 shipments per year (as described in Section 5.11).

The fraction of various nuclides released, by accident category, are listed in Table 7.4-5. These release fractions are a function of 19 accident severity categories and 5 chemical groups. The values are from NUREG-1815 (NRC, 2006). The model release fractions, aerosol and respirable fractions are the conditional probabilities, given an accident occurs, for specific severity categories.

The model deposition velocities are consistent with Appendix E in DOE/EIS-0250 (DOE, 2002). All chemical groups are defined at 0.01 m/s.

Other RADTRAN parameters were the default values from the RADCAT 2.3 User Guide (SNL, 2006), and from Appendix G of NUREG-1815 (NRC, 2006).

The source term in Table 7.4-10 is based on the sum of all waste type expected (average) annual activities. The radionuclides chosen are >1% of the total activity (with the exception of Ag-110m, which is not in the RADTRAN 5.6 Library), and those in Table G-9 of NUREG-1815 (NRC, 2006) plus isotopes in the same family (such as Co-58 and Ru-103). On page G-23 of that report the NRC performed a screening analysis that showed that these were the dominant nuclides.

The model accident rate is the probability that an accident will occur during the trip along each road through each state. The route's average accident rate is the sum of the distance weighted accident rate through each state. Table 7.4-11 presents the individual state accident rate data compiled from ANL/ESD/TM-150 (ANL, 1999) and the associated average rate. Since the commercial route is mainly on Interstate roads, only the interstate rate data was used in the model.

The result from RADTRAN is the annual population dose per year of 7.3E-06 person-rem/yr (7.3E-08 person-Sv/yr).

7.4.2 Non-radiological Impacts

Two non-radiological impacts associated with the postulated accidents during transportation of new fuel, irradiated fuel, and radioactive waste were calculated, the fatal injury rate per 100 reactor years and the nonfatal injury rate per 10 reactor years.

7.4.2.1 New Fuel

TRAGIS (ORNL, 2003) was used to calculate the commercial routing through each state. Interstate travel is the dominant road designation and was used for all route types. It was assumed that all shipments came from the fuel fabrication facility furthest from CCNPP located in Richland, WA.

As described in Section 5.11.3.1, the average number of new fuel shipments was assumed to be 7.5 per year, each covering the 2,723 mi (4,381 km) distance, including the return of the empty truck the same distance. This is based on the distances and road types from the calculation of radiological impacts above and the fatal injury rates from Table 4 of ANL/ESD/TM-150 (ANL, 1999).

Based on the above and the average fatality rate from Table 7.4-7 of 1.63E-08 fatalities/truck-mi (1.01E-08 fatalities/truck-km), the non-radiological fatal injury rate impact associated with postulated accidents as a result of new fuel shipments is 6.6E-02 per 100 reactor years.

Based on the same routes, distances, and assumptions above and the average nonfatal injury rate from Table 7.4-7 of 3.68E-07 nonfatal injuries/truck-mi (2.29E-07 nonfatal injuries/truck-km), the non-radiological nonfatal injury rate impact associated with postulated accidents as a result of new fuel shipments is 1.5E-01 nonfatal injuries per 10 reactor years.

7.4.2.2 Irradiated Fuel

The methodology for evaluating the fatal and nonfatal injury rates as a result of postulated accidents during the transportation of irradiated fuel is the same as that described in Section 7.4.2.1 above with the exceptions of the number of trips and the routing assumed in the TRAGIS evaluation. Twenty-one irradiated fuel shipments from the CCNPP site to the proposed Yucca Mountain repository per year were evaluated (as discussed in Section 5.11) and the TRAGIS Highway Route Controlled Quantity was utilized as the basis to calculate the shipping distance.

Based on the above and the accident rates from Table 7.4-4, the non-radiological fatal injury rate impact associated with postulated accidents as a result of irradiated fuel shipments is 1.78E-01 per 100 reactor years.

Based on the above and the accident rates from Table 7.4-6, the non-radiological nonfatal injury rate impact associated with postulated accidents as a result of irradiated fuel shipments is 4.08E-01 nonfatal injuries per 10 reactor years.

7.4.2.3 Radioactive Waste

The fatal injury rate for accidents associated with radwaste shipments is 1.06E-01 fatal injuries per 100 reactor years. This is based on the fatality rates from Table 4 of ANL/ESD/TM-150 (ANL, 1999). TRAGIS was used to calculate the commercial routing through each state. Interstate travel is the dominant road designation and was used for all route types.

It is assumed that all shipments go from the CCNPP site to the farthest potential disposal repository located in Hanford, WA 2,733 mi (4,399 km) and that the truck conservatively returns to the plant empty (doubling the traveled distance.) The state-specific fatality rates are in Table 7.4-11. The number of radwaste shipments from the site to Hanford per year is 15 as described in Section 5.11.3.3. The distance weighted fatality rate from Table 7.4-11 is 1.29E-08 fatalities/truck-mi (8.00E-09 fatalities/truck-km). The Radwaste Fatality (SFF) rate was calculated to be 1.06E-01 fatal injuries/100 reactor years.

The nonfatal injury rate associated with radwaste shipments is 3.06E-01 nonfatal injuries per 10 reactor years. This is based on the distances and road types from the radiological impact calculations and the injury rates from Table 4 of ANL/ESD/TM-150 (ANL, 1999). TRAGIS was used to calculate the commercial routing through each state. Interstate travel is the dominant road designation and was used for all route types.

It is assumed that all shipments go from the site to the farthest potential disposal repository located in Hanford, WA 2,733 mi (4,399 km) and that the truck conservatively returns to plant empty (doubling the traveled distance.) The state-specific fatality rates are in Table 7.4-11. The number of radwaste shipments from the site to Hanford per year is 15 as described in Section 5.11.3.3. The average injury rate from Table 7.4-11 is 3.73E-07 injuries/truck-mi (2.32E-07 injuries/truck-km). The nonfatal Radwaste Injury rate was calculated to be 3.06E-01 nonfatal injuries/10 reactor years.

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 (DOE, 1981) transported to and from the CCNPP site has been performed in accordance with 10 CFR 51.52(b) (CFR, 2007).

Table 7.4-12 summarizes the radiological impact, and Table 7.4-13 summarizes the non-radiological impact. These environmental impact results are bounded by 10 CFR 51.52(c) (CFR, 2007), Table S-4. These impacts represent the contribution of postulated transportation accidents to the environmental costs of operating the proposed facility.

As shown in Table 7.4-13, the calculated impacts from transportation accidents are less than those corresponding impacts listed in Table S-4 of 10 CFR 51.52 (CFR, 2007). Therefore the corresponding impacts from transportation accidents for the transportation of fuel and waste to and from the proposed facility are small and will be less than those accepted by 10 CFR 51.52 (CFR, 2007).

7.4.4 References

AEC, 1972. Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants, WASH-1238, Atomic Energy Commission, December 1972.

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

CFR, 2007. Title 10, Code of Federal Regulations, Part 51, Environmental Protection Regulations for Domestic Licensing and related Regulatory Functions, 2007.

DOE, 2002. Final Environmental Impact Statement for a Geologic Repository for the Disposal of Irradiated Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, DOE/EIS-0250, Office of Civilian Radioactive Waste Management, U.S. Department of Energy, 2002.

DOE, 1981. Radioactive Decay Data Tables, DOE/TIC-11026, U.S. Department of Energy, D. Kocher, 1981

NRC, 1975. Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants, Supplement 1, NUREG-75/038, Nuclear Regulatory Commission, April 1975.

NRC, 2000. Re-Examination of Spent Fuel Shipment Risk Estimates, NUREG/CR-6672, Nuclear Regulatory Commission, 2000.

NRC, 2006. Environmental Impact Statement for an Early Site Permit (ESP) at the Exelon ESP Site Final Report, NUREG-1815, Nuclear Regulatory Commission, July, 2006.

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

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

Table 7.4-1— 10 CFR 51.52 Summary Table S-4 Excerpt Environmental Impact of Transportation of Fuel and Waste to and from One Light-Water-Cooled Nuclear Power Reactor Accidents in Transport

Types of Effects	Environmental Risk
Radiological Effects	**Small**
Common (nonradiological) causes	1 fatal injury in 100 reactor years 1 nonfatal injury in 10 reactor years $475 property damage per reactor year

Table 7.4-2— RADTRAN/TRAGIS Model Irradiated Fuel Input Parameters

Parameter	CCNPP Model U.S. EPR (English Units)	CCNPP Model U.S. EPR (SI Units)
TRAGIS Input:		
Route Mode	HRCQ	
Route Origin	CCNPP	
Route Destination	Yucca Mt, NV	
RADTRAN Input TRAGIS:		
Total Shipping Distance	2,680 mi	4,312.7 km
Travel Distance – Rural	2,036 mi	3,275.2 km
Travel Distance – Suburban	568 mi	914 km
Travel Distance – Urban	77 mi	123.8 km
Population Density – Rural	30 person/mi^2	11.5 person/km^2
Population Density – Rural	817 person/mi^2	315.5 person/km^2
Population Density – Rural	6,166 person/mi^2	2,381.8 person/km^2
Stop Time, hr/trip	5.0 (1)	
RADTRAN Input from NRC Models		
Vehicle Speed	55 mph	88.49 km/hr
Traffic Count – Rural, Vehicles / hr	530	530
Traffic Count – Suburban, Vehicles / hr	760	760
Traffic Count – Urban, Vehicles / hr	2,400	2,400
Dose Rate at 3.3 ft (1 m) from Vehicle	14 mrem/hr	0.14 mSv/hr
Packaging Length	17 ft	5.2 m
Packaging Diameter	3 ft	1.0 m
Number of Truck Crew	2	
Population Density at Stops (radii: 3.3 to 33 ft (1 to 10 m))	77,666 person/mi^2	30,000 person/km^2
Population Density at Stops (radii: 33 to 2,625 ft (10 to 800 m))	880 person/mi^2	340 person/km^2
Shielding Factor at Stops (radii: 3.3 to 33 ft (1 to 10 m))	1	
Shielding Factor at Stops (radii: 33 to 2,625 ft (10 to 800 m))	0.2	

Note:
(1) Based on TRAGIS output: 10 stops at 30 minutes each.

Table 7.4-3— Irradiated Fuel Source Term

Radionuclide (a)	CCNPP Model U.S. EPR 5 Year Decay Ci/MTU	CCNPP Model U.S. EPR 5 Year Decay Bq/MTU
Am-241	1.25E+03	4.62E+13
Am-242m	2.38E+01	8.82E+11
Am-243	3.22E+01	1.19E+12
Cm-144	1.52E+04	5.62E+14
Cm-242	4.35E+01	1.61E+12
Cm-243	3.19E+01	1.18E+12
Cm-244	4.84E+03	1.79E+14
Cm-245	6.19E-01	2.29E+10
Co-60	7.59E+01	2.81E+12
Cs-134	5.84E+04	2.16E+15
Cs-137	1.42E+05	5.25E+15
Eu-154	1.16E+04	4.31E+14
Eu-155	5.73E+03	2.12E+14
I-129	4.65E-02	1.72E+09
Kr-85	1.05E+04	3.88E+14
Pm-147	3.54E+04	1.31E+15
Pu-238	6.95E+03	2.57E+14
Pu-239	4.24E+02	1.57E+13
Pu-240	7.24E+02	2.68E+13
Pu-241	1.17E+05	4.34E+15
Pu-242	2.28E+00	8.44E+10
Ru-106	2.05E+04	7.59E+14
Sb-125	5.35E+03	1.98E+14
Sr-90	1.03E+05	3.81E+15
Y-90	1.03E+05	3.82E+15

Table 7.4-4— Irradiated Fuel CCNPP Model Accident and Fatality Rates

State	Accident Rate Accidents / truck-mi (Accidents / truck-km)	Fatality Rate Fatalities / truck-mi (Fatalities / truck-km)	Distance mi (km)	Accident Rate distance weighted fraction accident / truck-mi (accident / truck-km)	Fatality Rate distance weighted fraction fatality / truck-mi (fatality / truck-km)
AZ	2.12E-07 (1.32E-07)	1.51E-08 (9.40E-09)	29.3 (47.1)	2.32E-09 (1.44E-09)	1.66E-10 (1.03E-10)
IL	3.57E-07 (2.22E-07)	1.34E-08 (8.30E-09)	162.2 (261.7)	2.17E-08 (1.35E-08)	8.11E-10 (5.04E-10)
IN	3.62E-07 (2.25E-07)	1.08E-08 (6.70E-09)	151.2 (243.4)	2.04E-08 (1.27E-08)	6.08E-10 (3.78E-10)
IA	1.80E-07 (1.12E-07)	1.51E-08 (9.40E-09)	307.0 (494.1)	2.06E-08 (1.28E-08)	1.74E-09 (1.08E-09)
MD	8.69E-07 (5.40E-07)	1.05E-08 (6.50E-09)	235.4 (378.8)	7.63E-08 (4.74E-08)	9.19E-10 (5.71E-10)
NE	5.13E-07 (3.19E-07)	2.20E-08 (1.37E-08)	456.6 (734.8)	8.75E-08 (5.44E-08)	3.75E-09 (2.33E-09)
NV	3.62E-07 (2.25E-07)	1.06E-08 (6.60E-09)	167.5 (269.5)	2.27E-08 (1.41E-08)	6.63E-10 (4.12E-10)
OH	2.64E-07 (1.64E-07)	6.28E-09 (3.90E-09)	239.9 (386.1)	2.37E-08 (1.47E-08)	5.62E-10 (3.49E-10)
PA	8.27E-07 (5.14E-07)	2.17E-08 (1.35E-08)	107.2 (172.6)	3.32E-08 (2.06E-08)	8.69E-10 (5.40E-10)
UT	4.67E-07 (2.90E-07)	1.92E-08 (1.19E-08)	379.2 (610.3)	6.6E-08 (4.10E-08)	2.70E-09 (1.68E-09)
WV	2.77E-07 (1.72E-07)	2.70E-08 (1.68E-08)	43.3 (69.7)	4.47E-09 (2.78E-09)	4.28E-10 (2.72E-10)
WY	1.08E-06 (6.74E-07)	1.74E-08 (1.08E-08)	400.5 (644.6)	1.63E-07 (1.01E-07)	2.59E-09 (1.61E-09)
Sum:			2680 (4312.7)	5.41E-07 (3.36E-07)	1.58E-08 (9.84E-09)
				Fatalities per Accident [(1)]:	2.93E-02

Note:
(1) Fatalities per accident = Fatality Rate / Accident Rate.

Table 7.4-5— Irradiated Fuel and Radioactive Waste Models Severity and Release Fractions

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-06	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-02
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

Note:
Aerosol and Respirable Fractions set to 1.0.

Table 7.4-6— Irradiated Fuel CCNPP Transportation Injury Rates

State	Injury Rate Injury / truck-mi (Injury / truck-km)	Distance mi (km)	Injury Rate Distance Weighted Fraction Injury / truck-mi (Injury / truck-km)
AZ	1.88E-07 (1.17E-07)	29.3 (47.1)	2.06E-09 (1.28E-09)
IL	2.41E-07 (1.50E-07)	162.6 (261.7)	1.46E-08 (9.10E-09)
IN	2.25E-07 (1.40E-07)	151.2 (243.4)	1.27E-08 (7.90E-09)
IA	1.38E-07 (8.60E-08)	307.0 (494.1)	1.59E-08 (9.85E-09)
MD	7.39E-07 (4.59E-07)	235.4 (378.8)	6.49E-08 (4.03E-08)
NE	3.17E-07 (1.97E-07)	456.6 (734.8)	5.41E-08 (3.36E-08)
NV	2.38E-07 (1.48E-07)	167.5 (269.5)	1.49E-08 (9.25E-09)
OH	2.25E-07 (1.40E-07)	239.9 (386.1)	2.01E-08 (1.25E-08)
PA	6.16E-07 (3.83E-07)	107.2 (172.6)	2.46E-08 (1.53E-08)
UT	4.07E-07 (2.53E-07)	379.2 (610.3)	5.76E-08 (3.58E-08)
WV	1.80E-07 (1.12E-07)	43.3 (69.7)	2.91E-09 (1.81E-09)
WY	5.20E-07 (3.23E-07)	400.5 (644.6)	7.77E-08 (4.83E-08)
	Sum:	2680 (4312.7)	3.62E-07 (2.25E-07)

Table 7.4-7— New Fuel CCNPP Transportation Fatality and Injury Rates

State	Fatality Rate Fatalities / Truck-mi (fatality / truck-km)	Injury Rate Injuries Truck-mi (injury / truck-km)	Distance mi (km)	Fatality Rate Distance Weighted Fraction Fatality / Truck-mi (fatality / truck-km)	Injury Rate Distance Weighted Fraction Injury / Truck-mi (injury / truck-km)
ID	6.12E-09 (3.80E-09)	4.94E-07 (3.07E-07)	275.6 (443.5)	6.20E-10 (3.85E-10)	5.01E-08 (3.11E-08)
IL	1.34E-08 (8.30E-09)	2.41E-07 (1.50E-07)	162.6 (261.7)	7.98E-10 (4.96E-10)	1.44E-08 (8.96E-09)
IN	1.08E-08 (6.70E-09)	2.25E-07 (1.40E-07)	151.2 (243.4)	5.99E-10 (3.72E-10)	1.25E-08 (7.78E-09)
IA	1.51E-08 (9.40E-09)	1.38E-07 (8.60E-08)	305.3 (491.3)	1.69E-09 (1.05E-09)	1.55E-08 (9.64E-09)
MD	1.05E-08 (6.50E-09)	7.39E-07 (4.59E-07)	153.7 (247.4)	5.91E-10 (3.67E-10)	4.17E-08 (2.59E-08)
NE	2.20E-08 (1.37E-08)	3.17E-07 (1.97E-07)	452.7 (728.5)	3.67E-09 (2.28E-09)	5.28E-08 (3.28E-08)
OH	6.28E-09 (3.90E-09)	2.25E-07 (1.40E-07)	239.9 (386.1)	5.54E-10 (3.44E-10)	1.98E-08 (1.23E-08)
OR(1)	3.28E-08 (2.04E-08)	2.19E-07 (1.36E-07)	208.5 (335.5)	2.51E-09 (1.56E-09)	1.67E-08 (1.04E-08)
PA	2.17E-08 (1.35E-08)	6.16E-07 (3.83E-07)	187.3 (301.5)	1.50E-09 (9.29E-10)	4.25E-08 (2.64E-08)
UT	1.92E-08 (1.19E-08)	4.07E-07 (2.53E-07)	149.1 (240)	1.05E-09 (6.52E-10)	2.24E-08 (1.39E-08)
WA	2.90E-09 (1.80E-09)	2.90E-07 (1.80E-07)	35.7 (57.4)	3.80E-11 (2.36E-11)	3.80E-09 (2.36E-09)
WY	1.74E-08 (1.08E-08)	5.20E-07 (3.23E-07)	400.5 (644.6)	2.56E-09 (1.59E-09)	7.64E-08 (4.75E-08)
		Sum:	2723 (4380.9)	1.63E-08 (1.01E-08)	3.68E-07 (2.29E-07)

Note:
Interstate data not provided.

Table 7.4-8— EPR Radwaste Annual Generation

Waste Type	Annual Activity [a]	
	Bq	Ci
Evaporator Concentrates	5.55E+12	1.50E+02
Spent Resins (other)	3.96E+13	1.07E+03
Spent Resins (Radwaste Demineralizer System)	1.10E+12	2.96E+01
Wet Waste from Demineralizers	6.25E+10	1.69E+00
Waste Drum for Solids Collection from Centrifuge System of KPF	6.25E+10	1.69E+00
Filters (quantity)	2.54E+13	6.86E+02
Sludge	5.48E+11	1.48E+01
Mixed Waste	1.48E+09	4.00E-02
Non-Compressible Dry Active Waste (DAW)	1.10E+10	2.97E-01
Compressible DAW	2.22E+11	6.01E+00
Combustible DAW	1.18E+12	3.19E+01
Total	7.37E+13	1.99E+03

Note:
(a) Refer to Section 3.5.

Table 7.4-9— RADTRAN/TRAGIS Radwaste Model Input Parameters

Parameter	CCNPP Model EPR
TRAGIS Input:	
Route Mode	Commercial
Route Origin	CCNPP
Route Destination	Hanford, WA
RADTRAN Input from TRAGIS:	
Total Shipping Distance, mi (km)	2,733 (4,399)
Travel Distance - Rural, mi (km)	2,063 (3,320)
Travel Distance - Suburban, mi (km)	594 (955.5)
Travel Distance - Urban, mi (km)	76.5 (123.2)
Population Density - Rural, person/mi^2 (person/km^2)	30 (11.6)
Population Density - Suburban, person/mi^2 (person/km^2)	835 (322.4)
Population Density - Urban, person/mi^2 (person/km^2)	6,085 (2,349.5)
Stop Time, hr/trip	5.5[b]
RADTRAN Input from NRC Models [(a)]	
Vehicle Speed, mph (km/hr)	55 (88.49)
Traffic Count - Rural, vehicles/hr	530
Traffic Count - Suburban, vehicles/hr	760
Traffic Count - Urban, vehicles/hr	2,400
Dose Rate at 3 ft (1 m) from Vehicle, mrem/hr (mSv/hr)	14 (0.14)
Packaging Length, ft (m)	17 (5.2)
Packaging Diameter, ft (m)	3.3 (1.0)
Number of Truck Crew	2
Population Density at Stops (radii: 3.3 to 33 ft (1 to 10 m)), person/mi^2 (person/km^2)	77,700 (30,000)
Population Density at Stops (radii: 33 to 2,655 ft (10 to 800 m)), person/mi^2 (person/km^2)	881 (340)
Shielding Factor at Stops (radii: 3.3 to 33 ft (1 to 10 m))	1
Shielding Factor at Stops (radii: 33 to 2,655 ft (10 to 800 m))	0.2

Notes:
(a) From NUREG-1815 for spent fuel shipments.
(b) Based on TRAGIS output: 11 stops at 30 minutes each.

Table 7.4-10— Radwaste Annual Source Term

	RADTRAN Input	
	Annual Activity	
Radionuclide	***Bq***	***Ci***
CE 144	2.87E+10	7.75E-01
CO 58	4.21E+12	1.14E+02
CO 60	8.75E+12	2.37E+02
CS 134	6.79E+12	1.84E+02
CS 137	1.29E+13	3.49E+02
FE 55	1.75E+13	4.73E+02
I 129	3.35E+07	9.06E-04
I 131	3.39E+08	9.16E-03
MN 54	1.33E+13	3.60E+02
PU 241	1.26E+10	3.39E-01
RU 103	4.62E+11	1.25E+01
RU 106	7.71E+11	2.08E+01
SB 124	4.22E+08	1.14E-02
SB 125	1.38E+09	3.74E-02
SR 89	4.92E+08	1.33E-02
SR 90	9.75E+10	2.64E+00
Y 90	9.43E+10	2.55E+00
ZN 65	3.46E+12	9.34E+01

Table 7.4-11— Radwaste CCNPP Transportation Accident, Fatality and Injury Rates

(Page 1 of 2)

State	Accident Rate	Fatality Rate	Injury Rate	Distance	Distance Weighted Fraction		
	Accidents / truck-mi (Accidents / truck-km)	Fatalities / truck-mi (Fatalities / truck-km)	Injuries / truck-mi (Injuries / truck-km)	mi (km) [(a)]	Accident Rate	Fatality Rate	Injury Rate
ID	4.75E-07 (2.95E-07)	6.12E-09 (3.80E-09)	4.94E-07 (3.07E-07)	72 (116.6)	7.82E-09	1.01E-10	8.14E-09
IL	3.57E-07 (2.22E-07)	1.34E-08 (8.30E-09)	2.41E-07 (1.50E-07)	118 (190.7)	9.62E-09	3.60E-10	6.50E-09
IN	3.62E-07 (2.25E-07)	1.08E-08 (6.70E-09)	2.25E-07 (1.40E-07)	151 (243.4)	1.24E-08	3.71E-10	7.75E-09
MD	8.69E-07 (5.40E-07)	1.05E-08 (6.50E-09)	7.39E-07 (4.59E-07)	154 (247.4)	3.04E-08	3.66E-10	2.58E-08
MN	2.75E-07 (1.71E-07)	4.82E-09 (3.00E-09)	1.35E-07 (8.40E-08)	275 (442.4)	1.72E-08	3.02E-10	8.45E-09
MT	9.98E-07 (6.20E-07)	2.19E-08 (1.36E-08)	4.12E-07 (2.56E-07)	552 (888.5)	1.25E-07	2.75E-09	5.17E-08
OH	2.64E-07 (1.64E-07)	6.28E-09 (3.90E-09)	2.25E-07 (1.40E-07)	240 (386.1)	1.44E-08	3.42E-10	1.23E-08
PA	8.27E-07 (5.14E-07)	2.17E-08 (1.35E-08)	6.16E-07 (3.83E-07)	187 (301.5)	3.52E-08	9.25E-10	2.62E-08
SD	3.75E-07 (2.33E-07)	9.82E-09 (6.10E-09)	2.77E-07 (1.72E-07)	412 (662.4)	3.51E-08	9.19E-10	2.59E-08
WA	4.26E-07 (2.65E-07)	2.90E-09 (1.80E-09)	2.90E-07 (1.80E-07)	175 (281.5)	1.70E-08	1.15E-10	1.15E-08
WI	7.23E-07 (4.49E-07)	1.46E-08 9.10E-09	5.36E-07 3.33E-07	188 (301.9)	3.08E-08	6.25E-10	2.29E-08
WY	1.08E-07 (6.74E-07)	1.74E-08 (1.08E-08)	5.20E-07 (3.23E-07)	209 (336.7)	5.16E-08	8.27E-10	2.47E-08

Table 7.4-11— Radwaste CCNPP Transportation Accident, Fatality and Injury Rates

(Page 2 of 2)

	Accident Rate	Fatality Rate	Injury Rate	Distance	Distance Weighted Fraction		
State	**Accidents / truck-mi (Accidents / truck-km)**	**Fatalities / truck-mi (Fatalities / truck-km)**	**Injuries / truck-mi (Injuries / truck-km)**	**mi (km) [(a)]**	**Accident Rate**	**Fatality Rate**	**Injury Rate**
Sum:				2,733 mi (4,399 km)	6.23E-07 (3.87E-07)	1.29E-08 (8.00E-09)	3.73E-07 (2.32E-07)
						Per truck-mi (per truck-km)	
Fatalities per Accident [(b)] :						2.07E-02 Fatalities per accident	

Notes:
(a) From TRAGIS.
(b) Fatalities per accident = Fatality Rate / Accident Rate.

Table 7.4-12— Population Dose from Transportation Accidents

Environmental Impact	New Fuel	Irradiated Fuel	Radwaste	Total
U.S. EPR Dose Person-rem/ U.S. EPR-reactor-year (person-Sv/ U.S. EPR-reactor-year)	See below	1.9E-04 (1.9E-06)	7.3E-06 (7.3E-08)	2.0E-04 (2.0E-06)

The dose from new fuel accidents is assumed to be negligible compared to the doses from Irradiated Fuel and Radioactive Waste as described in Section 7.4.2.

Table 7.4-13— U.S. EPR Summary of Annual Transportation Accident Non-Radiological Impact

Environmental Impact	New Fuel	Irradiated Fuel	Radwaste	Total	10 CFR 51.52 Table S-4
Fatal Injury per 100 reactor years	6.6E-02	1.8E-01	1.1E-01	3.6E-01	1.0
Non-Fatal Injury per 10 reactor years	1.5E-01	4.1E-01	3.1E-01	8.7E-01	1.0

ENVIRONMENTAL REPORT

CHAPTER 8

NEED FOR POWER

8.0 NEED FOR POWER

This chapter provides an assessment of the need for electric power in support of the COL application for the proposed Calvert Cliffs Nuclear Power Plant (CCNPP) Unit 3. Also provided is a description of the existing regional electric power system, current and future demand for electricity, and present and planned power supplies.

The assessment of power needs is based on input provided by the Maryland Public Service Commission (PSC) on the need to sustain a safe and reliable electric system in the state and reduce the state's reliance on imported electric power. Maryland is one of several states that have restructured their regulatory programs for electric utilities. Restructuring has changed the PSC role relative to the pricing of electricity generation and establishes that retail electric choice will be available to all customers (MDPSC, 2006).

Effective July 2000, the Maryland Electric Customer Choice and Competition Act of 1999 restructured the electric utility industry in Maryland to allow electric retail customers to shop for power from various suppliers (MD, 1999). These retail suppliers can generally be grouped into two categories:

- Local Utility - Entity that supplies electricity as a regulated monopoly and is the current default provider of electricity supply for customers who do not choose an alternative competitive electricity supplier.
- Competitive Suppliers - Competing entities that began supplying electricity in the competitive marketplace when the market was restructured.

Prior to restructuring, the local electric utility operated as a regulated, franchised monopoly. It supplied all end-use customers within its franchised service area with the three principal components of electric power service: generation, transmission, and distribution. With the restructuring of the electric power industry in Maryland, generation of electricity is now provided in a competitive marketplace (transmission and distribution remain regulated monopolies). Prices for power supply are determined by a competitive electric power supply market rather than by the PSC in a regulated environment.

Retail customers of the investor-owned utilities in Maryland have been allowed to select their own electric supplier since 2000. Electric restructuring has been gradually implemented since then, but the PSC still monitors and reports on the adequacy and reliability of electric power supply in the state.

However, no new generating capacity has been built in Maryland for a number of years. The PSC role in licensing of new generation facilities is discussed in Section 8.1.

Additionally, to gain the efficiency and reliability benefits of interstate and intrastate power transactions, the Maryland utilities participate in multi-utility power markets called the PJM Interconnection LLC (PJM), which also includes all or part of 13 states, including most of Pennsylvania, New Jersey, Delaware and the District of Columbia. The PJM reliability planning process is discussed further in Section 8.1.

As noted in NUREG-1555, "Standard Review Plan for Environmental Reviews of Nuclear Power Plants" (ESRP) Section 8.1 (NRC, 1999):

> Affected States and/or regions are expected to prepare a need-for-power evaluation. NRC will review the evaluation and determine if it is (1) systematic, (2) comprehensive, (3) subject to confirmation, and (4) responsive to forecasting uncertainty. If the need for power evaluation is found acceptable, no additional independent review by NRC is needed, and the analysis can be the basis for ESRPs 8.2 through 8.4 (NRC, 1999).

Additionally, the NRC recognizes that the "need for power" should be analyzed on an individualized basis:

> The guidance in [ESRP 8.0] is limited because changes in the regulatory structure are occurring as the guidance is being revised. Reviewers of issues related to the need for power should identify current NRC policy before beginning their review. Deregulation in the electricity market will have a significant impact on the analysis of the need for power. Applicants may be power generators rather than utilities; <u>therefore, analysis of the need for power must be sufficiently flexible to accommodate the applicant type</u> [emphasis added]. (NRC, 1999)

The following sections show that the licensing process and other regulatory reviews occurring in the restructured utility market in Maryland meet the characteristics of an acceptable analysis of the need for power that satisfies NUREG-1555.

8.0.1 REFERENCES

MD, 1999. Maryland Electric Customer Choice and Competition Act of 1999, Maryland Code Annotated, Public Utilities Company Article, Section 7-501, 1999, Website: http://mlis.state.md.us/cgi-win/web_statutes.exe?gpu&7-501, Date accessed: April 11, 2007.

MDPSC, 2006. Ten-Year Plan (2006-2015) of Electric Companies in Maryland, Maryland Public Service Commission, Prepared for the Maryland Department of Natural Resources, December 2006, Website: http://www.psc.state.md.us/psc/Reports/2006-10YrPlan.pdf, Date accessed: April 11, 2007.

NRC, 1999. Standard Review Plans for Environmental Reviews of Nuclear Power Plants, NUREG-1555, Nuclear Regulatory Commission, October 1999.

8.1 DESCRIPTION OF POWER SYSTEM

This section evaluates the following criteria described in NUREG-1555 (NRC, 1999):

> Affected States and/or regions are expected to prepare a need-for-power evaluation. NRC will review the evaluation and determine if it is (1) systematic, (2) comprehensive, (3) subject to confirmation, and (4) responsive to forecasting uncertainty. If the need for power evaluation is found acceptable, no additional independent review by NRC is needed, and the analysis can be the basis for ESRPs 8.2 through 8.4.
>
> As part of their analyses of the need for power, States and/or regional authorities are expected to describe and assess the regional power system. <u>The reviewer should evaluate the description and determine if it is comprehensive and subject to confirmation</u>. [emphasis added] If it is found acceptable, no additional data collection by NRC should usually be needed. These data may be supplemented by information sources such as the Energy Information Administration, FERC [Federal Energy Regulatory Commission], the North American Electric Reliability Council, and others. (NRC, 1999)

In 1999, the State of Maryland restructured the manner in which it regulates the state's utilities by allowing for customer choice of electricity suppliers and by deregulating the price of electric supply. In the Electric Customer and Competition Act of 1999, the Maryland state legislature outlined the goals of electric restructuring and the Maryland Public Service Commission's (PSC) role in its implementation under the new statute:

> In assessing and approving each electric company's restructuring plan, and overseeing the transition process and regulation of the restructured electric industry, the Commission shall provide that the transition to a competitive electricity supply and electricity supply services market shall be orderly, maintain electric system reliability, and ensure compliance with federal and State environmental regulations, be fair to customers, electric company investors, customers of municipal electric utilities, electric companies, and electricity suppliers, and provide economic benefits to all customer classes (MD, 1999).

Despite the deregulation of the price of electric supply and generation in Maryland, electric power generators must obtain a "Certificate of Public Convenience and Necessity" (CPCN) from the PSC to build or modify power plants and transmission lines in the state. The CPCN is a single, comprehensive licensing process for the State. The CPCN encompasses the requirements of the Clean Air Act (CAA), including the Prevention of Significant Deterioration (PSD) approval, which the PSC, on behalf of Maryland, has been authorized by the U.S. Environmental Protection Agency (USEPA) to issue to power developers.

For a CPCN to be approved, the applicant must submit an application that will be processed and reviewed under the regulations promulgated by the Maryland PSC (MD, 2007). The application must include descriptions of the site and existing power plant installations, all proposed changes or alterations of the site and plant, the new or altered associated facilities, the environmental and other impacts of the project, and the environmental and other benefits to be realized from the project.

The CPCN application is filed with the PSC pursuant to the PUC Article Section 7-207 (MD, 2007). The Power Plant Research Program (PPRP) of the Maryland Department of Natural

Resources (MDNR) coordinates and receives recommendations from various federal, state, and local agencies regarding the CPCN application with ultimate disposition of these recommendations and the application itself by the PSC.

The information in the CPCN application presents the scope and impacts of the project and contains the information required by Maryland regulations (COMAR, 2007). It addresses the environmental and socioeconomic aspects of the project by presenting information on the existing natural and human environment, the facilities proposed to be constructed and operated, and the impacts of those new facilities on the environment. The MDNR, through the PPRP, also monitors construction of new power plants.

As part of the review, the PPRP performs the following functions:

- Consolidates issue analysis involving the MDNR, Environment, Agriculture, Business and Employment Development, and Transportation; the Office of Planning; and the Energy Administration. The PPRP usually represents those agencies in the PSC CPCN hearing process.
- Evaluates potential impacts of the proposed facility on environmental resources, including air, surface water and groundwater, terrestrial resources, and cultural and historic resources, while assessing overall site suitability.
- Manages the development of a consolidated set of recommendations to be included as conditions within the CPCN.

In addition, the PPRP provides a Cumulative Environmental Impact Report, which provides biennial information about potential environmental impacts of existing plants and power transmission on Maryland natural resources, cultural foundation, and economic situation, including power demand forecasts and growth factors.

Figure 8.1-1 provides an overview of the power plant construction approval process in Maryland.

8.1.1 Systematic Process

In Maryland, two state agencies are primarily responsible for the review and approval of applications to build new electric generating facilities in the state. Public concern about potential environmental damage to Chesapeake Bay prompted the creation of the PPRP (within the MDNR) to ensure a comprehensive, objective evaluation, based on sound science, to resolve environmental and economic issues before decisions were made regarding whether and where to build additional power-generating facilities. The PPRP, as noted above, coordinates the analysis of new generating plants by the various state agencies and the recommendations made by those agencies concerning the conditions to be imposed by the PSC upon the authorization of the new generating plants. The PSC approves the construction of the new facilities by issuing the necessary CPCN license after conducting hearings on each CPCN application. The PSC also provides an annual report to the MDNR describing the composition, fuel type, and adequacy of Maryland's existing electric generation facilities as well as proposed generation resources planned for construction in the state.

The PPRP coordinates the comprehensive review of all proposed power generation and transmission facilities and develops technically based licensing recommendations. The PPRP evaluates impacts to Maryland surface water, groundwater, air, land, and socioeconomics for all proposed power facilities, including new plants, expansions of existing plants, and transmission lines.

Within the CPCN process, PPRP facilitates extensive interagency cooperation and planning. The PPRP may meet with representatives of potential applicants who are considering new generating station or transmission line projects to discuss whether and how all relevant concerns will be addressed and to ensure that the applicant understands the PSC regulations and procedures. Once the applicant submits an application to the PSC, the PPRP prepares a project description and summary of key issues to inform the other state agencies and the public at large. This discussion includes a review of power and reliability reports developed by the PSC and PPRP. (PPRP, 2006a)

The adjudicatory process starts with the filing of the CPCN application, summarizing the impact analyses that have been performed and discussing the mitigation that the applicant has proposed to undertake to address environmental concerns. The applicant prepares prefiled testimony that addresses the criteria established by Maryland law and regulation for the issuance of a CPCN and then responds to discovery requests from intervenors. Thereafter, the PPRP and any other parties that have intervened in the process may cross examine this testimony and present their own analyses in direct testimony. The PPRP testimony, presented on behalf of the various state agencies, presents initial recommended licensing conditions.

Other intervening parties, including the PSC staff, Office of People's Counsel (a state agency charged with protecting the interests of electricity ratepayers), and citizen's groups, can prepare and submit direct testimony. The Commission, a panel of Commissioners, or a Hearing Examiner (appointed by the PSC) takes into consideration the recommended license conditions, testimony, and briefs filed by the PPRP, the applicant, and any other parties, and issues a decision in the form of a proposed order on whether the CPCN should be granted and any associated conditions. Where a Hearing Examiner is utilized, after a period during which an appeal can be made to the full Commission, a final order is released granting or denying the application.

PJM Interconnection, LLC (PJM) also performs systematic reliability planning (PJM 2007a). The PJM Capacity Adequacy Planning (CAP) Department is responsible for determining and monitoring the generation reliability requirements of PJM. This includes analyzing the growth of electrical peak load within the region (Brattle, 2006). As part of its reliability planning obligations as a Regional Transmission Organization (RTO), PJM also focuses on planning the enhancement and expansion of transmission capability on a regional basis.

PJM has recently developed independent load forecasting procedures to enhance reliability planning and transmission expansion. For example, reliability planning was previously based on individual reports from each transmission zone within the PJM. Each submitting entity produced its forecast based on its own methodology, though it was common that the energy forecast was derived from the company's retail sales forecast and the energy forecast was then used to derive the peak load forecast. After receiving these individual forecasts, PJM would then prepare a report showing the aggregate coincident and non-coincident peak reports and release these to the public (PJM, 2007a).

With the advent of electric industry restructuring, PJM, as the RTO, determined that a single independent forecast should replace the diversified "sum of zones" report. In 2004, PJM began developing its forecast model and framework. PJM still relies on data from its members, but performs an independent forecast to determine the need for transmission improvements and expansion. The latest transmission expansion report notes plans for new capacity as well as dynamic growth forecasts (PJM, 2007b).

In order to reliably and cost efficiently operate the region's electricity grid, PJM employs an operating procedure known as security constrained economic dispatch. With security constrained economic dispatch, PJM maximizes the use of its lowest cost generating units (coal and nuclear plants) and only uses more expensive units (oil or gas-fired units) when the lower cost units are already running at their maximum levels.

Additionally, the mission of the North American Electric Reliability Corporation (NERC), the "electric reliability organization" as certified by the FERC, is to improve the reliability and security of the bulk power system in North America. To achieve that, NERC develops and enforces reliability standards; monitors the bulk power system; assesses future adequacy; audits owners, operators, and users for preparedness; and educates and trains industry personnel.

NERC develops and publishes long-term reliability assessment reports annually to assess the adequacy of the bulk electric system in the U.S. and Canada over a 10 year period, including summer and winter assessments, and special regional, interregional, or interconnection assessment as needed. These reports project electricity supply and demand, evaluates transmission system adequacy, and discusses key issues and trends that could affect reliability (NERC, 2007).

These processes provide the necessary regulatory reviews and approvals to ensure that proposed power plants can be built to provide reliable, reasonably priced electricity without improperly harming the state's natural resources.

8.1.2 Comprehensive Process

The PSC performs an assessment of the generating or transmission capacity in Maryland. The Maryland Power Plant Research Act (MD, 2006) provides the process for analyzing forecasted energy consumption and peak demand in the restructured Maryland electricity marketplace.

The PSC is required to "assess the amount of electricity generated in Maryland as well as the amount of electricity imported from other states in order to determine whether a sufficient supply of electricity is available to customers in the State" (MD, 2006). Within the PSC, the Energy Resources and Markets Division (ERMD) is responsible for monitoring developments in the energy markets as they affect Maryland, and promoting PSC policies that accomplish more-robust and competitive energy markets, including at PJM, the RTO for the region that includes Maryland. Because retail electricity customers in Maryland either obtain electricity supply from a competitive retail supplier or from their distribution utility acting as the default supplier who purchases electricity through competitive auctions, the ERMD does not "plan" what is the best mix of energy supplies and method of delivery.

ERMD (formerly known as the Integrated Resource Planning (IRP) Division) was established in March 1993 to assess the capability for reliably meeting Maryland customers' electricity and natural gas energy demands. Division members have analytical and/or oversight responsibilities on a wide range of subjects, including regional power supply and transmission planning; applications for construction of major electric facilities; oversight of the Standard Offer Service competitive solicitations; developments in the wholesale energy markets, focusing on prices and availability; air emission compliance plans and emission monitoring as they affect the availability of power supplies; Maryland renewable portfolio standard; load management and conservation programs; and certification of natural gas and electricity suppliers.

During 2006, ERMD performed the following activities:

- Prepared the 10 Year Plan (2006 through 2015) of Electric Companies in Maryland (MDPSC, 2006). In this report, the ERMD notes that Maryland imports over 27% of its electricity from other states over the transmission grid. The report also outlines the PSC efforts to evaluate the status of restructuring in the state. The report notes the PSC reliability concerns and congestion issues. Further, it highlights an overall concern in the state and region over the predicted decline in capacity margins, volatility in the price of electricity, and the lack of in-state generation capacity in Maryland.

- Prepared the Electric Supply Adequacy Report of 2007 (MDPSC, 2007). This report is required by Section 7-505 of Maryland Code Annotated, and describes the amount of electricity generated in Maryland, as well as the amount of electricity imported from other states. This assessment determines whether there is a sufficient, reliable supply of electricity to customers as part of electric market restructuring in Maryland. The report concludes that Maryland's electric supply has become "uncertain, if not precarious." In addition, the in-state electricity supply is inadequate to meet current demand. If new generating capacity is not built and/or upgrades to the transmission system are not made, the likelihood of a reliability crisis in Maryland will increase and may become unavoidable. This report is discussed further, along with its relationship to regional reliability planning efforts, in Section 8.3.

- Monitored wholesale electricity prices in Maryland, including spot prices as measured by locational marginal prices.

- Participated in the PJM planning processes to put in place a new long-term transmission planning protocol addressing both reliability and market efficiency. PJM manages price and transmission reliability, and operates a centrally dispatched wholesale market within the region (PJM, 2007a).

- Actively participated in several PJM committees and working groups, including the Transmission Expansion Advisory Committee, the Markets and Reliability Committee, the Planning Committee, the Market Implementation Committee, the Members Committee, the Demand Response Working Group, and the Regional Planning Process Working Group (PJM, 2007b).

- The PPRP is authorized by the Maryland Power Plant Research Act to prepare a Cumulative Environmental Impact Report (CEIR) each biennium. The intent of the CEIR is to assemble and summarize information regarding the impacts of electric power generation and transmission on Maryland's natural resources, cultural foundations, and economic situation. The CEIR report provides analysis of resource impacts and provides a topical discussion of current trends in the electricity industry (PPRP, 2006).

- The PPRP also provides the PSC with energy consumption forecasts. PPRP provides statewide and regional energy consumption forecasts within the state based on multiple scenarios with low and high case alternatives (PPRP, 2006).

Accordingly, both the PPRP and the PSC, work to monitor the conditions supporting sufficient energy supply to serve Maryland electricity customers. As a result, the process is comprehensive.

8.1.3 Confirmation Process

Consolidated review of power plants and transmission lines by the State of Maryland provides an important opportunity for coordination and confirmation within state government. The PPRP serves as a central point of contact for input from various state agencies. PPRP staff members communicate with other agencies to ensure that all issues are identified, and the program undertakes impact evaluations with input and involvement of those agencies. The PPRP represents seven state agencies before the PSC during the licensing process. Through the development of a consolidated set of recommended licensing conditions, the CPCN process is a valuable tool for bringing together the perspectives of various government bodies and evaluating them within a common framework.

The PPRP has historically conducted a program of independent electric load forecasts as part of its responsibility to monitor the adequacy of future power supplies and to independently evaluate the potential for excess generating capacity. With the restructuring of the retail electric industry in Maryland brought about by the enactment of the Maryland Electric Customer Choice and Competitive Act of 1999, the preparation of load forecasts (energy sales and peak demands) for the individual investor-owned electric utilities operating within Maryland is not sufficient to provide the information required for the PPRP to assess the adequacy of planned supply.

Under restructuring, the primary issues relating to power supply affecting Maryland consumers are the adequacy of generating capacity and the adequacy of transmission system capacity. These assessments remain the responsibility of the PPRP, using the 10 year plans developed by ERMD. To assess and monitor the sufficiency of generating and transmission capacity, the PPRP now forecasts energy requirements and peak demands for the state as a whole and for the various regions within the state.

The PPRP forecast studies, including those historically performed for the service areas of the individual utilities as well as the state-wide forecast, use economic theory as the organizing principle to model the demand for electricity, and rely on econometric methods for estimation and projection. The data that are used to run these models, both historical and projected, are comprised of variables assumed to significantly affect the demand for electricity. Economic variables include income, the price of electricity, and employment; non-economic variables include population and weather. Historical information is required for estimating purposes, while projected data are necessary to forecast the demand for power econometrically. The uncertainty associated with these predictions is discussed in Section 8.1.4.

The PSC reviews certain of these assessments and market demand forecasts in Commission proceedings. The agency also provides the PPRP and the legislature with assessments of transmission reliability and demand projections. Further, the PSC is in the process of conducting a major policy review covering the provision of electricity to retail customers.

8.1.4 Consideration of Uncertainty

In its annual reliability report, the PSC notes the basic uncertainties of forecasting electricity consumption on a long-term basis and that actual demand could vary significantly, particularly in the years calculated for the end of the 10 year analysis period. A number of Maryland-specific factors add to this unpredictability. For example, the elasticity of consumer response to sharply higher electricity prices, on both a short-term and long-term basis, is very difficult to forecast.

Customers might not reduce demand for electricity as much as one might otherwise expect in the face of higher prices and widespread availability of demand-reduction programs. On the other hand, these price signals could help force demand response and energy efficiency programs and ultimately cause consumer demand to fall short of levels projected by PJM reliability studies and the utilities. Given the long lead times required to plan and construct generation and transmission facilities, and current shortages of both forms of infrastructure in Maryland, the PSC recognizes that it needs to assess the extent to which it can rely on the most optimistic and most pessimistic of the load forecasts.

Both the PPRP and the PSC recognize that uncertainties in market trends, income, rapid increase in population and demand, and fuel supply diversity will remain significant uncertainties in forecast methodology.

8.1.5 References

Brattle, 2006. An Evaluation of PJM's Peak Demand Forecasting Process, The Brattle Group, December 2006, Website: http://www.pjm.com/planning/resadequacy/downloads/brattle-final-report.pdf, Date accessed: June 1, 2007.

COMAR, 2007. Annotated Code of Maryland, COMAR 20.79.03, Details of Filing Requirements, Website: http://www.dsd.state.md.us/comar/idq_files/search.idq, Date accessed: June 19, 2007.

MD, 1999. Maryland Electric Customer Choice and Competition Act of 1999, Maryland Code Annotated, Public Utilities Company Article, Section 7-501, 1999, Website: http://mlis.state.md.us/cgi-win/web_statutes.exe?gpu&7-501, Date accessed: April 11, 2007.

MD, 2006. Annotated Code of Maryland, Natural Resources Article, Section 3-304, 2006, Website: http://mlis.state.md.us/cgi-win/web_statutes.exe?gnr&3-304, Date accessed: April 23, 2007.

MD, 2007. Annotated Code of Maryland, Public Utility Companies Article, Electric Generation Facility Planning, Section 2-207, 2007, Website: http://mlis.state.md.us/cgi-win/web_statutes.exe?gpu&7-207, Date accessed: June, 19, 2007.

MDPSC, 2006. Ten Year Plan (2006-2015) of Electric Companies in Maryland. Maryland Public Service Commission, Prepared for the Maryland Department of Natural Resources, December 2006, Website: http://www.psc.state.md.us/psc/Reports/2006-10YrPlan.pdf, Date accessed: April 11, 2007.

NERC, 2007. About NERC, North American Electricity Reliability Corporation, Website: www.nerc.com/about, Date accessed: June 19, 2007.

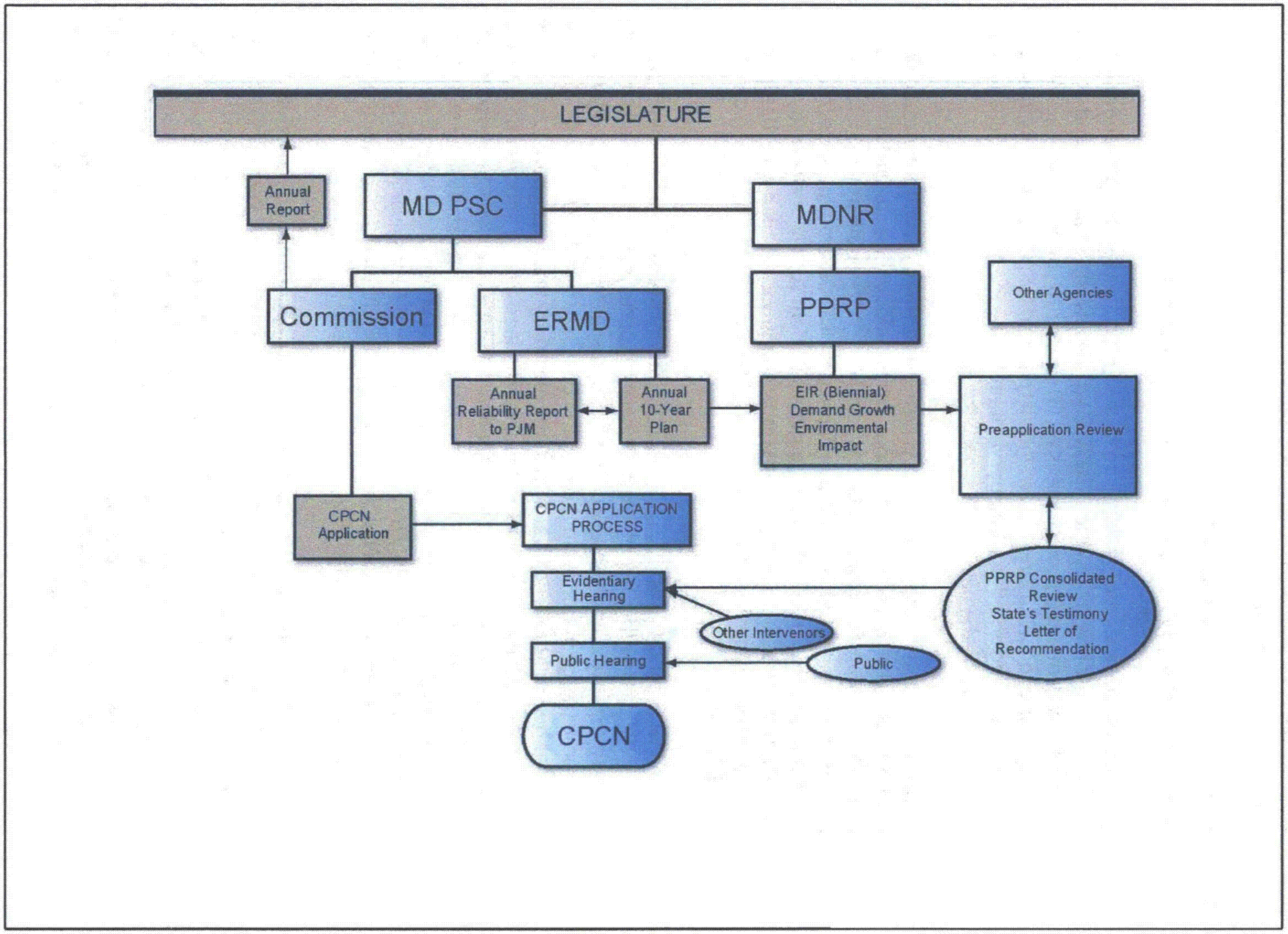
NRC, 1999. Standard Review Plans for Environmental Reviews of Nuclear Power Plants, NUREG-1555, October 1999, Nuclear Regulatory Commission, 1999.

PJM, 2007a. PJM Load Forecasting Model, PJM Interconnection LLC, Capacity Adequacy Planning Committee, February 2007, Website: http://www.pjm.com/planning/res-adequcy/downloads/forecast-model-whitepaper.pdf, Date accessed: June 1, 2007.

PJM, 2007b. PJM 2006 Regional Transmission Expansion Plan, PJM Interconnection LLC, February 2007, Website: http://www.pjm.com/planning/reg-trans-exp-plan.html, Date accessed: June 1, 2007.

PPRP, 2006. Maryland Power Plants and the Environment: A Review of the Impacts of Power Plants and Transmission Lines on Maryland's Natural Resources, PPRP CEIR-13, MDNR Publication Number 12-9202005-57, Power Plant Research Program, January 2006.

Figure 8.1-1— Power Planning and Plant Construction Approval – Maryland



8.2 POWER DEMAND

The guidance in NUREG-1555, "Standard Review Plan for Environmental Reviews of Nuclear Power Plants" (ESRP) 8.2 (NRC, 1999), allows that a state program describing current power demand and forecasts may support the need for power described in this chapter. This section describes the power resource adequacy review performed by the Maryland Public Service Commission (PSC) and the Power Plant Research Program (PPRP) of the Maryland Department of Natural Resources (MDNR).

8.2.1 Power And Energy Requirements

NUREG-1555 (NRC, 1999) provides the following guidance in ESRP 8.2.1:

> Affected States and/or regions continue to prepare need-for-power evaluations for proposed energy facilities. The NRC will review the evaluation and determine if it is (1) systematic, (2) comprehensive, (3) subject to confirmation, and (4) responsive to forecasting uncertainty. If the need for power evaluation is found acceptable, no additional independent review by the NRC is needed, and the analysis can be the basis for ESRPs 8.2 through 8.4 (NRC, 1999).

In Maryland's restructured marketplace, power and energy requirements are defined by customer demand (energy consumption), supply adequacy, and reliability. Section 7-505(e)(1) of the Public Utility Companies (PUC) Article (MD, 1999) requires the PSC to "assess the amount of electricity generated in Maryland as well as the amount of electricity imported from other states in order to determine whether a sufficient supply of electricity is available to customers in the State." The report on supply adequacy was filed with the General Assembly every two years beginning January 2001 until January 2007. In its 2007 report (MDPSC, 2007), the PSC noted:

> Maryland imports over 25% of its electric energy needs. On an absolute basis, Maryland is the fifth largest electric energy importer in the U.S. Virginia and New Jersey are in a comparable situation, being respectively the third and fourth largest energy importers in the country. Delaware and the District of Columbia, neighboring jurisdictions, are also large electricity importers, particularly given their relative small size. Thus, not only is Maryland a large importer of electricity, but so are states to the south, east and north of it as well. This makes much of the mid-Atlantic region deficient in generating capacity or, in industry parlance, a "load sink." Of states in the surrounding area, Maryland can import electricity in appreciable amounts only from West Virginia and Pennsylvania, and is competing with Delaware, Virginia, New Jersey, and the District of Columbia for the available exports from those states.
>
> Exacerbating this situation is that Maryland's dependence on out of state electricity supplies will likely increase over the next several years. On the supply side, little new in-state electric generation is scheduled to be built in the next five years. Additionally, some fossil-fired generating capacity may be de-rated or retired in order to comply with both federal and State air emission requirements, including the sulfur dioxide and mercury provisions of Maryland's Healthy Air Act. On the demand side, Maryland's electric utilities and PJM forecast that electricity demand will continue to rise, albeit at a modest pace of between 1% and 2% per year, further increasing Maryland's need for additional electricity supplies.

> Maryland's position as a large net importer and the fact many other jurisdictions in PJM are in a similar situation gives the State little margin for error in ensuring electric reliability. Significantly, Maryland has no in-state reserve margin. Existing in-state generating capacity would have to be increased by over 4,000 MW to bring load and electric supply into balance if Maryland was forced to rely on in-state resources alone. De-rating or retiring any existing instate generation would further increase this need. Maryland has been relying on the bulk electric transmission grid to make up the difference between available in-State supply and demand. However, Maryland's ability to import additional electricity over that grid, particularly during times of peak demand, is limited at best. This is because the current transmission facilities that allow the importation of electricity into the State is operating at peak capacity during peak load periods. In other words, even though generators in Pennsylvania, West Virginia and states farther west may have excess generation to sell to Maryland, the transmission network is unable to deliver that power during times of peak demand.

Additionally, the PPRP recently noted that base demand will continue to rise through 2015 (PPRP, 2006a). However, the PPRP also predicts that consumption may slow because of increases in the real price of electricity over the forecast period, resulting from the expiration of fixed prices for power purchased from the local investor-owned distribution utilities that prevailed following implementation of restructuring.

The expiration of fixed prices, combined with market factors that cause increases in wholesale electricity prices (such as fuel price increases), have resulted in significant increases in electricity prices for the latest customer base (created when the latest price restrictions were lifted in Maryland). Additional price increases will be borne by those customers that continue to be served under the frozen rates – the last of which are set to expire shortly.

To prevent long-term reliability issues, Maryland requires the adoption of long-term energy policies that encourage:

- The construction of generation capacity in-state;
- Siting and building of new transmission facilities that give increased access to out-of-state generation; and
- Energy conservation and demand management programs that will reduce the need for new electric supplies, and make more efficient use of both existing and planned electric infrastructure.

8.2.2 Factors Affecting Growth and Demand

The PPRP has historically conducted a program of independent electric load forecasts as part of its effort to monitor the adequacy of future power supplies. Due to the restructuring of the retail electric industry in Maryland, brought about by the enactment of the Maryland Electric Customer Choice and Competitive Act of 1999, the preparation of load forecasts (energy sales and peak demands) for the individual investor-owned electric utilities operating within Maryland no longer provides sufficient information for the PPRP to assess the adequacy of planned supply.

Peak demand occurs when consumers in aggregate use the greatest amount of electricity. Over the course of a year, peak demand usually occurs on hot summer afternoons and cold winter evenings. The load profile diagram presented in Figure 8.2-1 shows how electricity demand within a region changes during a typical summer day.

Virtually all power plants operate by using some form of energy to drive a generator to produce electricity. The needed energy can come in the form of steam created from coal, oil, natural gas, or nuclear fission. Gas turbines and internal combustion engines can also be used to drive generators directly. Hydroelectric plants use moving water to spin generators, while wind turbines use wind. Each of these technologies has different performance characteristics, entails different capital costs, and carries different operation and maintenance costs.

The power plants that are least expensive to run operate almost continuously to meet the minimum level of electricity that is demanded by a system (the base load). Also, known as baseload facilities, these continually running generators are predominantly coal-fired and nuclear plants. During periods when consumers demand more electricity, the power plants that can be quickly fired up to meet the peak load are put into operation. These "peaking plants," while expensive to operate due to fuel costs (typically oil or natural gas), are relatively inexpensive to construct (PPRP, 2006b).

Based on the projected load forecasts, both the PSC and the PPRP review the adequacy of generating capacity and the adequacy of transmission system capacity. The PPRP has modified its load forecasting program. Rather than focusing on the individual electric utilities serving consumers in the state, the PPRP now forecasts energy requirements and peak demands for the state as a whole and for the various regions within the state. The PPRP notes (PPRP, 2006a):

> The total demand for any good or service, including electricity, is simply the sum of the demands of the individual consumers in the market. The portion of market demand for residential use of electricity is driven by factors to which individual residential consumers are sensitive. Similarly, for the commercial and industrial sectors of the market demand for electricity, the factors affecting demand are those to which producers are sensitive.
>
> In the case of residential demand, electricity forms part of the basket of goods and services purchased by the consumer. The residential demand for electricity is assumed to result from the exercise of choice by which the consumer maximizes his welfare subject to a budget constraint. Consumer demand for electricity is taken to be a function of its price, consumer income, weather, and the price of related commodities (i.e., substitutes and complements). It is important to note that electricity, in and of itself, conveys no benefits to the consumer. Rather, the consumer benefits from the services of the stock of appliances that require electricity. These services include space conditioning, refrigeration, cooking, clothes washing and drying, and numerous other services and functions. Consequently, the demand for electricity can be appropriately viewed as a derived demand; that is, it results from the demand for the services provided by electricity-consuming appliances.

For commercial and industrial factors, the PPRP assumes that the decisions about consumption are made by the consumer to maximize profits. Thus, the demand for power will be driven by price, the price of related inputs, and the level of output, and other factors – including weather. The PPRP also looks at the following in predicting demand: per capita income trends, employment trends, and population trends.

These three trends all show increases in the 10 year analysis period, with a predicted annual growth rate in demand of about 1.5% through the year 2015. Similar predictions of load growth were provided by the PJM in their 2007 Strategic Report (PJM, 2007).

8.2.3 Energy Efficiency and Substitution

Energy efficiency and demand side management (DSM) programs result in estimated load drops that reduce the demand for energy. There has been a substantial increase in DSM programs in recent years. While beneficial, these programs do not meaningfully affect the supply or demand side of the market and cannot be reasonably expected to substitute for necessary power upgrade projects. The DSM program measures are generally considered the cheapest possible compliance option and are often projected to provide a positive cash flow to the customer or utility implementing those measures. These measures can include rebates or other incentives for residential customers to update inefficient appliances with Energy Star® replacements. Customers can also receive credits on their bills for allowing a utility to control, or intermittently turn off their central air conditioning or heat pumps when wholesale electricity prices are high.

Recent legislation passage positions the State of Maryland as one of the leaders in energy efficiency and climate policy. On the energy efficiency side, the state recently launched the EmPOWER Maryland Initiative, which establishes a state goal of achieving a 15 percent reduction in per capita electricity use and peak demand by the end of 2015. This requires the state's utilities to implement energy efficiency programs and tasks the MDPSC with tracking progress toward that goal. This energy efficiency initiative, unlike energy conservation, which is based on changing behaviors and lifestyles, is technology-based.

Baltimore Gas & Electric Company (BGE), a Constellation Energy Group company, has recently taken steps to initiate DSM efforts through its Smart Energy Savers Program™, BGE recognizes that it relies heavily on electricity generated outside its market area, that there are higher costs resulting from market-based generation, and that customers expect them to promote energy efficiency. As a result, the BGE proposes to develop innovative programs promoting energy efficiency for its customers. These programs include: demand response infrastructure (DRI), energy efficiency/conservation, and advanced metering infrastructure (AMI) (BGE, 2007).

DRI is an effort to achieve customer benefits by reducing customer demand during periods of tight or peak supply. This can be accomplished technology-based measures such as programmable communicating thermostats and advanced air conditioning control switches. These technologies allow the BGE to regulate the demand and operation during periods of very high electricity use (that is, peak demand times). As part of the energy efficiency/ conservation efforts, the BGE is proposing to offer rebates or incentives to customers to purchase high efficiency products, such as Energy Star®; expand the current low-income gas Comprehensive Home Improvement Program (CHIP); and encourage homebuilders to build homes that meet Energy Star® standards. Through these efforts, the BGE hopes to reduce gas consumption by about 10 percent over the first 10 years of the program and reduce greenhouse gas emissions by an average of 2 billion pounds of carbon dioxide ($C0_2$) per year (BGE, 2007).

AMI, also referred to as "smart meters" is a state-of-the-art technology to read gas and electric meters. Simply put, AMI provide a two-way communication between the BGE and a customer's meter. The MDPSC approved the BGE AMI pilot in 2007 and the BGE proposes to provide about 9,000 meters to 5,000 customers in early 2008. BGE anticipates the complete AMI rollout to start in late 2008 and take 3 years to complete (BGE, 2007).

In addition, there are a number of state, regional, and national initiatives that promote both energy efficiency and climate policy. National concern for developing adequate supplies of electric power in an environmentally sound manner has led to state consideration of *renewable minimum percentage of their power from renewable energy resources* by a certain date. As of June 2007, there were 24 states, plus the District of Columbia, that have RPS policies in place Together these states account for more than half of the electricity sales in the United States (PJM, 2008).

In Maryland, the Governor recently set new renewable energy requirements for the state. These requirements propose to more than double the state's requirements for renewable energy by 2022. This new law proposes to slow the growth of the RPS over the next several years but then accelerates it starting in 2011. It still maintains a requirement for 2 percent of the state's power to come from solar energy by 2011 (MEA, 2008).

8.2.4 References

BGE, 2007. BGE Demand Side Management Programs, presentation at NAPEE Mid-Atlantic Regional Meeting, April 30, 2007.

MD, 1999. Annotated Code of Maryland Code, Public Utility Companies Article, Section 7-505., Website: http://mlis.state.md.us/cgi-win/web_statutes.exe?gpu&7-505, Date accessed: May 17, 2007.

MDPSC, 2007. Electric Supply Adequacy Report of 2007, Maryland Public Service Commission, January 2007, Website: http://www.psc.state.md.us/psc/Reports/2007SupplyAdequacyReport_01172007.pdf, Date accessed: April 11, 2007.

MEA, 2008. Maryland Strategic Electricity Plan, January 14, 2008.

NRC, 1999. Standard Review Plans for Environmental Reviews of Nuclear Power Plants, NUREG-1555, October 1999, Nuclear Regulatory Commission, 1999.

NRC, 2007. Standard Review Plans for Environmental Reviews of Nuclear Power Plants, NUREG-1555, July 2007, Nuclear Regulatory Commission, 2007.

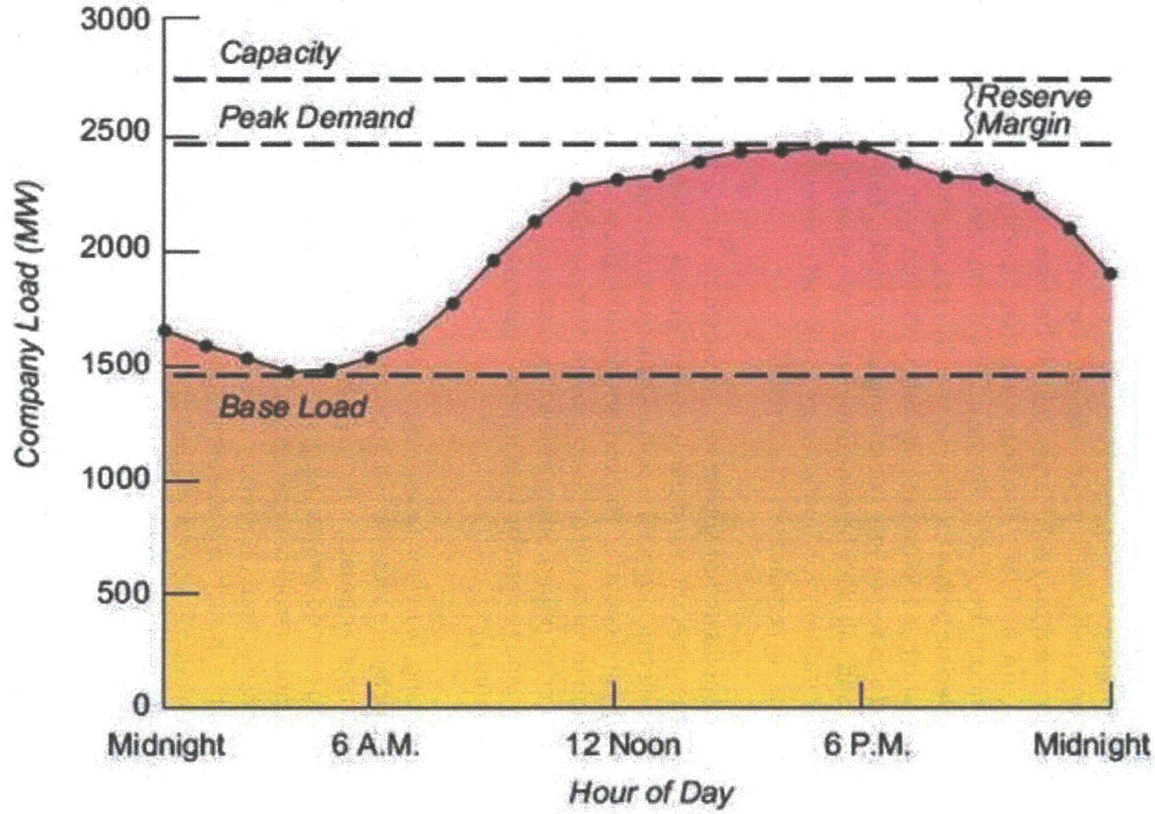
PJM, 2007. PJM 2007 Strategic Report, PJM Interconnect LLC, January 2007, Website: http://www.pjm.com/planning/res-adequacy/downloads/2007-load-report.pdf, Date accessed: May 29, 2007.

PJM, 2008. 2007 Regional Transmission Expansion Plan, PJM Interconnection LLC, February 2008.

PPRP, 2006a. Maryland Power Plants and the Environment: A Review of the Impacts of Power Plants and Transmission Lines on Maryland's Natural Resources, PPRP CEIR-13, MDNR Publication Number 12-9202005-57, Power Plant Research Program, January 2006, Website: http://esm.versar.com/pprp/ceir13/intro.htm, Date accessed: April 20, 2007.

PPRP, 2006b. Electricity in Maryland – Factbook 2006, Power Plant Research Program, September 2006, Website: http://esm.versar.com/pprp/factbook/factbook.htm, Date accessed: April 20, 2007.

Figure 8.2-1— Summer Power Demand



8.3 POWER SUPPLY

In Maryland, the Public Service Commission (PSC) is tasked with assessing and reporting on the adequacy of the power supply in the region to meet the state's forecasted demand. The legislature has required the PSC to report its assessments of the reliability of the power supply and transmission to the Maryland marketplace.

The PSC describes a challenging power outlook in Maryland (MDPSC, 2007), despite increases in energy efficiency and voluntary conservation measures from consumers:

> If new generating capacity is not built, and/or upgrades to the transmission system are not made, the likelihood of a reliability crisis in Maryland, and eastern PJM generally, will increase, and may become unavoidable. As shown in earlier sections, not only will Maryland likely become more capacity deficient in the near-term but PJM is also projecting that capacity reserve margins will decline throughout the system. By the middle of the next decade, reserve margins in PJM may decline below the levels generally associated with ensuring reliable service. Maryland is in a large capacity deficit position, with little new capacity likely to be added and some older generating units possibly being de-rated or retired. Maryland will likely be confronted with a large and growing capacity deficiency unless transmission upgrades are made that will provide increased access to generating resources in western PJM.
>
> Renewables do not appear to be a substitute for traditional enhancements to the electric generation and transmission network. Renewable sources (excepting large hydroelectric projects) supply less than one percent of Maryland's and PJM's energy and capacity. This contribution may grow somewhat with time, but not by enough to meet electric load growth or replace older fossil units that may be de-rated or retired. Siting renewable resources can also be controversial (e.g., siting wind generation in Maryland is opposed by elements of the environmental community).
>
> In closing, Maryland faces major challenges in securing reliable and economic electricity supplies that will support its economy. The Commission recognizes that a balanced approach is required to ensure adequate electricity supplies, including adding new generation, upgrading the transmission system, preserving existing generation resources, and encouraging cost-effective conservation and demand response actions on the part of energy consumers. The Commission has been proactive in each of these areas and is committed to sustaining its efforts. The Commission is also committed to working with Maryland utilities, energy suppliers, and consumers; PJM and its stakeholders; and Maryland policymakers in moving initiatives forward in each of these areas.

The outlook for the adequacy of Maryland's electricity supply can perhaps be best characterized as fragile. Greater reliability depends on several electric grid infrastructure additions and upgrades whose timing may be problematic.

8.3.1 References

MDPSC, 2007. Electric Supply Adequacy Report of 2007, Maryland Public Service Commission, January 2007, Website: : http://www.psc.state.md.us/psc/Reports/2007SupplyAdequacyReport_01172007.pdf, Date accessed: April 11, 2007.

8.4 ASSESSMENT OF NEED FOR POWER

In assessing the costs and benefits of the project, NUREG-1555, "Standard Review Plan for Environmental Reviews of Nuclear Power Plants" (ESRP) 8.4 (NRC, 1999), provides the following review criterion:

> If a need-for-power analysis conducted by or for one or more relevant regions affected by the proposed plant concludes there is a need for new generating capacity, that finding should be given great weight provided that the analysis was systematic, comprehensive, subject to confirmation, and responsive to forecast uncertainty.
>
> Although this criterion does not show a need for baseload capacity, it does demonstrate a need for new capacity that is independent of type. This criterion, coupled with an affirmative indication that there is a need for baseload capacity, justifies a baseload addition within the time span determined by the ... forecast analysis.

8.4.1 Assessment of the Need for New Capacity

As the Maryland Public Service Commission (PSC) noted in its latest adequacy supply report (MDPSC, 2007), the need for in-state generating capacity is increasing rapidly. The PSC assessed the following factors as contributing to its growing concern about reliability and power supply:

- Maryland's growing reliance on imported electricity.
- Need for infrastructure additions and new transmission.
- Energy efficiency, wholesale, and retail opportunities.

<u>Maryland's Growing Reliance on Imported Electricity</u>

Maryland's dependence on out-of-state generation resources will likely increase over the next 5 to 10 years because of both growth in electricity demand and the possible de-rating or retirement of existing generating units. Both Maryland utilities and PJM are forecasting electricity demand to grow by between 1% and 2% per year. Military base realignments, proximity to the national capital, Maryland's attractive port facilities, its central location in the Atlantic economic corridor, and Maryland's attractiveness as a recreational destination lends credence to these forecasts.

<u>Need for Infrastructure Additions and New Transmission</u>

Further contributing to uncertainty in the power supply adequacy outlook is that over the next 10 years only a small number of new electricity generators will likely be built in Maryland. In 2003 the PSC granted a CPCN for a new 640 MWe generating unit to be built at the Doubs substation near Frederick, Maryland; however, the site developer has taken no action to initiate construction, and no prospective action appears to be likely.

As described in Section 2.8.6, the only other significant baseload generation plants in the PJM generation project queue are the addition of two combustion turbine generating units at an existing power plant near Easton, Maryland, and the addition of four combustion turbine generating units at an existing power plant near Eagle Harbor, Maryland. These units, even if built, would not provide sufficient baseload generating capacity to alleviate current generating capacity shortfalls in the region and future demand growth without reliance on additional new baseload generating capacity. The proposed CCNPP Unit 3, if licensed and built in a timely fashion, would enter service in 2015 at the earliest.

In addition, federal and Maryland regulations require sharp reductions in sulfur dioxide, nitrous oxide, and mercury emissions from fossil-fired generating plants. Some of the older generating units may have difficulty in satisfying the stricter emission limits, or may be unable to satisfy them at all. If they are unable to comply, it is possible they would discontinue operations.

Even units that achieve compliance may see net energy output reduced because of parasitic losses associated with operation of the emission control equipment. Other states in PJM have also put in place strict air emission requirements, with similar potential effects on fossil-fired generating units. Maryland has also joined the Regional Greenhouse Gas Initiative (RGGI), which will place further limitations on fossil-fueled generation.

Energy Efficiency, Wholesale, and Retail Opportunities

More efficient use of electricity is occurring in Maryland. Electricity demand growth has been moderate despite strong economic growth. Since restructuring legislation was implemented, electric consumption in Maryland has increased at an average annual rate of 2.5%. The recent increase in wholesale electricity rates will likely reduce this rate of electric load growth. Both the Maryland utilities and PJM are forecasting that, over the next 10 years, electricity demand growth will be about 1.5% per year. Regional efforts under PJM, such as load response programs to encourage consumers to voluntarily reduce consumption, also contribute to efficiency. The long-term objective of these efficiency programs is to establish market conditions so that demand response and generation are, in effect, competing with one another (MDPSC, 2007).

8.4.2 Other Benefits of New Nuclear Capacity

The guidance in NUREG-1555 (NRC, 1999) allows for an applicant to assess the need for the proposed facility on other grounds. The following criteria suggest the continuing benefits of, and the need for, a new nuclear baseload generating facility in the state independent of the need for power:

- The relevant region's need to diversify sources of energy (e.g., using a mix of nuclear fuel and coal for baseload generation).

  Although new generation should be sufficient to meet established reliability criteria within the region, the PSC is concerned about the lack of fuel diversity exhibited by generation additions. Combustion turbine capacity in eastern PJM is expected to remain the predominant source of quickly built generation for at least the next 5 years. Natural gas prices have of course risen sharply in recent years and remain volatile.

  In the PJM region, many projects have been withdrawn because of unsatisfactory profit forecasts, general financial market instability, and, more recently, the much higher fuel costs for gas-fired plants, making them less economical to operate (MDPSC, 2002). The addition of new nuclear would help diversify the fuel mix and reduce dependence on gas-fired plants.

- The potential to reduce the average cost of electricity to consumers.

  The PSC and the Power Plant Research Program (PPRP) of the Maryland Department of Natural Resources (MDNR) note that the potential for new power generation to increase availability to in-state consumers is essential to ensure reliability and a robust competitive market. The addition of a new nuclear plant to Maryland's electricity supply would provide an additional source of baseload power that would help stabilize the cost of electricity for consumers.

- The national need to reduce reliance on fossil fuels generally and increase energy security.

The current national policy is to develop ways to reduce dependence on fossil fuels. New baseload nuclear generating capacity is required to enhance U.S. energy supply diversity and energy security, a key National Energy Policy (NEP) objective (WH, 2001). The national policy in support of new nuclear is also apparent in Nuclear Power 2010, which is a joint government/industry cost-shared effort to identify sites for new nuclear plants, develop and bring to market advanced nuclear plant technologies, evaluate the business case for building new nuclear power plants, and demonstrate untested regulatory processes (DOE, 2007). The Energy Policy Act of 2005 (PL, 2005) also encourages needed investment in the national energy infrastructure, helps boost electric reliability, and promotes a diverse mix of fuels, including nuclear, to generate electricity. The Energy Policy Act of 2005 includes a number of provisions that directly encourage the development of new nuclear facilities, including the following:

- Authorizes construction cost-overrun support of up to $2 billion total for up to six new nuclear power plants;
- Authorizes a production tax credit of up to $125 million total per year, estimated at 1.8 US¢/kWh during the first eight years of operation for the first 6000 MW of new nuclear capacity;
- Authorizes a loan guarantee program to support advanced nuclear energy facilities.

The addition of nuclear baseload power to the nation's electricity supply supports national policy objectives and increases energy security.

Other recent national policy statements assert the benefits of baseload capacity that reduces GHG, including nuclear power. The concern over GHG, and the resulting climate change, has triggered a number of policy trends:

- During the 109th Congress, both houses of the U.S. Congress introduced resolutions calling for a national program of carbon reduction (USC, 2006) (USS, 2006).
- Several states, including Maryland, have joined regional GHG initiatives (MD, 2007). In addition to the RGGI, several western states have likewise joined the trend (WCGGWI, 2004). California has recently passed stringent requirements in order to curtail GHG (CAB, 2007).
- The 110th Congress continues its exploration of legislation that would limit carbon emissions in the U.S. Known as "cap and trade" legislation, the legislation seeks to bring carbon emissions down through a series of industry caps and trading strategies (USS, 2007b).

Costs of climate change have also triggered concerns about the economic effects of continuing carbon emission growth. The following examples highlight the growing concern in the U.S.:

- A British study reviewed by the U.S. Senate notes that unabated climate change will sharply affect economic systems globally, ultimately costing more than 20 percent annually of gross domestic product by the year 2050 (USS, 2007a).
- U.S. economic reviews of the British study support it with "high confidence" (Yohe, 2007)."

  Because nuclear power plants do not produce significant GHG emissions, the addition of nuclear baseload power to the nation's electricity supply supports national policy objectives and furthers national efforts to reduce GHG emissions.

- The Maryland need to reduce reliance on fossil fuels generally.

  The state recently placed drastic limits on emissions from coal- and natural gas-fired plants. The Maryland Healthy Air Act (MDE, 2006) will provide larger reductions in NOx, SO2, and mercury in a faster timeframe than the federal Clean Air Interstate Rule (CAIR) and Clean Air Mercury Rule (CAMR). The Maryland Healthy Air Act prohibits Maryland power plants from acquiring out-of-state emissions allowances (trading credits) in lieu of adding pollution controls locally.

  Maryland has also recently joined RGGI to combat state reliance on fossil fuels, as well as to reduce greenhouse gases (GHG). RGGI is a cap-and-trade program to control carbon dioxide emissions and is aimed primarily at reducing carbon dioxide pollution through a mandatory emissions cap on the electric generating sector, coupled with a market-based trading program (MD, 2007).

  Because nuclear power plants do not produce significant GHG emissions, new nuclear plants provide the benefits of baseload power without the environmental costs of other fossil-fueled facilities. The addition of nuclear baseload power to Maryland's electricity supply supports state policy objectives and furthers state programs that aim to reduce GHG emissions.

8.4.3 Summary of Need for Power

In summary:

- The State of Maryland has a well-defined, systematic, and comprehensive resource monitoring, assessment, and reporting process that reviews the State's resources and growing demand for additional baseload capacity, eliminating the need for additional NRC review.
- The Maryland PSC has concluded that there is a need for new baseload capacity, and this conclusion has been given "great weight," herein as allowed for by the guidance in NUREG-1555 (NRC, 1999).
- The Maryland PSC/PPRP/CPCN process gives NRC assurance that construction would not proceed without the State's due consideration of the project's impact on supply adequacy and on the stability and reliability of the electric system in the state.
- The growing demand for new capacity shows benefits to be derived from CCNPP Unit 3.
- Given State concerns about climate change and carbon emissions, CCNPP Unit 3 serves another important need by reducing carbon emissions in Maryland. The new

plant will offset significant amounts of carbon, as compared to a coal-fired generating plant.

- Decreased reliance on fossil fuels.
- The potential to reduce the average cost of electricity to consumers by increasing availability of low cost power generation to in-state consumers through the competitive marketplace.
- Improved diversity of the sources of energy relied upon for baseload generation.

Section 9.2 discusses the viability of various baseload energy alternatives. Section 10.4 further reviews the costs and benefits of CCNPP Unit 3.

8.4.4 References

CAB, 2007. California Global Warming Solutions Act, California Assembly Bill (CAB) 32 2007, Chapter 488, California Statutes of 2006, Division 25.1, Section 38500, et seq., Website: http://www.leginfo.ca.gov/pub/05-06/bill/asm/ab_0001-0050/ab_32_bill_20060927_chaptered.pdf, Date accessed: May 16, 2007.

DOE, 2007. Nuclear Power 2010 Program, Department of Energy, Website: http://www.ne.doe.gov/np2010/neNP2010a.html, Date accessed: June 12, 2007.

MD, 2006. Maryland Power Plant Research Act, Maryland Code Annotated, Natural Resources Article, Section 3-304, 2006, Website: http://mlis.state.md.us/cgi-win/web_statutes.exe?gnr&3-304, Date accessed: April 23, 2007.

MD, 2007. "Governor Martin O'Malley Signs Greenhouse Gas Agreement, Climate Change Executive Order," Office of the Governor, State of Maryland, Press Release dated April 20, 2007 available online at, http://www.gov.state.md.us/pressreleases/070420.html, accessed June 25, 2007.

MDE, 2006. The Maryland Healthy Air Act, Maryland Department of the Environment, available online at: http://www.mde.state.md.us/Air/MD_HAA.asp, accessed June 25, 2007.

MDPSC, 2007. Electric Supply Adequacy Report of 2007 in compliance with Section 7-505(e) of the Public Utility Companies Article, Maryland Public Service Commission, January 2007, Website: http://www.psc.state.md.us/psc/Reports/2007SupplyAdequacyReport_01172007.pdf, Date accessed: April 11, 2007.

NRC, 1999. Standard Review Plans for Environmental Reviews of Nuclear Power Plants, NUREG-1555, Nuclear Regulatory Commission, October 1999.

PL, 2005. Energy Policy Act of 2005, Public Law 109-58, August 2005, Website: http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=109_cong_public_laws&docid=f:publ058.109, Date accessed: May 19, 2007.

USC, 2006. Expressing the Sense of Congress Regarding the Need for the United States to Address Global Climate Change Through the Negotiation of Fair and Effective International Commitments, H.CON.RES 453, 109th Congress, 2nd Session, July 25, 2006, available online at: http://thomas.loc.gov/cgi-bin/query/D?c109:3:./temp/~c109kmQUJP::, accessed June 25, 2007.

USS, 2006. Expressing the Sense of the Senate Regarding the Need for the United States to Address Global Climate Change Through the Negotiation of Fair and Effective International Commitments, S.RES 312, 109th Congress, 2nd Session, May 25, 2006, available online at: http://thomas.loc.gov/cgi-bin/query/D?c109:2:./temp/~c109kmQUJP::, accessed June 25, 2007.

USS, 2007a. Full Committee Hearing: Stern Review of the Economics of Climate Change, U.S. Senate Committee on Energy and Natural Resources, February 13, 2007, Website: http://energy.senate.gov/public/index.cfm?FuseAction=Hearings.Hearing&Hearing_ID=1605, Date accessed: May 16, 2007.

USS, 2007b. January 22nd, 2007 - Global Warming Documents Bingaman-Specter Discussion Draft, U.S. Senate Committee on Energy and Natural Resources, January 22, 2007, Website: http://energy.senate.gov/public/index.cfm?FuseAction=IssueItems.Detail&IssueItem_ID=47&Month=1&Year=2007, Date accessed: May 16, 2007.

WCGGWI, 2004. "West Coast States Strengthen Joint Climate Protection Strategy," West Coast Governors Global Warming Initiative, 2004, Press Release dated November 2004. available online at: http://www.ef.org/westcoastclimate/, accessed June 25, 2007.

WH, 2001. National Energy Policy: Report of the national Energy Policy Development Group, Website: http://www.whitehouse.gov/energy/National-Energy-Policy.pdf, Date accessed: June 12, 2007.

Yohe, 2007. Prepared Statement of Gary W. Yohe, Full Committee Hearing: Stern Review of the Economics of Climate Change, February 13, 2007, Website: http://energy.senate.gov/public/_files/Yohe.doc, Date accessed: May 16, 2007.

ENVIRONMENTAL REPORT

CHAPTER 9

ALTERNATIVES TO THE PROPOSED ACTION

9.0 ALTERNATIVES TO THE PROPOSED ACTION

This chapter assesses alternatives to the proposed siting and construction of a new nuclear power plant at the existing Calvert Cliffs Nuclear Plant (CCNPP) site.

Chapter 9 describes the alternatives to construction and operation of a new nuclear unit with closed cycle cooling adjacent to the CCNPP Units 1 and 2 site location, and alternative plant and transmission systems. The descriptions provide sufficient detail to facilitate evaluation of the impacts of the alternative generation options or plant and transmission systems relative to those of the proposed action. The chapter is divided into four sections:

- "No-Action" Alternative
- Energy Alternatives
- Alternative Sites
- Alternative Plant and Transmission Systems

9.1 NO ACTION ALTERNATIVE

The "No-Action" alternative refers to a scenario where a new nuclear power plant, as described in Chapter 2, is not constructed and no other generating station, either nuclear or non-nuclear, is constructed and operated.

The most significant effect of the No-Action alternative would be loss of the potential 1,600 MWe additional generating capacity that CCNPP Unit 3 would provide, which could lead to a reduced ability of existing power suppliers to maintain reserve margins and supply lower cost power to customers. Chapter 8 describes a 1.5% annual increase in electricity demand in Maryland over the next 10 years. Under the No-Action alternative, this increased need for power would need to be met by means that involve no new generating capacity.

As discussed in Chapter 8, this area of the country where CCNPP Unit 3 would be sited currently imports a large portion of its electricity, so the ability to import additional resources is limited. Demand-side management is one alternative; however, even using optimistic projections, demand-side management will not meet future demands.

Implementation of the No-Action alternative could result in the future need for other generating sources, including continued reliance on carbon-intensive fuels, such as coal and natural gas. Therefore, the predicted impacts, as well as other unidentified impacts, could occur in other areas.

9.2 ENERGY ALTERNATIVES

This section discusses the potential environmental impacts associated with electricity generating sources other than a new nuclear unit at the CCNPP site. These alternatives include: purchasing electric power from other sources to replace power that would have been generated by a new unit at the CCNPP site, a combination of new generating capacity and conservation measures, and other generation alternatives that were deemed not to be viable replacements for a new unit at the CCNPP site.

Alternatives that do not require new generating capacity were considered, including energy conservation and Demand-Side Management (DSM). Alternatives that would require the construction of new generating capacity, such as wind, geothermal, oil, natural gas, hydropower, municipal solid wastes (MSW), coal, photovoltaic (PV) cells, solar power, wood waste/biomass, and energy crops, as well as any reasonable combination of these alternatives, were also analyzed.

The proposal to develop a nuclear power plant on land adjacent to the existing nuclear plant was primarily based on market factors such as the proximity to an already-licensed station, property ownership, transmission corridor access, and other location features conducive to the plant's intended merchant generating objective.

Alternatives that do not require new generating capacity are discussed in Section 9.2.1, while alternatives that do require new generating capacity are discussed in Section 9.2.2. Some of the alternatives discussed in Section 9.2.2 were eliminated from further consideration based on their availability in the region, overall feasibility, and environmental consequences. Section 9.2.3, describes the remaining alternatives in further detail relative to specific criteria such as environmental impacts, reliability, and economic costs.

9.2.1 Alternatives Not Requiring New Generating Capacity

The Federal Energy Regulatory Commission (Commission) issued a Final Rule, in 1996, requiring all public utilities that own, control or operate facilities used for transmitting electric energy in interstate commerce to have on file open access non-discriminatory transmission tariffs that contain minimum terms and conditions of nondiscriminatory service. The Final Rule also permitted public utilities and transmitting utilities to seek recovery of legitimate, prudent and verifiable stranded costs associated with providing open access and Federal Power Act section 211 transmission services. The Commission's goal was to remove impediments to competition in the wholesale bulk power marketplace and to bring more efficient, lower cost power to the Nation's electricity consumers (FERC, 1996).

This section describes the assessment of the economic and technical feasibility of supplying the demand for energy without constructing new generating capacity. Specific alternatives include:

- Initiating conservation measures (including implementing DSM actions)
- Reactivating or extending the service life of existing plants within the power system
- Purchasing power from other utilities or power generators
- A combination of these elements that would be equivalent to the output of the project and therefore eliminate its need.

9.2.1.1 Initiating Conservation Measures

Under the Energy Policy Act of 2005 (PL, 2005) a rebate program was established for homeowners and small business owners who install energy-efficient systems in their buildings. The rebate was set at $3,000, or 25% of the expenses, whichever was less. The Act authorized $150 million in rebates for 2006 and up to $250 million in 2010. This new legislation was enacted in the hope that homeowners and small business owners would become more aware of energy-efficient technologies, lessening energy usage in the future.

Historically, state regulatory bodies have required regulated utilities to institute programs designed to reduce demand for electricity. DSM has shown great potential in reducing peak-load consumption (maximum power requirement of a system at a given time). In 2005, peak-load consumption was reduced by approximately 25,710 MWe, an increase of 9.3% from the previous year (EIA, 2006a). However, DSM costs increased by 23.4% (EIA, 2006b).

The following DSM programs can be used to directly reduce summer or winter peak loads when needed:

- Large load curtailment - This program provides a source of load that may be curtailed at the Company's request in order to meet system load requirements. Customers who participate in this program receive a credit on their bill.

- Voltage control - This procedure involves reducing distribution voltage by up to 5% during periods of capacity constraints. This level of reduction does not adversely affect customer equipment or operations.

9.2.1.1.1 Conservation Programs

In 1991, the Maryland General Assembly enacted an energy conservation measure that is codified as Section 7-211 of the Public Utility Companies (PUC) Article (MGA, 1991). This provision requires each gas and electric company to develop and implement programs to encourage energy conservation. In response to this mandate and continuing with preexisting initiatives under its existing authority, the Maryland Public Service Commission (PSC) directed each affected utility to develop a comprehensive conservation plan. The PSC further directed each utility to engage in a collaborative effort with staff, the Office of People's Counsel (OPC), and other interested parties to develop its conservation plan. The result of these actions was that each utility implemented conservation and energy efficiency programs. (MDPSC, 2007a)

The PSC requires Maryland electric utilities to implement DSM as a means to conserve energy and to take DSM energy savings into account in long-range planning. Baltimore Gas and Electric Company, the regulated electric distribution affiliate of Constellation Generation Group, has an extensive program of residential, commercial, and industrial programs designed to reduce both peak demands and daily energy consumption (i.e., DSM). Program components include the following:

- Peak clipping programs - Include energy saver switches for air conditioners, heat pumps, and water heaters, allowing interruption of electrical service to reduce load during periods of peak demand; dispersed generation, giving dispatch control over customer backup generation resources; and curtailable service, allowing customers' load to be reduced during periods of peak demand.

- Load shifting programs - Use time-of-use rates and cool storage rebate programs to encourage shifting loads from peak to off-peak periods.

- Conservation programs - Promoting use of high-efficiency heating, ventilating, and air conditioning; encouraging construction of energy-efficient homes and commercial buildings; improving energy efficiency in existing homes; providing incentives for use of energy-efficient lighting, motors, and compressors.

It is estimated that the Baltimore Gas and Electric DSM program results in an annual peak demand generation reduction of about 700 MWe, and believed that generation savings can continue to be increased from DSM practices. The load growth projection anticipates a DSM savings of about 1,000 MWe in 2016. These DSM savings are an important part of the plan for meeting projected regional demand growth in the near-tem (BGE, 1998).

However, since the most viable and cost-effective DSM options are pursued first, it is not likely that demand reductions of similar size will be available or practical in the future. Consequently, DSM is not seen as a viable "offset" for the additional baseload generation capacity that will be provided by CCNPP Unit 3, and UniStar Nuclear Operating Services does not foresee the availability of another 1,600 MWe (equivalent to the CCNPP Unit 3 capacity) of viable and cost-effective DSM to meet projected load demand and baseload power needs. Therefore, it is concluded that DSM is not a feasible alternative for the CCNPP Unit 3 facility.

9.2.1.2 Reactivating or Extending Service Life of Existing Plants

Maryland's dependence on out-of-state electricity supplies will likely increase over the next several years. On the supply side, few new in-state electric generating facilities are scheduled to be built during the next 5 years. Additionally, some fossil-fired generating capacity may be de-rated or retired in order to comply with both federal and state air emission requirements, including the sulfur dioxide and mercury provisions of Maryland's Healthy Air Act (HAA). On the demand side, Maryland's electric utilities and PJM Interconnection, LLC (PJM), the regional electricity grid operator, forecast that electricity demand will continue to rise, albeit at a modest pace of between 1% and 2% per year, further increasing Maryland's need for additional electricity supplies (MDPSC, 2007a).

There has been very little change to the amount and the mix of electrical power generation in Maryland this decade. No significant generation has been added in the past 3 years, and no units have been retired since the Gould Street plant (101 MWe) ceased operations in November 2003 (MDPSC, 2007a).

It is possible that some older units that cannot meet stricter environmental standards at the federal or state level may eventually be retired. Certificate of Public Convenience and Necessity (CPCN) filings have been made to the State of Maryland by six Maryland coal-fired facilities for various environmental upgrades for compliance with the HAA. However, some of these units and other older Maryland coal units may have to be retired if the emissions restrictions (including those for carbon dioxide that may be mandated by the Regional Greenhouse Gas Initiative) make these plants uneconomic to operate in the future (MDPSC, 2007a).

Scheduled retirement of older generating units will also occur elsewhere in PJM. In New Jersey, four older facilities are scheduled to retire in the next 2 years: 285 MWe at Martins Creek (September 2007), 447 MWe at B.L. England (December 2007), 453 MWe at Sewaren (September 2008), and 383 MWe at Hudson (September 2008) (MDPSC, 2007a).

Retired fossil fuel plants and fossil fuel plants slated for retirement tend to be those old enough to have difficulty economically meeting today's restrictions on air contaminant emissions. In the face of increasingly stringent environmental restrictions, delaying retirement or reactivating plants in order to forestall closure of a large baseload generation facility would require extensive construction to upgrade or replace plant components. Upgrading existing plants would be costly and at the same time would neither increase the amount of available generation capacity, nor alleviate the growing regional need for additional baseload generation capacity. A new baseload facility would allow for the generation of needed power and would meet future power needs within the region of interest (ROI), which is Maryland. This ROI is further evaluated in Section 9.3. Therefore, extending the service life of existing plants or reactivating old plants may not be feasible.

9.2.1.3 Purchasing Power from Other Utilities or Power Generators

The uncertainty of Maryland's supply adequacy begins with Maryland's status as one of the largest electric energy importing states in the country. Maryland currently imports more than 25% of its electric energy needs. On an absolute basis, Maryland is the fifth-largest electric energy importer in the U.S. Neighboring states Virginia and New Jersey are in a comparable situation, being respectively the third and fourth largest energy importers in the country, and Delaware and the District of Columbia are also large electricity importers.

Consequently, not only is Maryland a large importer of electricity, but so are states to the south, east and north of it. This makes much of the mid-Atlantic region deficient in generating capacity, or what is referred to in the industry as a "load sink." Of the states in the surrounding area, Maryland can only import electricity in appreciable amounts from West Virginia and Pennsylvania, and is competing with Delaware, Virginia, New Jersey, and the District of Columbia for the available exports from those states (MDPSC, 2007a).

Maryland has been relying on the bulk electric transmission grid to make up the difference between economically dispatched in-state supply and demand. However, Maryland's ability to import additional electricity over that grid, particularly during times of peak demand, is limited at best. The current transmission facilities that allow the importation of electricity into the State already operate at peak capacity during peak load periods. In other words, even though generators in Pennsylvania, West Virginia, and states farther west may have excess power to sell to Maryland, the transmission network is unable to deliver that power during times of peak demand (MDPSC, 2007a).

Imported power from Canada or Mexico is also unlikely to be available to supply the equivalent capacity of the proposed facility. In Canada, 62% of the country's electricity capacity is derived from renewable sources, principally hydropower. Canada has plans to continue developing hydroelectric power, but the plans generally do not include large-scale projects. Canada's nuclear power generation is projected to decrease by 1.7% by 2020, and its share of power generation in Canada is projected to decrease from 14% currently to 13% by 2020 (EIA, 2001b).

The Department of Energy projects that total gross U.S. imports of electricity from Canada and Mexico will gradually increase from 47.4 billion kWh in 2000 up until year 2005, and then gradually decrease to 47.4 billion kWh in 2020 (EIA, 2001b). Therefore, imported power from Canada or Mexico is not a viable option to alleviate the growing regional need for power, or the need for additional baseload generation capacity to meet projected power demands.

In conclusion, because there is not enough electricity to import from nearby states or Canada and Mexico, purchasing power from other utilities or power generators is not considered feasible.

9.2.2 Alternatives That Require New Generating Capacity

Although many methods are available for generating electricity and many combinations or mixes can be assimilated to meet system needs, such expansive consideration would be too unwieldy to reasonably examine in depth, given the purposes of this alternatives analysis. The alternative energy sources considered are listed below.

- Wind
- Geothermal
- Hydropower
- Solar Power
  - Concentrating Solar Power Systems
  - Photovoltaic (PV) Cells
- Wood Waste
- Municipal Solid Waste
- Energy Crops
- Petroleum liquids (Oil)
- Fuel Cells
- Coal
- Natural Gas
- Integrated Gasification Combined Cycle (IGCC)

Based on the installed capacity of 1,600 MWe that CCNPP Unit 3 will produce, not all of the above-listed alternative sources are competitive or viable. Each of the alternatives is discussed in more detail in later sections, with an emphasis on coal, solar, natural gas, and wind energy. As a renewable resource, solar and wind energies, alone or in combination with one another, have gained increasing popularity over the years, in part due to concern over greenhouse gas emissions. Air emissions from solar and wind facilities are much smaller than fossil fuel air emissions. Although the use of coal and natural gas has undergone a slight decrease in popularity, it is still one of the most widely used fuels for producing electricity.

The current mix of power generation options in Maryland is one indicator of the feasible choices for electric generation technology within the state. Calvert Cliffs 3 Nuclear Project and UniStar Nuclear Operating Services evaluated Maryland's electric power generating capacity and utilization characteristics. "Capacity" is the categorization of the various installed technology choices in terms of their potential output. "Utilization" is the degree to which each choice is actually used.

Combined heat and power systems that are geographically dispersed and located near customers were identified as a potential option for producing heat and electrical power.

However, distributed energy generation was not seen as a competitive or viable alternative and was not given detailed consideration.

In 2005, electricity imports amounted to 27.5% of all the electricity consumed in Maryland, about 10% more than the imported 17.7% of the electricity consumed in 1999. Consumption increased 15.7% from 1999 to 2005, while generation only increased by 1.9% during the same period. In effect, nearly all the electricity load growth in Maryland between 1999 and 2005 was met by importing electricity from other states within the region. This growing dependence on imported power means that Maryland has an enormous stake in the reliability of the regional transmission grid and the existence of a robust wholesale power market. (MDPSC, 2007a)

As required by Section 7-505(e) of the PUC Article, the Electric Supply Adequacy Report of 2007 included an assessment of the regional need for power. This review of the need for power in this region takes into account conservation, load management, and other demand-side options along with new utility-owned generating plants, non-utility generation, and other supply-side options in order to identify the resource plan that will be most cost-effective for the ratepayers consistent with the provision of adequate, reliable service (MDPSC, 2007a).

- The need for power assessment contains the following information:
- A description of the power system in Maryland
- An assessment of power demand and predictions
- An evaluation of present and planned capacity (including other utility company providers
- A concluding assessment of the need for power

In 2006, the Department of Energy released a transmission congestion study that shows that the region from New York City to northern Virginia (which includes Maryland) is one of the two areas of the country most in need of new bulk power transmission lines (MDPSC, 2007a).

This section includes descriptions of power generating alternatives that Calvert Cliffs 3 Nuclear Project and UniStar Nuclear Operating Services have concluded are not reasonable and the basis for this conclusion. This COL application is premised on the installation of a facility that would primarily serve as a large base-load generator and that any feasible alternative would also need to be able to generate baseload power. In performing this evaluation, Calvert Cliffs 3 Nuclear Project and UniStar Nuclear Operating Services have relied heavily upon the NRC Generic Environmental Impact Statement (GEIS) (NRC, 1996).

The GEIS is useful for the analysis of alternative sources because NRC has determined that the technologies of these alternatives will enable the agency to consider the relative environmental consequences of an action given the environmental consequences of other activities that also meet the purpose of the proposed action. To generate the set of reasonable alternatives that are considered in the GEIS, common generation technologies were included and various state energy plans were consulted to identify the alternative generation sources typically being considered by state authorities across the country.

From this review, a reasonable set of alternatives to be examined was identified. These alternatives included wind energy, PV cells, solar thermal energy, hydroelectricity, geothermal energy, incineration of wood waste and municipal solid waste, energy crops, coal, natural gas, oil, and delayed retirement of existing non-nuclear plants. These alternatives were considered pursuant to the statutory responsibilities imposed under the National Environmental Policy Act of 1969 (NEPA) (NEPA, 1982).

Although the GEIS is provided for license renewal, the alternatives analysis in the GEIS can be compared to the proposed action to determine if the alternative represents a reasonable alternative to the proposed action.

Each of the alternatives is discussed in the subsequent sections relative to the following criteria:

- The alternative energy conversion technology is developed, proven, and available in the relevant region within the life of the COL.
- The alternative energy source provides baseload generating capacity equivalent to the capacity needed and to the same level as the proposed nuclear plant.
- The alternative energy source does not create more environmental impacts than a nuclear plant would, and the costs of an alternative energy source do not make it economically impractical.

Each of the potential alternative technologies considered in this analysis are consistent with national policy goals for energy use and are not prohibited by federal, state, or local regulations. Based on one or more of these criteria described above, several of the alternative energy sources were considered technically or economically infeasible after a preliminary review and were not considered further. Alternatives considered to be technically and economically feasible are described in greater detail in Section 9.2.3.

9.2.2.1 Wind

In general, areas identified by the National Renewable Energy Laboratory (NREL) as wind resource Class 4 and above are regarded as potentially economical for wind energy production with current technology. Class 4 wind resources are defined as having mean wind speeds between 15.7 and 16.8 mph (25.3 to 27.0 kph) at 50 m elevation.

As a result of advances in technology and the current level of financial incentive support, a number of additional areas with a slightly lower wind resource (Class 3+) may also be suitable for wind development. These would, however, operate at a lower annual capacity factor and output than used by National Renewable Energy Laboratory (NREL) for Class 4 sites. Class 3 wind resources are defined as having mean wind speeds between 14.3 and 15.7 mph (23.0 to 25.3 kph) at 50 m (164 ft) elevation, with Class 3+ wind resources occupying the high end of this range.

Wind Powering America indicates that Maryland has wind resources consistent with utility-scale production. Several areas are estimated to have good-to-excellent wind resources. These are the barrier islands along the Atlantic coast, the southeastern shore of Chesapeake Bay, and ridge crests in the western part of the state, west of Cumberland. In addition, small wind turbines may have applications in some areas (EERE, 2006a).

Wind resource maps show that much of Maryland has a Class 1 or 2 wind resource, with mean wind speeds of 0.0 to 14.3 mph (0.0 to 23.0 kph) at 50 m (164 ft) elevation. The reason for the moderate wind speeds overall, despite strong winds aloft much of the year, is the high surface roughness of the forested land. The wind resource in central Maryland is moderate, but it improves near the coast because of the influence of the Atlantic Ocean and Chesapeake Bay. Offshore, especially on the Atlantic side, the wind resource is predicted to reach 16.8 to 19.7 mph (27.0 to 31.7 kph) at 50 m (164 ft), or NREL Class 4-5 (EERE, 2003).

For any wind facility, the amount of land needed for operation could be significant. Wind turbines must be sufficiently spaced to maximize capture of the available wind energy. If the turbines are too close together, they can lose efficiency. A 2 MWe turbine requires approximately 10,890 ft^2 (1000 m^2) of dedicated land for the actual placement of the wind turbine, allowing landowners to use the remaining acreage for some other purpose that does not affect the turbine, such as agricultural use.

For illustrative purposes, if all of the resources in Class 3+ and 4 sites were developed using 2 MWe turbines, with each turbine occupying 10,890 ft^2 (1,000 m^2) (i.e., 100 ft (30.5 m) spacing between turbines), 9,000 MWe of installed capacity would utilize 1.8 mi^2 (4.6 km^2) just for the placement of the wind turbines alone. Based upon the NERC capacity factor, it would create an average output of 1,530 MWe requiring approximately 31,800 ft^2 (2,954 m^2) per MWe. This is a conservative assumption because Class 3+ sites will have a lower percentage of average annual output.

If a Cla ss 3+ site were available and developed using 2 MWe turbines within the ROI, 9,400 MWe of installed capacity would be needed to produce the equivalent 1,600 MWe of baseload output. This would encompass a footprint area of approximately 1.9 mi^2 (4.9 km^2), which is more than half the size of the entire CCNPP site (Units 1 and 2 and proposed Unit 3). The CCNPP site is a Class 1 site; therefore, it would not be feasible to construct a wind power facility at the CCNPP site (EERE, 2003).

Technological improvements in wind turbines have helped reduce capital and operating costs. In 2000, wind power was produced in a range of $0.03 to $0.06 per kWh (depending on wind speeds), but by 2020 wind power generating costs are projected to fall to $0.03 to $0.04 per kWh.

The installed capital cost of a wind farm includes planning, equipment purchase, and construction of the facilities. This cost, typically measured in $/kWe at peak capacity, has decreased from more than $2,500 per kWe in the early 1980s to less than $1,000 per kWe for wind farms in the U.S, but "economies of scale" may not be available in the ROI, given the availability of the resource.

The EIA's "Annual Energy Outlook 2004" provides some unique insights into the viability of the wind resource (EIA, 2004a):

- In addition to the construction, operating, and maintenance costs for wind farms, there are costs for connection to the transmission grid. Any wind project would have to be located where the project would produce economical generation, but that location may be far removed from the nearest connection to the transmission system. A location far removed from the power transmission grid might not be economical, because new transmission lines would be required to connect the wind farm to the distribution system.

  Existing transmission infrastructure may need to be upgraded to handle the additional supply. Soil conditions and the terrain must be suitable for the construction of the towers' foundations. Finally, the choice of a location may 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 and distribution system.

- The distance from transmission lines at which a wind developer can profitably build depends on the cost of the specific project. For example, the cost of construction and interconnection for a 115 kV transmission line that would connect a 50 MWe wind farm with an existing transmission and distribution network. The EIA estimated, in 1995, the cost of building a 115 kV line to be $130,000 per mile, excluding right-of-way costs (EIA, 2003b).

  This amount includes the cost of the transmission line itself and the supporting towers. It also assumes relatively ideal terrain conditions, including fairly level and flat land with no major obstacles or mountains (more difficult terrain would raise the cost of erecting the transmission line). In 1993, the cost of constructing a new substation for a 115 kV transmission line was estimated at $1.08 million, and the cost of connection for a 115 kV transmission line with a substation was estimated to be $360,000 (EIA, 1995).

- In 1999, the DOE analyzed the total cost of installing a wind facility in various North American Electric Reliability Corporation (NERC) regions. The agency first looked at the distribution of wind resources and excluded land from development based on the classification of land. For example, land that was considered wetlands and urban were totally excluded, whereas land that was forested had 50% of its land excluded. Next, resources that were sufficiently close to existing 115 kV to 230 kV transmission lines were classified into three distinct zones and an associated standard transmission fee for connecting the new plant with the existing network was applied. DOE then used additional cost factors to account for the greater distances between wind sites and the existing transmission networks. Capital costs were added based on whether the wind resource was technically accessible at the time and whether it could be economically accessible by 2020 (EIA, 1999).

- Another consideration on the integration of the wind capacity into the electric utility system is the variability of wind energy generation. Wind-driven electricity generating facilities must be located at sites with specific characteristics to maximize the amount of wind energy captured and electricity generated. In addition, for transmission purposes, wind generation is not considered "dispatchable," meaning that the generator can control output to match load and economic requirements. Since the resource is intermittent, wind, by itself, is not considered a firm source of baseload capacity. The inability of wind alone to be a dispatchable, baseload producer of electricity is inconsistent with the objectives for the CCNPP site.

Finally, wind facilities pose environmental impacts, in addition to the land requirements posed by large facilities, as follows:

- Large-scale commercial wind farms can be an aesthetic problem, obstructing viewsheds and initiating conflict with local residents.

- High-speed wind turbine blades can be noisy, although technological advancements continue to lessen this problem.

- Wind facilities sited in areas of high bird use can expect to have avian fatality rates higher than those expected if the wind facility were not there.

Recently, the Center for Biological Diversity (CBD) has voiced mixed reviews regarding wind farms along migratory bird routes. The CBD supports wind energy as an alternative energy source and as a way to reduce environmental degradation. However, wind power facilities, such as the Altamont Pass Wind Resource Area (APWRA) in California, are causing mortality rates in raptor populations to increase as a result of turbine collisions and electrocution on power lines. The APWRA kills an estimated 881 to 1,300 birds of prey each year. Birds that have been affected to the greatest extent include golden eagles, red-tailed hawks, burrowing owls, great horned owls, American kestrels, ferruginous hawks, and barn owls (CBD, 2007).

Maryland's Renewable Energy Portfolio Standard, enacted in May 2004, and revised in 2007, requires electricity suppliers (all utilities and competitive retail suppliers) to use renewable energy sources to generate a minimum portion of their retail sales. Beginning in 2006, electricity suppliers are required to provide 1% of retail electricity sales in the State from Tier 1 renewable resources, such as wind. The requirement to produce electricity from Tier 1 renewable resources increases to 9.5% by 2022. (MDPSC, 2007b)

Wind energy will not always be dependable due to variable wind conditions, and there is no proven storage method for wind-generated electricity. Consequently, in order to use wind energy as a source of baseload generation it would be necessary to also have an idle backup generation source to ensure a steady, available power supply. With the inability of wind power to generate baseload power due to low capacity factors and limited dispatchability, the projected land use impacts of development of Class 3+ and Class 4 sites, the cost factors in construction and operation, along with the impacts associated with development, and cost of additional transmission facilities to connect turbines to the transmission system, a wind power generating facility by itself is not a feasible alternative to the new plant. Off-shore wind farms are not competitive or viable with a new nuclear reactor at the CCNPP site, and were therefore not considered in more detail.

Many renewable resources, such as wind, are intermittent (i.e., they are not available all of the time). The ability to store energy from renewable energy sources would allow supply to more closely match demand. For example, a storage system attached to a wind turbine could store captured energy around the clock, whenever the wind is blowing, and then dispatch that energy into higher demand times of the day (NREL, 2006). However, these technologies are not competitive or viable at this time.

9.2.2.2 Geothermal

As illustrated by Figure 8.4 in the GEIS (NRC, 1996), geothermal plants might be located in the western continental U.S., Alaska, and Hawaii, where hydrothermal reservoirs are prevalent.

Maryland is not a candidate for large scale geothermal energy and could not produce the proposed 1,600 MWe of baseload power. Therefore, geothermal energy is non competitive with a new nuclear unit at the CCNPP site.

9.2.2.3 Hydropower

The GEIS (NRC, 1996) estimates land use of 1,600 mi^2 (4,144 km^2) per 1,000 MWe generated by hydropower. Based on this estimate, hydropower would require flooding more than 2,600 mi^2 (6,734 km^2) to produce a baseload capacity of 1,600 MWe, resulting in a large impact on land use.

According to a study performed by the Idaho National Engineering and Environmental Laboratory (INEEL), Maryland has 36 possible hydropower sites: 1 developed and with a power-generating capacity of 20 MWe, 32 developed and without power and a possible generating capacity of 10 MWe, and 3 undeveloped sites with a possible 0.10 MWe of generating capacity. Only one site had the potential generating capacity of 20 MWe or more (INEEL, 1998). Therefore, hydropower is non-competitive with a new nuclear unit at the CCNPP site.

9.2.2.4 Solar Power

Solar energy depends on the availability and strength of sunlight (strength is measured as kWh/m^2), and solar power is considered an intermittent source of energy. Solar facilities would have equivalent or greater environmental impacts than a new nuclear facility at the CCNPP site. Such facilities would also have higher costs than a new nuclear facility.

The construction of solar power-generating facilities has substantial impacts on natural resources (such as wildlife habitat, land use, and aesthetics). In order to look at the availability of solar resources in Maryland, two collector types must be considered: concentrating collectors and flat-plate collectors. Concentrating collectors are mounted to a tracker, which allows them to face the sun at all times of the day. In Maryland, approximately 3,500 to 4,000 $W\text{-}hr/m^2/day$ can be collected using concentrating collectors. Flat-plate collectors are usually fixed in a tilted position to best capture direct rays from the sun and also to collect reflected light from clouds or the ground. In Maryland, approximately 4,500 to 5,000 $W\text{-}hr/m^2/day$ can be collected using flat-plate collectors. (EERE, 2006a). The footprint needed to produce a 1,600 MWe baseload capacity is much too large to construct at the proposed plant site.

9.2.2.4.1 Concentrating Solar Power Systems

Concentrating solar plants produce electric power by converting solar energy into high temperature heat using various mirror configurations. The heat is then channeled through a conventional generator, via an intermediate medium (i.e., water or salt). Concentrating solar plants consist of two parts: one that collects the solar energy and converts it to heat, and another that converts heat energy to electricity.

Concentrating solar power systems can be sized for "village" power (10 kWe) or grid-connected applications (up to 100 MWe). Some systems use thermal energy storage (TES), setting aside heat transfer fluid in its hot phase during cloudy periods or at night. These attributes, along with solar-to-electric conversion efficiencies, make concentrating solar power an attractive renewable energy option in the southwest part of the U.S. and other Sunbelt regions worldwide (EERE, 2006b). Others can be combined with natural gas. This type of combination is discussed in Section 9.2.3.3.

There are three kinds of concentrating solar power systems—troughs, dish/engines, and power towers - classified by how they collect solar energy (EERE, 2006b).

Concentrating solar power technologies utilize 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 energy for conversion into electricity. This "evolutionary" aspect - as distinguished from "revolutionary" or "disruptive" - allows for easy integration into the transmission grid. It also makes concentrating solar power technologies the most cost-effective solar option for the production of large-scale electricity generation (10 MWe and above).

While concentrating solar power technologies currently offer the lowest-cost solar electricity for large-scale electricity generation, these technologies are still in the demonstration phase of development and cannot be considered competitive with fossil or nuclear-based technologies (CEC, 2003). Current concentrating solar collection technologies cost $0.09 to $0.12 per kWh. In contrast, nuclear plants are anticipated to produce power in the range of $0.031 to $0.046 per kWh (DOE, 2002). In addition, concentrating solar power plants only perform efficiently in high-intensity sunlight locations, specifically the arid and semi-arid regions of the world (NREL, 1999). This does not include Maryland.

9.2.2.4.2 "Flat Plate" Photovoltaic Cells

The second common method for capturing the sun's energy is through the use of PV cells. A typical PV or solar cell might be a square that measures about 10 cm (4 in) on a side. A cell can produce about 1 watt of power—more than enough to power a watch, but not enough to run a radio.

When more power is needed, some 40 PV cells can be connected to form a "module." A typical module is powerful enough to light a small light bulb. For larger power needs, about 10 such modules are mounted in PV arrays, which can measure up to several meters on a side. The amount of electricity generated by an array increases as more modules are added.

"Flat-plate" PV arrays can be mounted at a fixed angle facing south, or they can be mounted on a tracking device that follows the sun, allowing them to capture more sunlight over the course of a day. Ten to 20 PV arrays can provide enough power for a household; for large electric utility or industrial applications, hundreds of arrays can be interconnected to form a single, large PV system (NREL, 2007). The land requirement for this technology is approximately 14 hectares (35 acres) per MWe (NRC, 1996). In order to produce the 1,600 MWe baseload capacity as CCNPP Unit 3, 22,660 hectares (55,993 acres) would be required for construction of the photovoltaic modules.

Some PV cells are designed to operate with concentrated sunlight, and a lens is used to focus the sunlight onto the cells. This approach has both advantages and disadvantages compared with flat-plate PV arrays. Economics of this design turn on the use of as little of the expensive semi-conducting PV material as possible, while collecting as much sunlight as possible. The lenses cannot use diffuse sunlight, but must be pointed directly at the sun and moved to provide optimum efficiency. Therefore, the use of concentrating collectors is limited to the west and southwest areas of the U.S.

Available PV cell conversion efficiencies are in the range of approximately 15% (SS, 2004). In Maryland, solar energy can produce an annual average of 4.5 to 5.0 kWh/m^2/day and even slightly higher in the summer. This value is highly dependent on the time of year, weather conditions, and obstacles that may block the sun (NREL, 2004).

Currently, PV solar power is not competitive with other methods of producing electricity for the open wholesale electricity market. When calculating the cost of solar systems, the totality of the system must be examined. There is the price per watt of the solar cell, price per watt of the module (whole panel), and the price per watt of the entire system. It is important to remember that all systems are unique in their quality and size, making it difficult to make broad generalizations about price. The average price for modules (dollars per peak watt) increased 9%, from $3.42 in 2001 to $3.74 in 2002. For cells, the average price decreased 14%, from $2.46 in 2001 to $2.12 in 2002. (EIA, 2003a) The module price, however, does not include the design costs, land, support structure, batteries, an inverter, wiring, and lights/appliances.

With all of these included, a full system can cost anywhere from $7 to $20 per watt. (Fitzgerald, 2007) Costs of PV cells in the future may be expected to decrease with improvements in technology and increased production. Optimistic estimates are that costs of grid-connected PV systems could drop to $2,275 per kWe and to $0.15 to $0.20 per kWh by 2020 (ELPC, 2001). These costs would still be substantially in excess of the costs of power from a new nuclear plant. Therefore, PV cells are non-competitive with a new nuclear plant at the CCNPP site.

Environmental impacts of solar power systems can vary based on the technology used and the site specific conditions.

- Land use and aesthetics are the primary environmental impacts of solar power.
- Land requirements for each of the individual solar energy technologies are large, compared to the land used by a new nuclear plant. The land required for the solar power generating technologies ranges from 56,660 to 141,640 ft^2 (60,000 to 140,000 m^2) per MWe compared to 10,000 ft^2 (1,000 m^2) per MWe for nuclear technology.
- Depending on the solar technology used, there may be thermal discharge impacts. These impacts are anticipated to be small. During operation, PV and solar thermal technologies produce no air pollution, little or no noise, and require no transportable fuels.
- PV technology creates environmental impacts related to manufacture and disposal. The process to manufacture PV cells is similar to the production of a semiconductor chip. Chemicals used in the manufacture of PV cells include cadmium and lead. Potential human health risks also arise from the manufacture and deployment of PV systems because there is a risk of exposure to heavy metals such as selenium and cadmium during use and disposal (CEC, 2004). There is some concern that landfills could leach cadmium, mercury, and lead into the environment in the long term.

  Generally, PV cells are sealed and the risk of release is considered slight; however, the long-term impact of these chemicals in the environment is unknown. Another environmental consideration with solar technologies is the lead-acid batteries that are used with some systems. The impact of these lead batteries is lessening; however, as batteries become more recyclable, batteries of improved quality are produced and better quality solar systems that enhance battery lifetimes are created (REW, 2001).

Concentrating solar power systems could provide a viable energy source for small power generating facilities, with costs as low as $0.09 to $0.12 per kWh. However, concentrating solar power systems are still in the demonstration phase of development and are not cost competitive with nuclear-based technologies. PV cell technologies are increasing in popularity as costs slowly decrease. However, the cost per kWh is substantially in excess of the cost of power from a new nuclear plant. Additionally, for all of the solar power options, because the output of solar-based generation is dependent on the availability of light, it would require a supplemental energy source to meet the CCNPP Unit 3 baseload capacity. The large estimate of land required for a solar facility is another limitiation.

Therefore, based on the lack of information and experience regarding large scale systems able to produce the 1,600 MWe baseload capacity, concentrating solar power systems are non-competitive with a new nuclear plant at the CCNPP site.

9.2.2.5 Wood Waste and Other Biomass

The use of wood waste and other biomass to generate electricity is largely limited to states with significant wood resources, such as California, Maine, Georgia, Minnesota, Oregon, Washington, and Michigan. Electric power is generated in these states by the pulp, paper, and paperboard industries, which consume wood and wood waste for energy, benefiting from the use of waste materials that could otherwise represent a disposal problem. However, the largest wood waste power plants are 40 to 50 MWe in size. This would not meet the proposed 1,600 MWe baseload capacity.

Nearly all of the wood-energy-using electricity generation facilities in the U.S. 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.

Construction of a wood-fired plant would have an environmental impact that would be similar to that for a coal-fired plant, although 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 (i.e., ash) disposal. Additionally, the operation of wood-fired plants creates environmental impacts, including impacts on the aquatic environment and air (NRC, 1996).

According to a technical report (NREL, 2005), the availability of biomass resources in Maryland are as follows in thousand metric tons/year (thousand tons/year): Crop Residues 530 (584), switchgrass on CRP lands 246 (271), forest residues 239 (263), methane from landfills 185 (204), methane from manure management 5.4 (6), primary mill 125 (138), secondary mill 30 (33), urban wood 566 (624), and methane from domestic wastewater 8.2 (9). This totals approximately 1,933 thousand metric tons/year (2,131 thousand tons/year)) total biomass availability in the State of Maryland (NREL, 2005).

Biomass fuel can be used to co-fire with a coal-fueled power plant, decreasing cost from $0.023/ to $0.021 per kWh. This is only cost effective if biomass fuels are obtained at prices equal to or less than coal prices. In today's direct-fired biomass power plants, generation costs are about $0.09 per kWh (EERE, 2007), which is significantly higher than the costs associated with a nuclear power plant ($0.031 to $0.046 per kWh) (DOE, 2002). Because of the environmental impacts and costs of a biomass-fired plant, biomass is non-competitive with a new nuclear unit at the CCNPP site.

9.2.2.6 Municipal Solid Waste

The initial capital costs for municipal solid waste (MSW) plants are greater than for comparable steam turbine technology at wood-waste facilities (NRC, 1996). This is because of the need for specialized waste separation and handling equipment.

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 use of landfills as a waste disposal option is likely to increase in the near term; however, it is unlikely that many landfills will begin converting waste to energy because of the numerous obstacles and factors that may limit the growth in MSW power generation. Chief among them are environmental regulations and public opposition to siting MSW facilities.

Estimates suggest that the overall level of construction impacts from a waste-fired plant should be approximately the same as those for a coal-fired plant. Additionally, waste-fired plants have the same or greater operational impacts (including impacts on the aquatic environment, air, and waste disposal) (NRC, 1996). Some of these impacts would be moderate, but still larger than the proposed action.

In 2003, 12,337,018 metric tons (13,599,235 tons) of solid waste was managed or disposed of in Maryland, with 1,310,270 metric tons (1,444,325 tons) of that amount being incinerated (MDE, 2004). As an MSW reduction method, incineration can be implemented, generating energy and reducing the amount of waste by up to 90% in volume and 75% in weight (USEPA, 2006b).

The U.S. has about 89 operational MSW-fired power generation plants, generating approximately 2,500 MWe, or about 0.3% of total national power generation. However, economic factors have limited new construction. This comes to approximately 28 MWe per MSW-fired power generation plant, and would not meet the proposed 1,600 MWe baseload capacity. Burning MSW produces nitrogen oxides and sulfur dioxide as well as trace amounts of toxic pollutants, such as mercury compounds and dioxins. MSW power plants, much like fossil fuel power plants, require land for equipment and fuel storage. The non-hazardous ash residue from the burning of MSW is typically deposited in landfills (USEPA, 2006a).

The cost of power for MSW-fired power generation plants would be partially offset by savings in waste disposal fees. However, MSW-fired power generation remains significantly more costly than nuclear power, even when disposal fee savings are included into the cost of power. A study performed for a proposed MSW-fired power facility in 2002 found that cost of power varied from $0.096 to $0.119¢ per kWh in the case with low MSW disposal fees, and from $0.037 to $0.055 per KWh in the case with high MSW disposal fees (APT, 2004). These costs, accounting for the disposal fees, are significantly higher than the costs associated with a nuclear power plant ($0.031 to $0.046 per kWh) (DOE, 2002). Therefore, MSW is non-competitive with a new nuclear unit at the CCNPP site.

9.2.2.7 Energy Crops

In addition to wood and MSW fuels, there are several other concepts for fueling electric generators, including burning energy crops, converting crops to a liquid fuel such as ethanol (ethanol is primarily used as a gasoline additive), and gasifying energy crops (including wood waste). None of these technologies has progressed to the point of being competitive on a large scale or of being reliable enough to replace a baseload plant capacity of 1,600 MWe.

Estimates suggest that the overall level of construction impacts from a crop-fired plant should be approximately the same as those for a wood-fired plant. Additionally, crop-fired plants would have similar operational impacts (including impacts on the aquatic environment and air) (NRC, 1996). In addition, these systems have large impacts on land use because of the acreage needed to grow the energy crops.

Ethanol is perhaps the best known energy crop. It is estimated that 3.0 mi^2 (7.69 km^2) of corn are needed to produce 1 million gallons of ethanol, and in 2005 Maryland produced approximately 727 mi^2 (1,882 km^2) of corn. Currently in Maryland, more corn is used for grain products than any other purpose. If ethanol were to be proposed as an energy crop, Maryland would have to supplement its corn production from nearby states. (USDA, 2006) Surrounding states also use corn for grain products and do not have the resources to supplement ethanol-based fuel facilities.

The energy cost per KWh for energy crops is estimated to be similar to, or higher than, other biomass energy sources (EIA, 2004b). A DOE forecast concluded that the use of biomass for power generation is not projected to increase substantially in the next ten years because of the cost of biomass relative to the costs of other fuels and the higher capital costs relative to those for coal- or natural-gas-fired capacity (EIA, 2002). Therefore, energy crops are non-competitive with a new nuclear unit at the CCNPP site.

9.2.2.8 Petroleum Liquids (Oil)

From 2002 to 2005, petroleum costs almost doubled, increasing by 92.8%, and the period from 2004 to 2005 alone produced an average petroleum increase of 50.1% (EIA, 2006c). As a result, from 2005 to 2006, net generation of electricity from petroleum liquids dropped by about 84% in Maryland (EIA, 2007b). In the GEIS for License Renewal, the staff estimated that construction of a 1,000 MWe oil-fired plant would require about 0.19 mi^2 (0.49 km^2) (NRC, 1996).

Operation of oil-fired plants would have environmental impacts (including impacts on the aquatic environment and air) that would be similar to those from a coal-fired plant. Oil-fired plants also have one of the largest carbon footprints of all the electricity generation systems analyzed. Conventional oil-fired plants result in emissions of greater than 650 grams of CO_2 equivalent/kilowatt-hour (gCO_2eq/kWh). This is approximately 130 times higher than the carbon footprint of a nuclear power generation facility (approximately 5 gCO_2eq/kWh). Future developments such as carbon capture and storage and co-firing with biomass have the potential to reduce the carbon footprint of oil-fired electricity generation (POST, 2006).

Apart from fuel price, the economics of oil-fired power generation are similar to those for natural gas-fired power generation. Distillate oil can be used to run gas turbines in a combined-cycle system; however, the cost of distillate oil usually makes this type of combined-cycle system a less competitive alternative when natural gas is available. Oil-fired power generation experienced a significant decline in the early 1970s. Increases in world oil prices have forced utilities to use less expensive fuels; however, oil-fired generation is still an important source of power in certain regions of the U.S. (NRC, 1996).

On these bases, an oil-fired generation plant is non-competitive with a new nuclear unit at the CCNPP site.

9.2.2.9 Fuel Cells

Phosphoric acid fuel cells are the most mature fuel cell technology, but they are only in the initial stages of commercialization. During the past three decades, significant efforts have been made to develop more practical and affordable fuel cell designs for stationary power applications, but progress has been slow. Today, the most widely marketed fuel cells cost about $4,500 per kWh of installed capacity.

By contrast, a diesel generator costs $800 to $1,500 per kWh of installed capacity, and a natural gas turbine can cost even less. DOE has launched an initiative – the Solid State Energy Conversion Alliance – to bring about dramatic reductions in fuel cell cost. The DOE goal is to cut costs to as low as $400 per kWh of installed capacity by the end of this decade, which would make fuel cells competitive for virtually every type of power application. (DOE, 2006)

As market acceptance and manufacturing capacity increase, natural-gas-fueled fuel-cell plants in the 50 to 100 MWe range are projected to become available. This will not meet the proposed 1,600 MW(e) baseload capacity. At the present time, fuel cells are not economically or technologically competitive with other alternatives for baseload electricity generation and that the fuel cell alternative non-competitive with a new nuclear unit at the CCNPP site.

9.2.2.10 Coal

Coal-fired steam electric plants provide the majority of electric generating capacity in the U.S., accounting for about 52% of the electric utility industry's total generation, including co-generation, in 2000 (EIA, 2001a). Conventional coal-fired plants generally include two or more generating units and have total capacities ranging from 100 MWe to more than 2,000 MWe. Coal is 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 (EIA, 1993).

The U.S. has abundant low-cost coal reserves, and the price of coal for electric generation is likely to increase at a relatively slow rate. Even with recent environmental legislation, new coal capacity is expected to be an affordable technology for reliable, near-term development and for potential use as a replacement technology for nuclear power plants (NRC, 1996).

The environmental impacts of constructing a typical coal-fired steam plant are well known because coal is the most prevalent type of central generating technology in the U.S. The impacts of constructing a 1,000 MWe coal plant at a greenfield site can be substantial, particularly if it is sited in a rural area with considerable natural habitat. An estimated 2.66 mi^2 (6.88 km^2) would be needed, resulting in the loss of the same amount of natural habitat and/or agricultural land for the plant site alone, excluding land required for mining and other fuel cycle impacts (NRC, 1996).

Currently, the state of Maryland produces 60% of its electricity through coal-fired power plants. These plants produce more than 80% of the carbon dioxide released via electricity production. Data collected by the EIA shows that electricity generation is the single biggest source of carbon dioxide emissions in Maryland.

An existing coal-fueled power plant usually averages about $0.023/kWh. However, co-firing with inexpensive biomass fuel can decrease the cost to $0.021/kWh. This is only cost effective if biomass fuels are obtained at prices equal to or less than coal prices (EERE, 2007).

The operating impacts of new coal plants would be substantial for several resources. Concerns over adverse human health effects from coal combustion have led to important federal legislation in recent years, such as the Clean Air Act and Amendments (CAAA). Although new technology has improved emissions quality from coal-fired facilities, health concerns remain. Air quality would be degraded by the release of additional carbon dioxide, regulated pollutants, and radionuclides.

Carbon dioxide has been identified as a leading cause of global warming. Sulfur dioxide and oxides of nitrogen have been identified with acid rain. Substantial solid waste, especially fly ash and scrubber sludge, would be produced and would require constant management. Losses to aquatic biota would occur through impingement and entrainment and discharge of cooling water to natural water bodies. However, the positive socioeconomic benefits can be considerable for surrounding communities in the form of several hundred new jobs, substantial tax revenues, and plant spending.

Based on the well-known technology, fuel availability, and generally understood environmental impacts associated with constructing and operating a coal gas-fired power generation plant, it is considered a competitive alternative and is therefore discussed further in Section 9.2.3.

9.2.2.11 Natural Gas

Currently, there are 15 natural gas-fired plants or plants with natural gas-fired components in Maryland. Together, they are able to generate more than 6,700 MWe of energy (PPRP, 2006).

Most of the environmental impacts of constructing natural gas-fired plants are similar to those of other large central generating stations. Land-use requirements for gas-fired plants are small, at 0.17 mi^2 (0.45 km^2) for a 1,000 MWe plant, so land-dependent ecological, aesthetic, erosion, and cultural impacts should be small. Siting at a greenfield location would require new transmission lines and increased land-related impacts, whereas co-locating the gas-fired plant with an existing nuclear plant would help reduce land-related impacts. Also, gas-fired plants, particularly combined cycle and gas turbine facilities, take much less time to construct than other plants (NRC, 1996).

According to the EIA, net generation from natural gas in the state of Maryland decreased by almost 16% between 2005 and 2006 (EIA, 2007a).

Based on the well-known technology, fuel availability, and generally understood environmental impacts associated with constructing and operating a natural gas-fired power generation plant, it is considered a competitive alternative and is therefore discussed further in Section 9.2.3.

9.2.2.12 Integrated Gasification Combined Cycle (IGCC)

Integrated Gasification Combined Cycle (IGCC) 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 prior to 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, a black, glassy, sand-like material that is potentially a 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.

At present, IGCC technology still has insufficient operating experience for widespread expansion into commercial-scale, utility applications. Each major component of IGCC has been broadly utilized in industrial and power generation applications. But 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 U.S. Experience has been gained with the chemical processes of gasification, coal properties and their impact on IGCC design, efficiency, economics, etc.

However, system reliability is still relatively lower than conventional pulverized coal-fired power plants. There are problems with the integration between gasification and power production as well. For example, if there is a problem with gas cleaning, uncleaned gas can cause various damages to the gas turbine. (PU, 2005)

Overall, IGCC plants are estimated to be about 15% to 20% more expensive than comparably sized pulverized coal plants, due in part to the coal gassifier and other specialized equipment. Recent estimates indicate that overnight capital costs for coal-fired IGCC power plants range from $1,400 to $1,800 per kilowatt (EIA, 2005). The production cost of electricity from a coal-based IGCC power plant is estimated to be about $0.033 to $0.045 per kilowatt-hour. The projected cost associated with operating a new nuclear facility similar to CCNPP Unit 3 is in the range of $0.031 to $0.046 cents per kWh.

To advance the development of IGCC technology, a $557 million advanced IGCC facility will be constructed in Central Florida as part of the U.S. Department of Energy's (DOE) Clean Coal Power Initiative. The 285 MW plant will gasify coal using state-of-the-art emissions controls. The DOE will contribute $235 million and commercial entities will contribute $322 million. (OUC, 2004).

Because IGCC technology currently requires further research to achieve an acceptable level of reliability, an IGCC facility is not a competitive alternative to CCNPP Unit 3.

9.2.3 Assessment of Reasonable Alternative Energy Sources and Systems

For the viable alterative energy source options identified in Section 9.2.2, the issues associated with these options were characterized based on the significance of impacts, with the impacts characterized as being either SMALL, MODERATE, or LARGE. This characterization is consistent with the criteria that NRC established in 10 CFR 51, Appendix B, Table B-1, Footnote 3, as follows:

- SMALL - Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource. For the purposes of assessing radiological impacts, the Commission has concluded that those impacts that do not exceed permissible levels in the Commission's regulations are considered small.
- MODERATE - Environmental effects are sufficient to alter noticeably, but not to destabilize, any important attribute of the resource.
- LARGE - Environmental effects are clearly noticeable and are sufficient to destabilize any important attributes of the resource (NRC, 1996).

Table 9.2-1provides a comparison of the alternatives regarding environmental categories.

9.2.3.1 Coal-Fire Generation

The environmental impacts from coal-fired generation alternatives were evaluated in the GEIS (NRC, 1996). It was concluded that construction impacts for coal-fired generation could be substantial, in part because of the large land area required (for the plant site alone; 2.65 mi^2 (6.88 km^2) for a 1,000 MWe plant), which would be in addition to the land resourced required for mining and other fuel cycle impacts. These construction impacts would be decreased to some degree by siting a new coal-fired plant where an existing nuclear plant is located.

9.2.3.1.1 Air Quality

The air quality impacts of coal-fired generation are considerably different from those of nuclear power. A coal-fired plant would emit sulfur dioxide (SO_2, as SO_x surrogate), oxides of nitrogen (NO_x), 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 NETL document DOE/NETL-2007/1281 (NETL, 2007). The emissions from this facility are based on a power generation capacity of 1,600 MWe. The coal-fired generation facility assumes the use of bituminous coal fired in a supercritical pulverized coal (PC) wall-fired unit. Emissions control was assumed to include the use of a flue gas desulfurization system to control acid gas emissions, selective catalytic reduction to minimize NO_x emissions and a baghouse to control PM. Table 9.2-2summarizes the air emissions produced by a 1,600 MWe coal-fired facility.

Operating impacts of a new coal plant include concerns over adverse human health effects, such as increased cancer and emphysema. Air quality would be impacted by the release of CO_2, regulated pollutants, and radionuclides. CO_2 has been identified as a leading cause of global warming, and SO_2 and oxides of nitrogen have been identified with acid rain. Substantial solid waste, especially fly ash and scrubber sludge, would be also be produced and would require constant management. Losses of aquatic biota due to cooling water withdrawals and discharges would also occur.

The Maryland Healthy Air Act proposes to limit future emissions of nitrous oxides (NO_x), sulfur dioxide (SO_2), and mercury from coal-fired power plants (MDE, 2006). Maryland is also planning to participate in the Regional Greenhouse Gas Initiative (RGGI), which would cap carbon dioxide (CO_2) emissions from power plants unless the plants obtain emission offsets from qualified CO_2 emission offset projects.

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 1,000 grams of CO_2 equivalent/kilowatt-hour (gCO_2eq/kWh). This is approximately 200 times higher than the carbon footprint of a nuclear power generation facility (approximately 5 gCO_2eq/kWh). Lower emissions can be achieved using new gasification plants (less than 800 gCO_2eq/kWh), but this is still an emerging technology so and not as widespread as proven combustion technologies. Future developments such as carbon capture and storage (CCS) and co-firing with biomass have the potential to reduce the carbon footprint of coal-fired electricity generation. (POST, 2006)

Based on the emissions generated by a coal-fired facility, air impacts would be MODERATE to LARGE.

9.2.3.1.2 Waste Management

Substantial solid waste, especially fly ash and scrubber sludge, would be produced and would require constant management (NRC, 1996).

With proper placement of the facility, coupled with current waste management and monitoring practices, waste disposal would not destabilize any resources. There would also need to be an estimated 34.4 mi^2 (89 km^2) for mining the coal and disposing of the waste could be committed to supporting a coal plant during its operational life (NRC, 1996).

As a result of the above mentioned factors, waste management impacts would be MODERATE.

9.2.3.1.3 Economic Comparison

DOE has estimated the cost of generating electricity from a coal facility to be approximately \$0.049 per kWh. The projected cost associated with operating a new nuclear facility similar to the CCNPP Unit 3 facility is in the range of \$0.031 to \$0.046 per kWh (DOE, 2002) (DOE, 2004).

9.2.3.1.4 Other Impacts

Construction of the power block and coal storage area would disturb approximately 0.47 mi^2 (1.21 km^2) of land and associated terrestrial habitat and 0.94 mi^2 (2.42 km^2) of land would be needed for waste disposal (MDPSC, 2007a). As a result, land use impacts would be MODERATE.

Impacts to aquatic resources and water quality would be minimized but could be construed as MODERATE to LARGE as a result of the plant using a new cooling water system design. Losses to aquatic biota would occur through impingement and entrainment and discharge of cooling water to natural water bodies. Physical impacts are discussed in Section 4.2.

As noted in Section 2.5.2.10.4, there is no direct rail access in Calvert or St. Mary's counties within an 8-mile vicinity of the CCNPP site. The nearest railhead, owned by CSX Transportation (CSXT), is located at the Benedict/Chalk Point node in adjacent Prince George's County (ORNL, 2003). Coal would need to be transported overland to the CCNPP site by heavy haul trucks or by barge on the Chesapeake Bay. As a result, the potential impacts from heavy haul traffic or from construction of a coal off-loading facility would be MODERATE to LARGE.

Three new, 200 ft (61 m) power plant structures and 600 ft (183 m) stacks potentially visible for 40 mi (64 km) in a relatively non-industrialized area would need to be constructed along with a possible 520 ft (159 m) cooling tower and associated plumes (MDPSC, 2007a). As a result, aesthetic impacts would be LARGE.

Cultural resources, ecological resources, and threatened and endangered species impacts would be SMALL as a result of an already disturbed CCNPP site.

Socioeconomic impacts would result from the additional staff needed to operate the coal-fired facility, and several hundred mining jobs and additional tax revenues would be associated with the coal mining. As a result, socioeconomic impacts would be MODERATE.

As a result of increased safety technologies, accident impacts would be SMALL.

As a result of increased air emissions and public health risks such as cancer and emphysema associated with those emissions, human health impacts would be MODERATE.

9.2.3.1.5 Summary

In order for a coal-fired plant constructed on the CCNPP site to be competitive with a nuclear plant on the same site, the coal-fired plant would need to generate power in excess of 1,600 MWe. The nuclear plant requires a much smaller construction footprint, whereas the coal-fired plant would require more than 2.66 mi^2 (688 km^2), and greenhouse gas emissions would be significantly greater (NRC, 1996). Therefore, a 1,600 MWe coal-fired generation plant would not be viable with the land area currently available.

9.2.3.2 Natural Gas Generation

Most environmental impacts related to constructing natural gas-fired plants should be approximately the same for steam, gas-turbine, and combined-cycle plants. These impacts, in turn, generally will be similar to those of other large central generating stations. The environmental impacts of operating gas-fired plants are generally less than those of other fossil fuel technologies of equal capacity.

9.2.3.2.1 Air Quality

Natural gas is a relatively clean-burning fossil fuel. Also, because the heat recovery steam generator does not receive supplemental fuel, the combined-cycle operation is highly efficient (56% vs. 33% 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 focuses on the reduction of NO_x emissions.

Human health effects are SMALL based on decreased air quality impacts. Natural gas technologies produce fewer pollutants than other fossil technologies, and SO_2, a contributor to acid rain, is not emitted in significant quantities (NRC, 1996). Air emissions were estimated for a natural gas-fired generation facility based on the emission factors contained in the NETL document DOE/NETL-2007/1281 (NETL, 2007). Emissions from the facility were based on a power generation capacity of 1,600 MWe.

Current gas powered electricity generation has a carbon footprint around half that of coal (approximately 500 gCO_2eq/kWh), because gas has a lower carbon content than coal. This is approximately 100 times higher than the carbon footprint of a nuclear power generation facility (approximately 5 gCO_2eq/kWh). Like coal-fired plants, gas plants could co-fire biomass to reduce carbon emissions in the future (POST, 2006).

The natural gas-fired generation facility assumes the use of a combined cycle gas turbine generator (GTG) with no duct firing. Selective catalytic reduction is used to control nitrogen oxides emissions. Table 9.2-2summarizes the air emissions produced by a 1,600 MWe natural gas-fired facility. Based on the emissions generated from a natural gas-fired facility, air impacts would be MODERATE.

9.2.3.2.2 Waste Management

Gas-fired generation would result in almost no waste generation, producing minor (if any) impacts. As a result, waste management impacts would be SMALL.

9.2.3.2.3 Economic Comparison

DOE has estimated the cost of generating electricity from a gas-fired facility to be $0.047 per kWh. The projected cost associated with operating a new nuclear facility similar to CCNPP Unit 3 is in the range of $0.031 to $0.046 per kWh (DOE, 2002) (DOE, 2004).

9.2.3.2.4 Other Impacts

Construction of the power block and would disturb approximately 0.1 mi^2 (0.24 km^2) of land and associated terrestrial habitat, and 435,600 ft^2 (40,000 m^2) of land would be needed for pipeline construction (MDPSC, 2007a). As a result, land use impacts would be SMALL.

Consumptive water use is about the same for steam cycle plants as for other technologies, although water consumption is likely to be less for gas turbine plants. There are potential impacts to aquatic biota through impingement and entrainment and increased water temperatures in receiving water bodies (NRC, 1996). Water quality impacts would be SMALL. Physical impacts are discussed in Section 4.2.

A new 100 ft (30 m) turbine building and 230 ft (70 m) exhaust stacks would need to be constructed. A closed-cycle cooling alternative could also introduce plumes (MDPSC, 2007a). As a result, aesthetic impacts would be MODERATE.

Cultural resources, ecological resources, and threatened and endangered species impacts would be SMALL as a result of an already disturbed CCNPP site.

Socioeconomic impacts would result from the approximately 150 people needed to operate the gas-fired facility, as estimated in the GEIS (NRC, 1996). As a result, socioeconomic impacts would be SMALL.

Due to increased safety technologies, accidents and human health impacts would be SMALL.

A proposed gas-fired unit would connect to an existing gas line adjacent to the site. The Dominion Cove Point Liquid Natural Gas (DCPLNG) pipeline passes within approximately 1.54 mi (2.48 km) of CCNPP Unit 3. As a result, construction impacts related to connecting to an existing gas line would be SMALL.

9.2.3.2.5 Summary

The gas-fired alternative discussed in Section 9.2.2.11 would be located at the CCNPP site. The natural gas generation alternative at the CCNPP site would require less land area than the coal-fired plant but more land area than the nuclear plant. The plant site alone would require 0.17 mi^2 (0.45 km^2) for a 1,000 MWe generating capacity. An additional 5.6 mi^2 (14.6 km^2) of land would be required for wells, collection stations, and pipelines to bring natural gas to the generating facility. (NRC, 1996) This is significantly greater than the 0.35 mi^2 (0.92 km^2) required for construction of a new nuclear unit. Therefore, constructing a natural gas generation plant would not be viable on the CCNPP site.

9.2.3.3 Combination of Alternatives

CCNPP Unit 3 will have a baseload capacity of approximately 1,600 MWe. Any alternative or combination of alternatives would be required to generate the same baseload capacity.

Because of the intermittent nature of the resources and the lack of cost-effective technologies, wind and solar energies are not sufficient on their own to generate the equivalent baseload capacity or output of CCNPP Unit 3, as discussed in Section 9.2.2.1 and Section 9.2.2.4. As noted in Section 9.2.3.1 and Section 9.2.3.2, fossil fuel fired technology generates baseload capacity, but the associated environmental impacts are greater than for a nuclear facility.

A combination of alternatives may be possible, but should be sufficiently complete, competitive, and viable to provide NRC with appropriate comparisons to the proposed nuclear plant.

9.2.3.3.1 Determination of Alternatives

A number of combinations of alternative power generation sources could be used satisfy the baseload capacity requirements of the CCNPP facility. Some of these combinations include renewable sources, such as wind and solar. Wind and solar do not, by themselves, provide a reasonable alternative energy source to the baseload power to be produced by the CCNPP facility. However, when combined with fossil fuel-fired plant(s), wind and solar may be a reasonable alternative to nuclear energy produced by the CCNPP facility.

CCNPP Unit 3 will operate as a baseload, merchant independent power producer. The power produced will be sold on the wholesale market without specific consideration to supplying a traditional service area or satisfying a reserve margin objective. The ability to generate baseload power in a consistent, predictable manner meets the business objective of CCNPP Unit 3. Therefore, when examining combinations of alternatives to CCNPP Unit 3, the ability to consistently generate baseload power must be the determining feature when analyzing the reasonableness of the combination. This section reviews the ability of the combination alternative to have the capacity to generate baseload power equivalent to CCNPP Unit 3.

When examining a combination of alternatives that would meet business objectives similar to that of CCNPP Unit 3, any combination that includes a renewable power source (either all or part of the capacity of CCNPP Unit 3) must be combined with a fossil-fueled facility equivalent to the generating capacity of CCNPP Unit 3. This combination would allow the fossil-fueled portion of the combination alternative to produce the needed power if the renewable resource is unavailable and to be displaced when the renewable resource is available.

For example, if the renewable portion is provided by some amount of wind generation and that resource became available, then the output of the fossil fueled generation portion of the combination alternative could be lowered to offset the increased generation from the renewable portion. This facility, or facilities, would satisfy business objectives similar to those of the CCNPP facility in that it would be capable of supporting fossil-fueled baseload power.

Greenhouse gas emissions are another factor that must be considered when evaluating alternative power generation combinations. CCNPP Unit 3 will not rely on carbon-based fuels for power generation, and will produce only a small amount of carbon dioxide (CO_2) emissions. Carbon dioxide is the principal greenhouse gas from power generating facilities that combust solid or liquid fuels. If the source of the carbon is biomass or derived from biomass (ethanol), then the impact is carbon neutral. If the source of the carbon is fossil fuel, then there is a net increase in atmospheric CO_2 concentrations and global climate change unless the carbon emissions are offset or sequestered.

Coal-fired and gas-fired generation have been examined as having environmental impacts that are equivalent to or greater than the impacts of CCNPP Unit 3. Based on the comparative impacts of these two technologies, as shown in Table 9.2-1, it can be concluded that a gas-fired facility would have less of an environmental impact than a comparably sized coal-fired facility. In addition, the operating characteristics of gas-fired generation are more amenable to the kind of load changes that may result from inclusion of renewable generation such that the baseload generation output of 1,600 MWe is maintained.

"Clean Coal" power plant technology could decrease the air pollution impacts associated with burning coal for power. Demonstration projects show that clean coal programs reduce NOx, SOx, and particulate emissions. However, the environmental impacts from burning coal using these technologies, if proven, will still be greater than the impacts from natural gas (NETL, 2001). Therefore, for the purpose of examining the impacts from a combination of alternatives to CCNPP Unit 3, a facility equivalent to that will be used in the environmental analysis of combination alternatives.

The analysis accounts for the reduction in environmental impacts from a gas-fired facility when generation from the facility is displaced by the renewable resource. The impact associated with the combined-cycle natural gas-fired unit is based on the gas-fired generation impact assumptions discussed in Section 9.2.3.2. Additionally, the renewable portion of the combination alternative would be any combination of renewable technologies that could produce power equal to or less than CCNPP Unit 3 at a point when the resource was available.

This combination of renewable energy and natural gas fired generation represents a viable mix of non-nuclear alternative energy sources. Many types of alternatives can be used to supplement wind energy, notably solar power. PV cells are another source of solar power that would complement wind power by using the sun during the day to produce energy while wind turbines use windy and stormy conditions to generate power. Wind and solar facilities in combination with fossil fuel facilities (coal, petroleum) could also be used to generate baseload power.

However, wind and solar facilities in combination with fossil fuel facilities would have equivalent or greater environmental impacts relative to a new nuclear facility at the CCNPP site. Similarly, wind and solar facilities in combination with fossil fuel facilities would have costs higher than a new nuclear facility at the CCNPP site. Therefore, wind and solar facilities in combination with fossil fuel facilities are non-competitive with a new nuclear unit at the CCNPP site.

9.2.3.3.2 Environmental Impacts

The environmental impacts associated with a gas-fired power generation facility sized to produce power equivalent to CCNPP Unit 3 have already been analyzed. Depending on the level of potential renewable output included in the combination alternative, the level of impact of the gas-fired portion will be comparably lower. If the renewable portion of the combination alternative were not enough to displace the power produced by the fossil fueled facility, then there would be some level of impact associated with the fossil fueled facility.

Consequently, if the renewable portion of the combination alternative were enough to fully displace the output of the gas-fired facility, then, when the renewable resource is available, the output of fossil fueled facility could be eliminated, thereby eliminating its operational impacts. Determination of the types of environmental impacts of these types of 'hybrid' plants or combination of facilities can be surmised from analysis of past projects.

For instance, in 1984, Luz International, Ltd. built the Solar Electric Generating System (SEGS) plant in the California Mojave Desert. The SEGS technology consists of modular parabolic-trough solar collector systems, which use oil as a heat transfer medium. One unique aspect of the Luz technology is the use of a natural-gas-fired boiler as an oil heater to supplement the thermal energy from the solar field or to operate the plant independently during evening hours. SEGS I was installed at a total cost of $62 million (approximately $4,500/kW) and generates power at $0.24 per kWh (in 1988 real levelized dollars).

The improvements incorporated into the SEGS III-VI plants (approximately $3,400/kW) reduced generation costs to about $0.12 per kWh, and the third-generation technology, embodied in the 80 MW design at an installed cost of $2,875/kW, reduced power costs still further, to $0.08 to $0.10 per kWh. Because solar energy is not a concentrated source, the dedicated land requirement for the Luz plants is large compared to conventional plants--on the order of 5 acres/MWe (2 hectares/MWe) (NREL, 1993), compared to 0.23 acres/MWe (0.093 hectares/MWe) for a nuclear plant.

Parabolic trough plants require a significant amount of land; typically the use is preemptive because parabolic troughs require the land to be graded level. A report, developed by the

California Energy Commission (CEC), notes that 5 to 10 acres (2 to 4 hectares) per MWe is necessary for concentrating solar power technologies such as trough systems (CEC, 2003).

The environmental impacts associated with a solar or wind facility equivalent to CCNPP Unit 3 have already been analyzed. It is reasonable to expect that the impacts associated with an individual unit of a smaller size would be similarly scaled. If the renewable portion of the combination alternative is unable to generate an equivalent amount of power as CCNPP Unit 3, then the combination alternative would have to rely on the gas-fired portion to meet the equivalent capacity of CCNPP Unit 3.

Consequently, if the renewable portion of the combination alternative has a potential output that is equal to that of CCNPP Unit 3, then the impacts associated with the gas-fired portion of the combination alternative would be lower but the impacts associated with the renewable portion would be greater. The greater the potential output of the renewable portion of the combination alternative, the closer the impacts would approach the level of impacts. The gas-fired facility alone has impacts that are larger than CCNPP Unit 3; some environmental impacts of renewables are also greater than or equal to CCNPP Unit 3. The combination of a gas-fired plant and wind or solar facilities would have environmental impacts that are equal to or greater than those of a nuclear facility.

- All of the environmental impacts of a new nuclear plant at the CCNPP site and all of the impacts from a gas-fired plant are small, except for air quality impacts from a gasfired facility (which are moderate). Use of wind and/or solar facilities in combination with a gas-fire facility would be small, and therefore would be equivalent to the air quality impacts from a nuclear facility.
- All of the environmental impacts of a new nuclear plant at the CCNPP site and all of the impacts from wind and solar facilities are small, except for land use and aesthetic impacts from wind and solar facilities (which range from moderate to large). Use of a gas-fired facility in combination with wind and solar facilities would reduce the land usage and aesthetic impacts from the wind and solar facilities. However, at best, those impacts would be small, and therefore would be equivalent to the land use and aesthetic impacts from a nuclear facility.

Therefore the combination of wind and solar facilities and gas-fired facilities is not environmentally preferable to CCNPP Unit 3.

9.2.3.3.3 Economic Comparison

As noted earlier, the combination alternative must generate power equivalent to the capacity of CCNPP Unit 3. DOE has estimated the cost of generating electricity from a gas-fired facility ($0.047 per kWh), a biomass facility ($0.09 per KWh), a coal facility ($0.049 per kWh), a wind facility ($0.057 per kWh), and a solar facility ($0.04 to $0.05 per kWh). The cost for a gas-fired facility in combination with a renewable facility would increase, because the facility would not be operating at full availability when it is displaced by the renewable resource.

As a result, the capital costs and fixed operating costs of the gas facility would be spread across fewer kWh from the gas facility, thereby increasing its cost per kWh. The projected cost associated with operating a new nuclear facility similar to CCNPP Unit 3 is in the range of $0.031 to $0.046 per kWh (DOE, 2002) (DOE, 2004). The projected costs associated with forms of generation other than from a nuclear unit would be higher. Therefore, the cost associated with the operation of the combination alternative would be non-competitive with CCNPP Unit 3.

9.2.3.3.4 Summary

As noted earlier, the combination alternative must generate power equivalent to the capacity of CCNPP Unit 3. DOE has estimated the cost of generating electricity from a gas-fired facility ($0.047 per kWh), a biomass facility ($0.09 per KWh), a coal facility ($0.049 per kWh), a wind facility ($0.057 per kWh), and a solar facility ($0.04 to $0.05 per kWh). The cost for a gas-fired facility in combination with a renewable facility would increase, because the facility would not be operating at full availability when it is displaced by the renewable resource.

As a result, the capital costs and fixed operating costs of the gas facility would be spread across fewer kWh from the gas facility, thereby increasing its cost per kWh. The projected cost associated with operating a new nuclear facility similar to CCNPP Unit 3 is in the range of $0.031 to $0.046 per kWh (DOE, 2002) (DOE, 2004). The projected costs associated with forms of generation other than from a nuclear unit would be higher. Therefore, the cost associated with the operation of the combination alternative would be non-competitive with CCNPP Unit 3.

9.2.4 Conclusion

Based on environmental impacts, it has been concluded that neither a coal-fired, gas-fired,or a combination of alternatives, including wind-powered and solar-powered facilities would appreciably reduce overall environmental impacts when compared to a nuclear plant. Furthermore, each of these types of alternatives, with the possible exception of the combination alternative, would entail a significantly greater environmental impact on air quality than a nuclear plant would.

To achieve the small reduction in air quality impact in the combination alternative; however, a moderate to large impact on land use would be incurred. It is therefore concluded that neither a coal-fired, gas-fired, nor a combination of alternatives would be environmentally preferable to a nuclear plant. Furthermore, these alternatives would have higher economic costs and therefore are not economically preferable to a nuclear plant.

9.2.5 References

APT, 2004. Investigation into Municipal Solid Waste Gasification for Power Generation, Alameda Power and Telecom, May 2004, Website: http://www.alamedapt.com/newsroom/reports/gasification.pdf, Date accessed: June 12, 2007.

BGE, 1998. Calvert Cliffs Nuclear Power Plant, Units 1 and 2, Docket Numbers 50-317 and 50-318, Application for License Renewal, Baltimore Gas and Electric Company, April 8, 1998.

CBD, 2007. Altamont Pass Wind Resource Area, The Center for Biological Diversity, Website: http://www.biologicaldiversity.org/swcbd/Programs/bdes/altamont/altamont.html, Date accessed: May 18, 2007.

CEC, 2003. Renewable Resources Development Report, Report 500-03-080F, November 2003, California Energy Commission (CEC), Website: http://www.energy.ca.gov/reports/2003-11-24_500-03-080.PDF, Date accessed: June 6, 2008.

CEC, 2004. Potential Health and Environmental Impacts Associated with the Manufacture and Use of Photovoltaic Cells, Report P500-04-003, California Energy Commission, August 2004, Website: http://www.energy.ca.gov/reports/500-04-053.PDF, Date accessed: May 17, 2007.

DOE, 2002. Business Case for New Nuclear Power Plants, U.S. Department of Energy, Office of Nuclear Energy, Science and Technology, July 2002, Website: http://www.ne.doe.gov/home/bc/businesscase.html, Date accessed: May 19, 2007.

DOE, 2004. The Economic Future of Nuclear Power, U.S. Department of Energy, Office of Nuclear Energy, August 2004, Website: http://nuclear.energy.gov/np2010/reports/NuclIndustryStudy-Summary.pdf, Date accessed: May 19, 2007.

DOE, 2006. Future Fuel Cells R&D, U.S. Department of Energy, Office of Science and Technology, Website: http://www.fossil.energy.gov/programs/powersystems/fuelcells/, Date accessed: May 18, 2007.

EERE, 2003. Wind Resource Maps of Maryland, U.S. Department of Energy, Energy Efficiency and Renewable Energy, January 2003, Website: http://www.eere.energy.gov/windandhydro/windpoweringamerica/maps_template.asp?stateab=md, Date accessed: May 19, 2007.

EERE, 2006a. State Energy Alternatives: Alternative Energy Resources in Maryland, U.S. Department of Energy, Energy Efficiency and Renewable Energy, Website: http://www.eere.energy.gov/states/alternatives/resources_md.cfm, Date accessed: May 19, 2007.

EERE, 2006b. Concentrating Solar Power, U.S. Department of Energy, Energy Efficiency and Renewable Energy, 2006, Website: http://www1.eere.energy.gov/solar/csp.html, Date accessed: May 31, 2007.

EERE, 2007. State Energy Alternatives, U.S. Department of Energy, Energy Efficiency and Renewable Energy, Website: http://www.eere.energy.gov/states/alternatives/biomass.cfm, Date accessed: May 18, 2007.

EIA, 1993. Renewable Resources in the U.S. Electricity Supply, USDOE/EIA-0561(92), U.S. Department of Energy, Energy Information Administration, February 1993, Website: ftp://ftp.eia.doe.gov/pub/electricity/renewmas.pdf, Date accessed: May 18, 2007.

EIA, 1995. Renewable Energy Annual 1995, DOE/EIA-0603(95), U.S. Department of Energy, Energy Information Administration, December 1995, Website: http://tonto.eia.doe.gov/FTPROOT/renewables/060395.pdf, Date accessed: May 18, 2007.

EIA, 1999. Issues in Midterm Analysis and Forecasting 1999, EIA/DOE-0607(99), U.S. Department of Energy, Energy Information Administration, 1999.

EIA, 2001a. Annual Energy Outlook, 2002: With Projections to 2020, USDOE/EIA-0383(2002), U.S. Department of Energy, Energy Information Administration, December 2001, Website: http://tonto.eia.doe.gov/FTPROOT/forecasting/0383(2002).pdf, Date accessed: May 17, 2007.

EIA, 2001b. International Energy Outlook 2001, DOE/EIA-0484(2001), U.S. Department of Energy, Energy Information Administration, March 2001, Website: http://tonto.eia.doe.gov/FTPROOT/forecasting/04842001.pdf, Date accessed: May 17, 2007.

EIA, 2002. Biomass for Electricity Generation, U.S. Department of Energy, Energy Information Administration, Website: http://www.eia.doe.gov/oiaf/analysispaper/biomass/index.html, Date accessed: June 12, 2007.

EIA, 2003a. Renewable Energy Annual 2002, DOE/EIA-0603(2002), U.S. Department of Energy, Energy Information Administration, November 2003, Website: http://tonto.eia.doe.gov/FTPROOT/renewables/060304.pdf, Date accessed: May 17, 2007.

EIA, 2003b. Table FE2 - Typical Costs and Capacity of New Transmission Lines, U.S. Department of Energy, Energy Information Administration, Website: http://www.eia.doe.gov/cneaf/pubs_html/feat_trans_capacity/table2.html, Date accessed: May 19, 2007.

EIA, 2004a. Annual Energy Outlook, 2004: With Projections to 2025, USDOE/EIA-0383(2004), U.S. Department of Energy, Energy Information Administration, January 2004, Website: http://www.econstats.com/EIA/AEO2004.pdf, Date accessed: May 19, 2007.

EIA, 2004b. Biomass for Electricity Generation, U.S. Department of Energy, Energy Information Administration, April 2004, Website: http://www.epa.gov/cleanrgy/pdf/haq_apr20.pdf, Date accessed: on June 12, 2007.

EIA, 2005. Annual Energy Outlook, 2005: With Projections to 2025, USDOE/EIA-0383(2005), U.S. Department of Energy, Energy Information Administration, February 2005, Website: http://www.econstats.com/EIA/AEO2004.pdf, Date accessed: June 3, 2007.

EIA, 2006a. Demand-Side Management Actual Peak Load Reductions by Program Category, U.S. Department of Energy, Energy Information Administration, October 2006, Website: http://www.eia.doe.gov/cneaf/electricity/epa/epat9p1.html, Date accessed: May 18, 2007.

EIA, 2006b. Demand-Side Management Program Direct and Indirect Costs, U.S. Department of Energy, Energy Information Administration, October 2006, Website: http://www.eia.doe.gov/cneaf/electricity/epa/epat9p7.html, Date accessed: February 12, 2007.

EIA, 2006c. Electric Power Annual 2005, DOE/EIA-0348(2005), U.S. Department of Energy, Energy Information Administration, November 2006, Website: http://www.eia.doe.gov/cneaf/electricity/epa/epa.pdf, Date accessed: May 19, 2007.

EIA, 2006d. Impact of Energy Policy Act of 2005 Section 206 Rebates on Customers and Renewable Energy Consumption, with Projections to 2010, U.S. Department of Energy, Energy Information Administration, Website: http://www.eia.doe.gov/cneaf/solar.renewables/page/epact/background.html, Date accessed: May 18, 2007.

EIA, 2007a. Net Generation from Natural Gas by State by Sector, Year-to-Date through December 2006 and 2005, U.S. Department of Energy, Energy Information Administration, Website: http://www.eia.doe.gov/cneaf/electricity/epm/table1_10_b.html, Date accessed: May 19, 2007.

EIA, 2007b. "Net Generation from Petroleum Liquids by State by Sector, Year-to-Date through December 2006 and 2005," U.S. Department of Energy, Energy Information Administration, Washington, D.C., available online at: http://www.eia.doe.gov/cneaf/electricity/epm/table1_8_b.html, accessed May 19, 2007.

Fitzgerald, 2007. Solar Electric Frequently Asked Questions, M. Fitzgerald, Website: http://www.solareco.com/articles/article.cfm?id=121, Date accessed: February 8, 2007.

INEEL, 1998. U.S. Hydropower Resource Assessment Final Report, Report DOE/ID-10430.2, Idaho National Engineering and Environmental Laboratory, December 1998.

MDE, 2004. Solid Waste Managed in Maryland Calendar Year 2003, Maryland Department of the Environment, September 2004, Website: http://www.mde.state.md.us/assets/document/SW_Managed_in_MD_Report_CY_2003.pdf, Date accessed: May 19, 2007.

MDE, 2006. Title 26, Subtitle 11, Section 27, Emission Limitations for Power Plants, Maryland Department of the Environment, 2006, Website: http://www.mde.state.md.us/assets/document/Emergency_Action_published_in_MDReg_2207.pdf, Date accessed: June 19, 2007.

MPPRP, 2006. Generation from Power Plants in Maryland, Maryland Department of Natural Resources, Maryland Power Plant Research Program, September 2006, Website: http://esm.versar.com/pprp/factbook/generation.htm, Date accessed: May 19, 2007.

MDPSC, 2007a. Electric Supply Adequacy Report of 2007, Maryland Public Service Commission, January 2007.

MDPSC, 2007b. Annotated Code of Maryland, Public Utilities Companies Article, Title 7, Subtitle 7, Section 7-701, Renewable Energy Portfolio Standards, Website: http://mlis.state.md.us/cgi-win/web_statutes.exe?gpu&7-701, Date accessed: June 19, 2007.

MGA, 1991. Section 7-211 of the Public Utility Companies Articles, Maryland General Assembly, Annapolis, Maryland.

NEPA, 1982. The National Environmental Policy Act of 1969, as amended, Publication L. 91-190, 42 U.S.C. 4321-4347, January 1, 1970, as amended by Publication L. 94-52, July 3, 1975, Publication L. 94-83, August 9, 1975, and Publication L. 97-258, Section 4(b), September 13, 1982.

NETL, 2001. Environmental Benefits of Clean Coal Technologies, Topical Report 18, U.S. Department of Energy, National Energy Technology Laboratory, April 2001, Website: http://www.netl.doe.gov/technologies/coalpower/cctc/topicalreports/pdfs/topical18.pdf, Date accessed: June 19, 2007.

NETL, 2007. National Energy Technology Laboratory (NETL), 2007. Cost and Performance Baseline for Fossil Energy Plants Volume 1: Bituminous Coal and Natural Gas to Electricity, U.S. Department of Energy, National Energy Technology Laboratory report, DOE/NETL-2007/1281 Rev. 1, August 2007; Available online at: http://www.netl.doe.gov/energy-analyses/pubs/BituminousBaseline_Final Report.pdf

NRC, 1996. Generic Environmental Impact Statement for License Renewal of Nuclear Plants, NUREG-1437, Nuclear Regulatory Commission, May 1996.

NRC, 1999. Standard Review Plans for Environmental Reviews of Nuclear Power Plants, NUREG-1555, Nuclear Regulatory Commission, October 1999.

NREL, 2004. PV Solar Radiation: Annual (Flat Plate, Facing South, Latitude Tilt), U.S. Department of Energy, National Renewable Energy Laboratory, Website: http://www.nrel.gov/gis/images/us_pv_annual_may2004.jpg, Date accessed: May 19, 2007.

NREL, 2005. A Geographic Perspective on the Current Biomass Resource Availability in the United States, Technical Report NREL/TP-560-39181, U.S. Department of Energy, National Renewable Energy Laboratory, December 2005, Website: http://www.nrel.gov/docs/fy06osti/39181.pdf, Date accessed: May 19, 2007.

NREL, 2006. Energy Storage Basics, U.S. Department of Energy, National Renewable Energy Laboratory, December 2005, Website: http://www.nrel.gov/learning/eds_energy_storage.html, Date accessed: June 19, 2007.

NREL, 2007. Photovoltaics, U.S. Department of Energy, National Renewable Energy Laboratory, Website: http://www.nrel.gov/learning/re_photovoltaics.html, Date accessed: April 3, 2007.

ORNL, 2003. Transportation Routing Analysis Geographic Information System (TRAGIS) User's Manual, Rev. 0, National Transporation Research Center (NTRC), managed by UT-Battelle for DOE, ORNL/NTRC-006, Oak Ridge National Laboratory, June 2003.

OUC, 2004. Department of Energy Selects OUC - Southern Company to Build Clean Coal Technology Plant, Orlando Utilities Commission, October 2004, Website: http://www.ouc.com/news/arch/20041021-cleancoal_proj.htm, Date accessed: June 3, 2007.

PL, 2005. Energy Policy Act of 2005, Public Law 109-58, August 2005.

POST, 2006. Carbon Footprint of Electricity Generation, October 2006, Parliamentary Office of Science and Technology, Website: http://www.parliament.uk/documents/upload/postpn268.pdf, Date accessed: June 19, 2007.

PU, 2005. Factors that Affect the Design and Implementation of Clean Coal Technologies in Indiana, Purdue Energy Research Modeling Groups, Purdue University, R. Rardin, Y. Zuwei, F. Holland, A. Black, J. Oberbeck, June 2005, Website: http://www.purdue.edu/dp/energy/pdf/Purdue-InterimReport-Jun10-2005.pdf, Date accessed: June 3, 2007.

REW, 2001. Minimizing the Environmental Impact of Large-Scale Rural PV, Renewable Energy World, Volume 4, Number 1, M. Real, H. Bader, and R. Scheidegger, January-February 2001.

SS, 2004. Facts about Solar Energy, Siemens Solar, Website: http://www.siemenssolar.com/facts.html, Date accessed: May 18, 2004.

USDA, 2006. Maryland State Agricultural Overview – 2005, U.S. Department of Agriculture, National Agricultural Statistics Service, Website: http://www.nass.usda.gov/Statistics_by_State/Ag_Overview/AgOverview_MD.pdf, Date accessed: May 19, 2007.

USEPA, 1995. AP-42, Fifth Edition, Volume I, as posted in the Technology Transfer Network, Clearinghouse for Inventories and Emission Factors, U.S. Environmental Protection Agency, Website: http://www.epa.gov/ttn/chief/ap42/, Date accessed: May 19, 2007.

USEPA, 2006a. Electricity from Municipal Solid Waste, U.S. Environmental Protection Agency, Website: http://www.epa.gov/cleanenergy/muni.htm, Date accessed: May 19, 2007.

USEPA, 2006b. Municipal Solid Waste: Basic Facts, U.S. Environmental Protection Agency, Website: http://www.epa.gov/msw/facts.htm, Date accessed: May 19, 2007.

Table 9.2-1— Impacts Comparison Table

Impact Category	CCNPP Unit 3	Coal-Fired Generation	Gas-Fired Generation	Combinations
Air Quality MT (tons)/yr	Small	Large SO_2 = 4,700 (5,177) NO_2 = 3,884 (4,278)	Moderate SO_2 = 83 (92) NO_2 = 385 (424)	Small to Large
Waste Management MT (tons)/yr	Small	Moderate Substantial amount scrubber sludge and fly ash produced	Small	Small to Moderate
Land Use mi^2 (km^2)	Small	Moderate Waste disposal – 0.94 (2.43) Coal storage and power block area 0.47 (1.21)	Small	Small to Large
Water Quality	Small	Moderate to Large Cooling water system losses to biota through impingement/ entrainment, discharge of cooling water to natural water bodies	Moderate to Large Cooling water system losses to biota through impingement/ entrainment, discharge of cooling water to natural water bodies	Small to Large
Aesthetics m (ft)	Small to Moderate Plant structures	Large Plant structures 61(200) high Stacks 183 (600) high	Moderate Turbine building 30 (100) high Stacks 70 (230) high	Small to Large
Cultural Resources	Small	Small	Small	Small
Ecological Resources	Small	Small	Small	Small
Threatened & Endangered Resources	Small	Small	Small	Small
Socioeconomics	Small	Moderate Staff needed to operate facility, several hundred mining jobs and additional tax revenues	Small	Small to Moderate
Accidents	Small	Small	Small	Small
Human Health	Small	Moderate (see air quality)	Small	Small to Moderate

Notes:
SMALL – Environmental effects are not noticeable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource.
MEDIUM – Environmental effects are sufficient to alter noticeably, nut not destabilize, any important attribute of the resource.
LARGE – Environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

Table 9.2-2— Air Emissions from Alternative Power Generation Facilities

Fuel	Bituminous Coal	Natural Gas
Combustion Facility	Supercritical, Pulverized Coal, Wall Fired	Combined Cycle GTG, No Duct Firing
Generation Capacity	1,600 MWe	1,600 MWe
Air Pollutant Emissions – metric tons (tons) per year		
Sulfur Dioxide (SO_2)	4,700 (5,177)	83 (92)
Nitrogen Dioxide (NO_2)	3,884 (4,278)	661 (729)385 (424)
Particulate Matter (PM)	722 (795)	Negligible
Carbon Dioxide, equiv. (CO_2e)	11,260,000 (12,407,000)	5,086,000 (5,603,000)
GTG – gas turbine generator		

9.3 ALTERNATIVE SITES

This section presents an evaluation of alternative sites to the proposed location of Calvert Cliffs Nuclear Power Plant (CCNPP) Unit 3. The objective of the evaluation is to identify reasonable *Alternative Sites* to the CCNPP Unit 3 site (*Proposed Site*) and to demonstrate that there are no *Alternative Sites* that have environmental preference (i.e., "Environmentally Preferable") to the *Proposed Site*. If environmental preference is established, then a second tier of evaluations is conducted based on other factors including commercial and financial criteria to demonstrate that there are no *Alternative Sites* that are "Obviously Superior" to the *Proposed Site*. The underlying assessment (UniStar, 2009) evaluated other candidate sites based on the guidance provided in NUREG-1555, Environmental Standard Review Plan (NRC, 1999), Regulatory Guide 4.2, Preparation of Environmental Reports for Nuclear Power Stations (NRC, 1976), Regulatory Guide 4.7, General Site Suitability for Nuclear Power Stations (NRC, 1998), and the Electric Power Research Institute (EPRI) Siting Guide: Site Selection and Evaluation Criteria for an Early Siting Permit Application Final Report (EPRI, 2002). The results of that assessment are provided in this section.

The NRC recognizes in NUREG-1555, Section 9.3(III)(8) that the proposed site for a new reactor may not always be based on a systematic review. Siting new units at existing nuclear sites has provided another option to the way alternatives are reviewed and selected. Existing sites offer decades of environmental and operational information about the impact of a nuclear plant on the environment. NUREG-1555 Section 9.3 (III)(8) states:

> Recognize that there will be special cases in which the proposed site was not selected on the basis of a systematic site-selection process. Examples include plants proposed to be constructed on the site of an existing nuclear power plant previously found acceptable on the basis of a NEPA review and/or demonstrated to be environmentally satisfactory on the basis of operating experience, and sites assigned or allocated to an applicant by a State government from a list of State-approved power-plant sites. For such cases, the reviewer should analyze the applicant's site-selection process only as it applies to candidate sites other than the proposed site, and the site-comparison process may be restricted to a site-by-site comparison of these candidates with the proposed site. As a corollary, all nuclear power plant sites within the identified region of interest having an operating nuclear power plant or a construction permit issued by the NRC should be compared with the applicant's proposed site.

The information provided in this section is consistent with this special case. This section provides a description of the evaluation of a set of alternative locations for the proposed site that includes direct comparisons of their environmental suitability to the environmental suitability of the proposed site. The objective is to confirm that no site is "Environmentally Preferable" and thus not "Obviously Superior" to the proposed location of CCNPP Unit 3.

9.3.1 Site Selection Process

The site selection process focuses on identifying and evaluating locations that represent a range of reasonable *Alternative Sites* to the *Proposed Site*.

The primary objective of the site selection process is to determine if any *Alternative Site* is "Environmentally Preferable" and, if so, "Obviously Superior" to the *Proposed Site* for eventual construction and operation of the proposed reactor units. The basic constraints and limitations applicable to the site-selection process are the currently implemented rules, regulations, and laws within the federal, state, and local agency levels. These provide a comprehensive basis and an objective rationale under which this selection process is performed. As stated in NUREG-1555, Section 9.3:

> "Region of interest" (ROI) is the geographic area considered in searching for candidate sites. "Candidate sites" are those sites (at least four) that are within the region of interest and that are considered in the comparative evaluation of sites to be among the best that can reasonably be found for the siting of a nuclear power plant. "Proposed site" is the candidate site submitted to the NRC by the applicant, or by a person requesting an early site review pursuant to Appendix A to 10 CFR 50, as the proposed location for a nuclear power plant. "Alternative sites" are those candidate sites that are specifically compared to the proposed site to determine if there is an obviously superior site. An "environmentally preferable" alternative site is a site for which the environmental impacts are sufficiently less than for the proposed site so that environmental preference for the alternative site can be established.

The evaluation process follows NUREG-1555 and elements of the EPRI siting guide (EPRI, 2002). The alternative site evaluation process is shown in Figure 9.3-1 and is summarized as follows:

- Establish the Region of Interest (ROI)
  - Establish the basis for the ROI and define the ROI
  - Develop the basis for establishing a pool of sites to evaluate
  - Establish an initial base pool of sites to evaluate
- Determine *Candidate Areas* within the ROI
  - Establish exclusionary criteria (e.g., population centers)
  - Apply the exclusionary criteria to the ROI
- Identify list of *Potential Sites*
  - Establish de-select criteria (e.g., < 420 ac (170 ha))
  - Apply de-select criteria to sites located within *Candidate Areas* to establish *Potential Sites*
- Identify list of *Candidate Sites*
  - Confirm *Potential Sites* are licensable and otherwise viable sites for constructing a new nuclear power station to establish *Candidate Sites*
- Identify list of *Alternate Sites*
  - Score Potential Sites based on non-commercial weighted criteria (i.e., environmental basis)
    - Establish scoring criteria and basis
    - Establish weighting criteria and basis

- Score *Candidate Sites*
- Select the top 3 to 5 ranked *Candidate Sites* as *Alternate Sites*
- Compare the *Alternative Sites* to the *Proposed Site*
  - Apply weighted scoring to *Proposed Site*
  - Evaluate if any *Alternate Sites* are "Environmentally Preferable" to the *Proposed Site*
- If one or more of the *Alternate Sites* is significantly higher, then apply commercial scoring criteria to evaluate whether an *Alternate Site* is "Obviously Superior" to *Proposed Site*

9.3.1.1 Region of Interest

The first step in the alternative site selection process is to define and identify the ROI. As defined in NUREG-1555 Section 9.3 (NRC, 2007), the ROI is the largest area considered and is the geographic area within which sites suitable for the size and type of nuclear power generating facility proposed by the applicant are evaluated. As stated in ER Section 1.1, Proposed Action:

> The purpose is to build and operate a baseload merchant power plant that will generate needed power for Maryland.

A detailed discussion of the need for power in Maryland is provided in Chapter 8. The Maryland Public Service Commission (PSC) (MDPSC, 2007; Scholer, 2007) has identified that "Maryland suffers from a State-wide shortfall in net generating capacity", that nuclear provides the highest cumulative economic value added ("EVA") compared to the costs of all other energy scenarios, and an expectation that the needed electric power, to meet in-state demand, should not be imported into the state (i.e., generation from within the state boundary of MD) to ensure reliable and cost-effective power to the Maryland consumer. In addition, the PSCs Final Order in Case No. 9127 granting a Certificate of Public Convenience and Necessity (CPCN), for construction of Calvert Cliffs Nuclear Power Plant Unit 3 states that:

> The plant will constitute a new large source of power that would be of benefit to the citizens and State of Maryland, with record showing that such plant location at the site of an existing nuclear plant campus will reduce impacts, and with conditions accepted herein will meet all applicable environmental standards and requirements.

NUREG-1555 (NRC, 1999), Section 9.3, Alternative Sites states:

> The basis for an ROI is the State in which the proposed site is located or the relevant service area for the proposed plant.

Based on the aforementioned, the ROI is defined as the state of Maryland. The ROI is provided in Figure 9.3-2.

9.3.1.2 Candidate Areas and Candidate Sites

Various brownfield sites, remediation sites, and other power facilities were considered within the ROI. In excess of one thousand sites within the ROI were initially identified for consideration (UniStar, 2009). To be retained for further consideration, the location must meet the following criteria as outlined in NUREG-1555 (NRC, 1999), Section 9.3 (III).

- Consumptive use of water should not cause significant adverse effects on other users.
- There should not be any further endangerment of Federal, State, regional, local, and affected Native American tribal listed threatened, endangered, or candidate species.
- There should not be any potential significant impacts to spawning grounds or nursery areas of populations of important aquatic species on Federal, State, regional, local, and affected Native American tribal lists.
- Discharges of effluents into waterways should be in accordance with Federal, State, regional, local, and affected Native American tribal regulations and would not adversely impact efforts to meet water-quality objectives.
- There would be no preemption of or adverse impacts on land specially designated for environmental, recreational, or other special purposes.
- There would not be any potential significant impact on terrestrial and aquatic ecosystems, including wetlands, which are unique to the resource area.
- Population density and numbers conform to 10 CFR 100.
- There are no other significant issues that affect costs by more than 5% or that preclude the use of the site.

The information presented in 10 CFR 100 does not specify a permissible population density or total population within a zone because the situation may vary from case to case. NRC Regulatory Guide 4.7 (NRC, 1998) contains the same information as presented in 10 CFR 100, but adds the following specific criteria:

> *Preferably a reactor would be located so that, at the time of initial site approval and within about 5 years thereafter, the population density, including weighted transient population, averaged over any radial distance out to 20 miles (cumulative population at a distance divided by the circular area at that distance), does not exceed 500 persons per square mile. A reactor should not be located at a site whose population density is well in excess of the above value.*

As functional requirements, the site also needs to be located near a suitable cooling water source and within proximity to adequate transmission lines. The following exclusionary criteria were used to *identify the Candidate Areas* and narrow the list of sites to be retained for further consideration:

- Population – Not located in densely populated areas (that is, not located in an area with greater than or equal to 300 persons per square mile) (300 persons per 2.6 km^2) (Figure 9.3-3). Note that this criterion is more restrictive than that specified in Regulatory Guide 4.7 and thus conservative.
- Transmission – Not located more than 30 miles (48.3 km) from a 345-kV or higher transmission line. The 345-kV or higher transmission lines are needed for the EPR standard grid connection design (Figure 9.3-4).

- Dedicated Land – Not located on Dedicated Land (e.g., within national or state parks, tribal lands, etc.) (Figure 9.3-5)

- Water – Not located more than 15 miles (24.1 km) from a cooling water source capable of providing 50 million gallons per day (MGD) or more (Figure 9.3-6).

Figure 9.3-7 shows all of the exclusion areas combined.

The *Candidate Areas* are those areas within the ROI that remain after applying the four exclusionary criteria and are shown in Figure 9.3-8. The locations of various sites within the *Candidate Areas* are shown in Figure 9.3-9. It should be noted that the *Candidate Areas* reduced the initial pool of sites in the ROI to 206 sites.

The next step in the site selection process involves screening the remaining sites using refined criteria to identify *Potential Sites* for the placement of the proposed nuclear power station. A de-select criteria, as allowed by NUREG-1555 and the EPRI siting guide (EPRI, 2002), was applied to the list of sites within the candidate areas to narrow the list. At least 420 acres (170 ha) are needed to construct the U.S. EPR. Therefore, all sites with less than 420 acres (170 ha) were screened out in this step. This narrowed the list to the following potential sites:

- Bainbridge Naval Training Center
- BWI Airport
- Beiler Property
- Conowingo
- EASTALCO
- Thiokol Site
- Morgantown
- Sparrows Point

Consistent with the evaluation process summarized in Section 9.3.1, the next step in the process was to confirm whether the *Potential Sites* were licensable and otherwise viable sites for constructing a new nuclear power station to establish the list of *Candidate Sites*. Of these eight locations, the BWI Airport site and the Sparrows Point site were determined not to be licensable due to population density within a 20 mile radius of the site significantly exceeding NRC's Regulatory Guide 4.7 criterion of 500 ppsm and being within 1 mile proximity to a population center greater than 25,000 persons. In addition, the BWI Airport site is adjacent to a major commercial airport.

The Morgantown site was determined not to be a viable site for a new nuclear power station based on the fact that utilizing Morgantown as the site does not meet the "need for power". That is, removing an existing/operating 1486 MW facility such as Morgantown to replace it with 1600 MW for a net of 114 MW does not increase electric supply significantly and, as such, does not meet the need for power.

The Beiler site was determined not to be a viable option after obtaining reconnaissance level information (needed to support scoring) and cursory evaluations identified that; 1) the nearest water source, Sassafras Creek, does not meet 7Q10 volume requirements (metric based on lowest 7-day average flow with a ten year return frequency) and 2) the next nearest water source, the confluence of Sassafras Creek and Chesapeake Bay, which is over 12 miles away at its nearest point, is too shallow to support an inlet structure and would require significant dredging several more miles out which would be beyond the 15 mile exclusionary criterion for the cooling water source. As a result, the following four sites were identified as licensable and viable for continuing as *Candidate Sites* for the next step of the process:

- Bainbridge Naval Training Center
- Conowingo
- EASTALCO
- Thiokol Site

The locations of the *Candidate Sites* are shown in Figure 9.3-10.

The next step in the evaluation process. was to identify *Alternative Sites* by ranking the *Candidate Sites* based on a set of non-commercial criteria. This screening was accomplished using a table similar to Table 9.3-2 in NUREG-1555. The ranking criteria used in this process are described in Table 9.3-3 and the rationale for the criteria is given in Table 9.3-4. The criteria used to evaluate the *Candidate Sites* were drawn from a larger, more comprehensive set of criteria identified in Section 9.3 of NUREG-1555 and the EPRI siting guide (EPRI, 2002). A weighting value is also applied at this step to each of the criteria (Appendix D, UniStar, 2009). The summarized totals from the underlying assessment (UniStar, 2009) are provided in Table 9.3-5. The three sites with the highest scores are those selected for comparison as the "Alternative Sites."

After ranking, the following three sites were identified as *Alternative Sites*:

- Bainbridge Naval Training Center
- EASTALCO
- Thiokol Site

These *Alternative Sites* were compared to the *Proposed Site* in the final step of the alternative site evaluation. The locations of the *Alternatives Sites* and the *Proposed Site* are shown in Figure 9.3-11.

9.3.2 Proposed and Altenative Site Evaluation

Once the *Alternative Sites* are identified, the next step in the site evaluation process is to compare the *Alternative Sites* to the *Proposed Site* in a two-part sequential test to determine whether an *Alternative Site* was 1) "Environmentally Preferable" and 2) if so, if it is "Obviously Superior" to the "Proposed Site." The *Alternative Sites* that are compared with the *Proposed Site* are:

- Bainbridge Naval Training Center
- EASTALCO
- Thiokol Site

Additionally, the *Proposed Site* is compared to a "Generic Greenfield" site.

The *Alternatives Sites* were compared to the *Proposed Site* based on information about the existing sites and the surrounding area, as well as existing environmental studies and Final Environmental Impact Statements issued by the Atomic Energy Commission and/or the U.S. Nuclear Regulatory Commission and other reconnaissance level information. This comparison is performed to determine whether any alternative sites are "Environmentally Preferable" to the *Proposed Site*.

Based on the alternative site evaluation (UniStar, 2009), none of the *Alternative Sites* were determined to be "Environmentally Preferable" to the *Proposed Site*. If any of the *Alternative Sites* is determined to be "Environmentally Preferable" to the *Proposed Site* then the evaluation would have continued to the second step of the process. The second step of the process would have used commercially-based evaluation criteria to rank the *Proposed Site* and the "Alternative Site(s)" that were determined to be "Environmentally Preferable" to determine if any *Alternative Site* was "Obviously Superior".

Throughout this section, environmental impacts of the alternatives are assessed using the NRC three-level standard of significance - SMALL, MODERATE, or LARGE. This standard of significance was developed using Council on Environmental Quality guidelines set forth in the footnotes to Table B-1 of 10 CFR 51, Subpart A, Appendix B (CFR, 2007):

- SMALL: Environmental effects are not detectable or are so minor they will neither destabilize nor noticeably alter any important attribute of the resource.
- MODERATE: Environmental effects are sufficient to alter noticeably but not to destabilize important attributes of the resource.
- LARGE: Environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

In order to analyze the effects of building a new nuclear plant at each of these locations, it was assumed the construction and operation practices described in Chapters 4 and 5 would generally be carried to each site. In this manner, it was possible to apply a consistent description of the impacts to each site. For example, in order to assess impacts to transportation infrastructure, a traffic impact study, prepared for construction and outage activities at CCNPP, was reviewed. The study findings were applied to each site to determine potential impacts from construction.

9.3.2.1 CCNPP (Proposed Site)

The CCNPP site is the preferred site for locating the new nuclear reactor. The CCNPP site is located in Maryland on the Chesapeake Bay southeast and adjacent to CCNPP Units 1 and 2. A detailed description of the CCNPP site and surroundings, environmental impacts of construction, and environmental impacts of operation are given in Chapter 2, Chapter 4, and Chapter 5. This information is summarized below.

9.3.2.1.1 Land Use

Land use in the area surrounding the CCNPP site is predominantly rural. Hunting is common in the region surrounding the plant because large areas are rural and forested. Less than 5% of the county land uses are classified as commercial or industrial. Land use impacts associated with the construction and operation of CCNPP Unit 3 are discussed in greater detail in Section 4.1 and Section 5.1, respectively. Overall land use impacts are anticipated to be SMALL for both construction and operation activities because of distance to population centers and population density.

9.3.2.1.2 Air Quality

Calvert County is in attainment with all National Ambient Air Quality Standards except for ozone. Because of its proximity to Washington, DC, the county is classified as a serious non-attainment zone for ozone. Moreover, because the CCNPP site is located in a serious non-attainment zone for ozone and has the potential to emit greater than 50 tons per year for both volatile organic compounds and nitrogen oxides, the facility is classified as a major source of these substances. Air quality impacts associated with the construction and operation of CCNPP Unit 3 are discussed in greater detail in Section 4.4.1 and Section 5.8.1, respectively. Air quality impacts are anticipated to be MODERATE for both construction and operation activities due to the potential plant emissions.

9.3.2.1.3 Water

The CCNPP site is located on the western shore of the Chesapeake Bay, which is an estuary approximately 200 mi (320 km) long and up to 35 mi (56 km) wide. Makeup water for the plant would be drawn from Chesapeake Bay as discussed in Chapters 4 and 5. The impacts to water resources are expected to be SMALL and would be less than or similar to impacts due to the existing reactors at the site. Groundwater at the site occurs at depths near 30 ft (9 m) and flows toward the Chesapeake Bay. The artesian aquifer from which water would be drawn during construction is approximately 550 ft (167 m) below ground surface and approximately 100 ft (30 m) thick. This aquifer underlies much of Maryland. Current groundwater use at the site for existing operational and domestic use does not noticeably alter offsite groundwater characteristics.

Operational fresh water needs will be provided by desalination of Chesapeake Bay water, so there will be no impacts on groundwater during operation. Additional groundwater withdrawals will be required for constructing the new reactor, so would be temporary and are not expected to destabilize offsite groundwater resources. Water impacts are discussed in greater detail in Section 4.2 and Section 5.2.

Due to the large size of both the surface water and groundwater resources and the current rural nature of the area and resultant low usage of these resources, impacts to water resources at the site from construction and operation of the new reactor unit are anticipated to be SMALL.

9.3.2.1.4 Terrestrial Ecology and Sensitive Species

The CCNPP site is largely forested and situated among other large forested tracts. Together these tracts form one contiguous and predominantly undeveloped forested area. The State of Maryland prepared a Wildlife Management Plan for the CCNPP site in 1987, and Baltimore Gas and Electric updated the plan in 1993 to include several habitat enhancement projects. The Wildlife Habitat Council has certified and registered the CCNPP site as a valuable corporate wildlife habitat.

The federally listed threatened puritan tiger beetle (*Cicindela puritana*) and the northeastern beach tiger beetle (*Cicindela dorsaliscan*) can be found at the base of the cliffs on the CCNPP site along the beach south of the barge dock. The bald eagle, which is federally protected under the Bald and Golden Eagle Act, has active nests on the CCNPP site. One state-listed terrestrial species, showy goldenrod (*Solidago speciosa*) was determined from ecological surveys to be present within the limits of disturbance for the CCNPP Unit 3 location. Terrestrial ecology impacts from the construction and operation of CCNPP Unit 3 are discussed in greater detail in Section 4.3.1, Section 5.3.3.2, and Section 5.6.1.

No significant impacts to the terrestrial ecosystems would be expected once construction of the new reactor is complete. Therefore, the impacts of construction may be MODERATE due to presence of federal and state threatened and endangered habitats/species disruptions; however, the impacts of operation would be SMALL.

9.3.2.1.5 Aquatic Ecology and Sensitive Species

The area of the Chesapeake Bay where the CCNPP site is located is in the mesohaline zone, which is characterized by moderate salinity. Recreationally and commercially important shellfish and finfish found in large numbers in the vicinity of the plant during pre-operational surveys included the eastern oyster (*Crassostrea virginica*), blue crab (*Callinectes sapidus*), striped bass (*Morone saxatilis*), and weakfish (*Cynoscion regalis*).

Two fish and two sea turtle species in the project area are afforded special protection under the Endangered Species Act: the Shortnose and Atlantic Sturgeon, and the Loggerhead and Kemp's Ridley Turtle.

The Shortnose Sturgeon (*Acipenser brevirostrum*) , is known to inhabit the Chesapeake Bay. However, this species has not been observed in the extensive impingement studies conducted at the CCNPP site area over the past 30 years.

A larger, longer-lived relative of the Shortnose Sturgeon, the Atlantic Sturgeon (*Acipenser oxyrhynchus*) once supported a robust fishery in the Chesapeake Bay. It is currently on the candidate species list maintained by NOAA Fisheries, because it is undergoing a status review under the Endangered Species Act.

Loggerheads (*Caretta caretta*) occur throughout the temperate and tropical regions of the Atlantic, Pacific, and Indian Oceans. The Loggerhead is the most abundant species of sea turtle found in U.S. coastal waters, including the Chesapeake Bay. At the global level, the primary threat to Loggerhead turtle populations is incidental capture in fishing gear, especially in longlines and gillnets, but also in trawls, traps and pots, and dredges. NOAA Fisheries is currently implementing a program to evaluate the incidence of bycatch of sea turtles in various types of gear, including pound nets in the Chesapeake Bay.

The Kemp's Ridley Turtle (*Lepidochelys kempil*) is one of the smallest of the sea turtles, with adults reaching about 2 ft (0.6 m) in length and weighing up to 100 lbs. The Kemp's Ridley Turtle has been on the endangered species list since 1970. The principal threats to this species occur on the nesting beaches, where both deliberate and accidental disturbances interfere with nesting success and in accidental take by fisheries vessels.

Construction impacts would be primarily due to runoff and siltation and will be controlled by best management practices and compliance with permit requirements. Aquatic ecology impacts at the CCNPP Unit 3 site from construction and operation activities are discussed in Section 4.3.2, Section 5.3.1.2, Section 5.3.2.2, and Section 5.6.2.

Because no sensitive species are known to occur in the vicinity and the new reactor is expected to have a similar impact to the existing reactor, construction and operation of the new reactor at this site is expected have a SMALL impact on the aquatic ecology in the Chesapeake Bay.

9.3.2.1.6 Socioeconomics

The evaluation of socioeconomic impacts that may result from the construction and operation of a third unit at the Calvert Cliffs site was based on selection of a Region of Influence (ROI) and the area encompassed by the 50 mile radius. The ROI for this site included St. Mary's and Calvert counties since over 91% of the current CCNPP workforce resides in these two counties. For purposes of assessing the impact of in-migration of the construction and operations workforces, a range of in-migration between 20 and 35% was chosen based on previous studies (See ER Chapters 2.5.1, 2.5.2, 4.4.2 and 5.8.2).

The estimated population of Calvert County in 2000 was approximately 74,563 people and increased to an estimated 86,000 people in 2004 and approximately 87,539 people in 2005-2007 (USCB, 2009) (ER Section 2.5.1). The estimated population of St. Mary's County in 2000 was approximately 86,211 people and had increased to an estimated 98,650 people in 2005-2007. Within the 50 mile radius of CCNPP Unit 3, there were an estimated 3,195,170 people based on the 2000 census. Population density within Calvert and St. Mary's counties was 376.5 and 238.6 people per square mile (ppsm) compared to 541.9 within the state of Maryland (ER Section 2.5.1). The median household income in Calvert County in 2000 was approximately $65,945 and had increased to $88,989 in 2005-2007. In the same period, the median household income of St. Mary's County had increased from approximately $54,706 to $71,559 (USCB, 2009).

Socioeconomic impacts associated with the construction and operation of CCNPP Unit 3 are discussed in greater detail in Section 4.4 and Section 5.8, respectively. The total number of construction workers was estimated to peak at approximately 3,950 direct workers. About 363 workers would be needed during operations. Under the 20% in-migration scenario, it was estimated that approximately 720 construction workers would migrate into the ROI. With 1,160 family members, the total increase in population size would be about 1,880 people. Of these about 1,400 people would in-migrate into Calvert County and 475 into St. Mary's County. Assuming 35% in-migration, a total of 1,260 direct construction workers would in-migrate into the ROI resulting in about 3,285 new residents; 2,455 in Calvert County and 830 in St. Mary's County.

These increases would result in a small impact to the area economy, representing a maximum 4.0% increase in the 39,341 total labor force in Calvert County in 2000 and 1.2% in the 46,032 total labor force in St. Mary's County (ER Section 4.4.2).

Based on the 2000 census there were approximately 5,568 total housing units vacant within the ROI. The number of in-migrating households under the 20% and 35% scenarios were estimated to represent less than 12.9% and 22.6% of these available housing units. In addition, the number of new residents was not expected to exceed existing capacity of public services including emergency response and schools. Numerous recreational opportunities were available in the area, many associated with the proximity of Chesapeake Bay.

A net benefit of the migration of workers and their families into the ROI would be the additional income from direct and indirect employment and increases in local and county tax revenues. Under the 35% in-migration, the estimated increase in annual income from construction workers would total about $66.5 million in Calvert County and $22.5 million annually in St. Mary's County. Tax revenues from the facility construction and operations while substantial would still represent only a small portion of county revenues. Tax revenues in Calvert County in 2005 were about $174.1 million and about $145.2 million in St. Mary's County.

Although construction and operation of a new reactor would create both temporary and permanent jobs, the percent of the population employed by the new plant, and therefore the effect of the new reactor on the area's population, is expected to be SMALL.

9.3.2.1.7 Transportation

Calvert County has one main four-lane road (Maryland State Highway 2/4) bisecting the County north to south with smaller roads running like veins from the main road to the water on each side. Very few of the smaller roads off Maryland State Highway 2/4 connect with each other; therefore, this highway services the bulk of the traffic for the length of the County. This highway runs adjacent to the CCNPP site and provides the only access to the site.

A traffic study prepared for construction at CCNPP predicts that construction traffic will peak above 1,450 vehicles per hour (Vph). Heavy vehicle shipments and construction traffic will make up most of the traffic, assuming a peak construction workforce of about 3,950 workers (calculated at 1.3 occupants per vehicle). It is anticipated that Calvert Beach Road and Nursery Road will be most heavily affected, but the impacts would occur during morning and evening commutes to the plant. Impacts on that road would be temporary, and likely end after construction was finished. Other roadways will likely be able to sustain the increase in traffic.

There are several ways to mitigate the potential transportation impacts during construction such as developing a construction traffic management plan prior to construction to address potential impacts on local roadways. If necessary, coordinating with local planning authorities for the upgrading of local roads, intersections, and signals to handle increased traffic loads could be considered.

The impacts of transportation from construction and operation of CCNPP Unit 3 and associated mitigation measures are discussed in greater detail in Section 4.4.1 and Section 5.8.2, respectively.

Schedules during workforce shift changes and for the delivery of larger pieces of equipment or structures could be coordinated to limit impacts on local roads. In addition the use of shared (e.g., carpooling) and multi-person transport (e.g., buses) during construction and/or operation of the facility could be encouraged. By implementing appropriate measures, it is expected that there would be SMALL to MODERATE impacts on transportation during construction activities and SMALL impact during operation of the facility.

9.3.2.1.8 Historic, Cultural, and Archeological Resources

There are eight historic sites within a 5 mi (8.0 km) radius of CCNPP site listed on the National Register of Historic Places. As described in Sections 11.D and XII.E of the Final Environmental Statement for CCNPP Units 1 and 2, two historic dwellings located on the original Calvert Cliffs site were evaluated by the Maryland Historical Trust and found to be too derelict to be nominated for inclusion on the National Register. However, photographs and some architectural elements of the structures were salvaged and are displayed in the Visitors Center (a remodeled old tobacco barn) onsite.

During 1992 and 1993, archeological surveys were conducted along a proposed South Circuit transmission line and right-of-way. As a result, two archeological sites were examined extensively during an evaluatory testing phase. One prehistoric site was found to retain sufficient subsurface integrity to be considered eligible for inclusion on the National Register of Historic Places. The impact areas of the site were evaluated extensively, and towers were located in areas that would not affect any intact subsurface deposits.

Potential impacts to historic, cultural, and archeological resources from the construction and operation of CCNPP Unit 3 are discussed in greater detail in Section 4.1.3 and Section 5.1.3, respectively.

It is anticipated that historic and cultural impacts would be SMALL to MODERATE given the secluded location of the CCNPP site and that appropriate mitigation will occur in coordination with the State Historic Preservation Officer prior to and during construction of the facility.

9.3.2.1.9 Environmental Justice

Within the 50 mile radius of CCNPP Unit 3, there were a total of 1,116 census block groups and, of these, a total of 714 census block groups met at least one of the criteria defined as minority population. Most of the African-American minority populations existed within the Washington D.C. metropolitan area. Of the 41 census block groups in Calvert County, none were defined as being a racial minority or Hispanic minority population. Two of the 55 census block groups in St. Mary's County met the criteria for aggregate minority but no census block group met the definition of having an individual racial minority or Hispanic population. Similarly, there were no low income census block groups in Calvert County and only one in St. Mary's County. As a result, the likelihood of minority or low income populations being disproportionately and adversely affected by this plant is SMALL.

Environmental justice impacts from the construction and operation of CCNPP Unit 3 are discussed in greater detail in Section 4.4.3 and Section 5.8.3, respectively.

9.3.2.1.10 Transmission Corridors

The existing CCNPP transmission facilities consist of three separate three-phase, 500 kV transmission lines. Two circuits deliver power to the Waugh Chapel substation and a third line connects to the Chalk Point generating station.

Transmission corridors and towers would be situated (if possible) in existing right-of-way to avoid critical or sensitive habitats/species as much as possible. Specific monitoring requirements for new transmission lines and corridors, and associated switchyards will be designed to meet conditions of applicable Federal, State, and Local permits, to minimize adverse environmental impacts, and to ensure that organisms are protected against transmission line alterations.

Transmission system environmental impacts due to the construction and operation of CCNPP Unit 3 are discussed in greater detail in Section 4.1.2 and Section 5.6, respectively. Due to the rural nature of the areas that would be transected by these transmission lines, any impacts are expected to be SMALL in nature.

9.3.2.2 Bainbridge Naval Training Center (Alternative Site 1)

The Bainbridge Site is located at a deactivated naval training center in Port Deposit, Cecil County, MD (Figure 9.3-12 and Figure 9.3-13). The Bainbridge Naval Training Center was deactivated in 1976. Part of the site was used by the Department of Labor as a Job Corps Training Center until 1990 (EPA, 2009a). In 2000, after remediation activities were completed, the Bainbridge site was transferred to the Bainbridge Development Corporation (BDC). The BDC was established to develop the Bainbridge Naval Training Center site and accelerate transfer of the site to the private sector (BDC, 2009).

9.3.2.2.1 Land Use

The Bainbridge site has an overall area of approximately 1,185 acres (480 hectares) (EPA, 2000). The structures that were used at the Bainbridge site have largely been demolished. The structures that remain are decrepit and are generally concentrated within several areas.

The Bainbridge site is located in Port Deposit, Cecil County, MD. The site is located adjacent to the Port Deposit town center. The southwestern edge (approximately 0.5 miles (0.8 km)) of the site is parallel to and less than a 0.1 mi (0.2 km) from the Susquehanna River. The site rises away from the river to the top of a hill, where the site becomes relatively flat. The site is currently used for truck driver training and bow hunting. Otherwise, the site resembles an abandoned industrial area (BDC, 2009 and Site inspection, July 3, 2009).

The site contains a sanitary landfill along the western edge (EPA, 2009a; MDE, 2009). The landfill is closed and has a grass cap. The areas of the site where military installations existed are overgrown with vegetation. The fence surrounding the site property is also overgrown with vegetation to the point of obscuring the existence of the fence in many places. The portions of the site that never supported buildings or naval activities are either forested or scrub (BDC, 2009 and Site inspection, July 3, 2009).

According to the Port Deposit website and Zoning Maps the Bainbridge Site is zoned as BSU-Bainbridge Special Use (Town of Port Deposit, 2009) and is located within the State of Maryland's Cecil County Enterprise Zone (Cecil County Office of Economic Development [CCOED], 2009; Maryland Department of Business and Economic Development [MDBED], 2009a).

The area around the site supports agricultural activity (farms), river-related recreational activities/businesses (e.g., boating and fishing), and housing.

While there is a significant degree of topographic relief at the site (262 feet total), the great majority of this grade change occurs near or along the bluff adjacent to the Susquehanna River (the bluff itself is approximately 142 feet high). This would not significantly affect development of the 420 acre (170 hectare) EPR site, which is relatively flat across approximately 70 percent of the site. Hence, cut and fill requirements for construction would be minimal except within a limited area of the site that is impacted by steeper relief sloping toward the bluff and for which cut and fill requirements for construction would be moderate. The site can easily accommodate the 420 acres (170 hectares) needed for the construction of an EPR Nuclear Power Plant.

Figure 9.3-12 shows the map location of Port Deposit, MD. Figure 9.3-13 is an aerial photograph of the site showing the existing property boundary. Figure 9.3-13 also has a 420-acre footprint comparable to the proposed Calvert Cliffs Unit 3 footprint superimposed to demonstrate the adequacy of the location to accommodate the proposed nuclear power plant. The location of the footprint is within the overall property boundary but is not intended to show an actual proposed location for the Plant. Although nuclear power plant structures would occupy only a portion of the 420 acre area, the construction process would result in some impact to an entire area.

The site contains two areas (the Old Base Landfill and Fire Training Area) where previous contamination has not been completely removed. The selected remedies for these locations are institutional controls (deed restrictions on the landfill cap and ground water use restrictions).

The Bainbridge site is not designated as a National Priority List (NPL) Site or a Voluntary Cleanup Program Site. However, some demolition of structures and some environmental remediation may be required.

Based upon GIS estimates, the nearest (Federal, State, or Tribal) dedicated land, Deer Creek Park, is approximately 6.9 mi (11.1 km) from the site.

The Bainbridge site is within 0.1 mi (0.2 km) from the Susquehanna River, its potential source of water. It would be necessary to acquire a small amount riverfront land sufficient for an intake, major pumping station and ancillary structures as well as additional land for the construction of a pipeline large enough to provide approximately 50 million gallons per day (mgd) (189 million liters per day (mld)) of river water to the plant site. A pipeline would necessarily cross both railroad tracks and several local roads; however, no major roads are located between the river and the plant site.

Overall land use impacts are expected to be SMALL or MODERATE due to existing environmental remediation needs and topography.

9.3.2.2.2 Air Quality

The Bainbridge site lies in a non-attainment area for 8 hour ozone (EPA, 2009b). Typically, the emissions from nuclear power plants are low enough to avoid triggering nonattainment area new source review because of the low emissions associated with plant operation. However, emissions from auxiliary equipment including Emergency Diesel Electric Generators and Diesel-driven Fire Water Pumps will require some level of permitting action. The air quality impacts of construction both from offsite transportation and onsite activities would also require regulatory consideration. Once the plant was completed, ongoing emission contributions associated with transportation of operating staff and periodic outage workers are expected to be small.

The proposed facility will contain a cooling tower that will emit water vapor and particulate matter to the atmosphere. Because of the exceptionally low level of emissions, operation activities are not expected to cause or contribute to a violation of any state or federal ambient air quality standards.

The Bainbridge site is at least 80 mi (129 km) from the closest Class 1 PSD area (EPA, 2009c; NPS, 2009a).

Overall air quality impacts to the surrounding area attributable to the construction and operation of the proposed facility would be SMALL due to adherence to regulatory requirements during construction and the typically low emissions for an operating nuclear power plant.

9.3.2.2.3 Water

The Bainbridge site lies less than 0.1 mi (0.2 km) from the Susquehanna River, the only sufficiently large source of water. The segment of the Susquehanna River proposed to be the source of cooling water is designated as tidal fresh water estuary (COMAR, 2009a). This portion of the Northern Chesapeake Bay (segment designator CB1TF2) surface water segment is part of the Lower Susquehanna River Area Sub-Basin.

The segment of the Lower Susquehanna River Sub-Basin considered as a potential cooling water source does not have a special water quality classification (COMAR, 2009b). The Surface

Water Use Designation for the Northern Chesapeake Bay (CB1TF2) segment is Use II-P: Support of Estuarine and Marine Aquatic Life and Shellfish Harvesting and Public Water Supplies (COMAR, 2009b).

Impacts to hydrology and consumptive water use will be primarily associated with water withdrawal from the main source of water. Consumptive water use is associated with evaporative cooling attributable to the use of closed cycle cooling systems that require the use of cooling towers for heat rejection from both the main steam condensers and plant auxiliary heat exchangers. The total water usage of the proposed facility at the Bainbridge Naval Training Center site is estimated to be 50 mgd (189 mld).

The main source of water for the proposed site will be the Susquehanna River. The low flow value for the period of record (42 years) for the river at the nearest USGS gage (01578310 at downstream side of Conowingo Dam, 1.0 mi (1.6 km) southwest of Conowingo, Maryland, and 9.9 mi (15.9 km) upstream from mouth) is approximately 93 mgd (352 mld) (USGS, 2009). The water usage of a nuclear power plant could be as high as approximately 54% of the lowest recorded value at the downstream side of the Conowingo Dam.

The existing hydrology may also be altered by the construction of temporary roads, parking areas, areas for stockpiling and assembly of construction materials, the development of measures for storm water control, erosion and sediment control and the construction of a river side intake structure and pipeline.

Groundwater impacts at this site would be minimal as it is unlikely that groundwater would be needed for plant operations; however, it would probably be necessary to temporarily utilize groundwater during construction. The quantities of construction water needed have not been determined for this site.

Although the site is close to the nearest source of cooling water, a determination regarding the provision of cooling water during design accident conditions would be required as an Ultimate Heat Sink (UHS) for this site. This is a Safety-Related requirement and the determination would entail physical security issues associated with the required waterfront structures and pipeline. In the absence of adequate security for the emergency cooling water supply, it would be necessary to construct a cooling water impoundment to be part of the nuclear power plant's UHS. The reservoir will be designed and configured to avoid interface with the groundwater table. Final design will address soil type and depth to water table. Measures such as clay liners will be used as appropriate. Based upon studies performed for the Calvert Cliffs Unit 3 plant, an impoundment with a surface area of approximately 4.7 acres and 25 feet deep with sloped sides at a 3:1 horizontal to vertical ratio would be required; however the actual dimensions would necessarily be influenced by local geology and hydrology. The 420 acre footprint provided for the proposed plant is sufficient to accommodate such an impoundment if required.

Water discharges from the plant would include cooling tower blowdown, treated process wastewater, treated sanitary wastewater and small amounts of radioactive water. Cooling tower blowdown also represents a thermal effluent to the receiving waters. Notwithstanding the use of potential engineered mitigation, these discharges would have some impact on the receiving waters. The manner of return of these effluents to the river has not been established at this time.

Overall water related impacts to the surrounding area attributable to the construction and operation of the proposed facility would be MODERATE due to the fraction of available water that may be pulled from the Susquehanna under low flow conditions.

9.3.2.2.4 Terrestrial Ecology and Sensitive Species

The Bainbridge Naval Training Center site is located in Cecil County, Maryland. The site consists principally of wooded areas, grasslands (mostly on the sanitary landfill), scrub, and previous training center areas (concrete base mats, pavement) being reclaimed by vegetation. The area surrounding the plant site is principally agricultural and residential, with some undeveloped areas. Wooded areas on the site are mostly mixed deciduous forested area. One percent of the site is within a FEMA-identified 100 or 500 year floodplain (USFWS, 2009c).

According to the National Wetlands Inventory, the project site has no wetlands (USFWS, 2008a). On-site construction wetlands-related impacts are therefore expected to be insignificant. See Table 9.3-12, Table 9.3-13, and Table 9.3-14 for wetlands/waterways information.

The mixed-deciduous forests at the Bainbridge Naval Training Center sites would likely include ecologically important species: tulip poplar, chestnut oak, and mountain laurel.

Common recreationally important terrestrial species potentially occurring within the vicinity of all three alternative sites, including the pipeline corridors, are the white-tail deer, wild turkey, northern bobwhite, and ring-necked pheasant. The white-tail deer occupies a variety of habitats (including forests, farms, wetlands, and other rural and urban areas), and would likely occur at all three proposed alternative sites (MDNR, 2009e). Wild turkeys are typically found in mature hardwood and pine forests and grassy fields (MDNR, 2009f). Turkey habitat is not optimal at the Bainbridge Naval Training Center. The northern bobwhite and ring-necked pheasant both occupy recently disturbed and early-successional habitats such as fallowed fields, brushy fencerows, and recently cleared forests (MDNR, 2007a). These species would likely occur at or in the immediate vicinity of the Bainbridge Naval Training Center sites as a result of the agricultural land use in the area.

A listing of current and historical rare, threatened, and endangered species of Cecil County is provided in Table 9.3-6. According to the Maryland Department of Natural Resources, Cecil County has five federally listed special status species, four animal and one plant. Special status state species include 12 animal and 108 plant species (MDNR, 2009c; MDNR, 2009d). The State's database contains a record for one federally-listed species and one state listed species as occurring adjacent to the project site.

To aid in estimation of which species listed in Table 9.3-6 may actually exist on the Bainbridge Naval Training Center site, a screening level evaluation of the site, as compared to the known and documented habitat and life cycle requirements of the individual species, was completed. Using this approach, many of the potential species listed may be considered highly unlikely to exist on the site or be potentially affected by nuclear facility construction and operation. The following key factors are presented to support the likely presence or absence of the species included in Table 9.3-5:

<u>Federally-Protected Species Occurring in Cecil County, Maryland</u>

- The Bainbridge Naval Training Center contains no groundwater-influenced, perennially saturated wetlands. Absent this specialized habitat, the swamp pink would not occur on the site (NatureServe Explorer, 2009a; Rhoads and Block, 2007; Weakley, 2009).

- The puritan tiger beetle uses the sandy frequently disturbed bases of river bluffs in Maryland (USFWS, 1993a). There is no suitable habitat at or adjacent to the Bainbridge Naval Training Center and the species would not be likely to occur there. The river banks where the proposed water intake and cooling water discharge would be located do not provide suitable habitat for this species.

- The Bainbridge Naval Training Center contains no open canopy sedge meadows or fens. Absent this specialized habitat, the bog turtle would not occur on the site (USFWS, 2001).

- The bald eagle may occur along the Susquehanna River as a transient or to forage. There are no suitable nest or roost trees on the Bainbridge Naval Training Center site and the site contains no open water areas that would be suitable for foraging (Sibley, 2000). Therefore, the bald eagle would not be expected to occur on the site. The bald eagle may forage along the Susquehanna and Sassafras Rivers near the Bainbridge Naval Training Center site, but would not be impacted by the construction and operation of the facility.

- The forested land on the site could support the Delmarva fox squirrel, but is marginal due to the lack of large diameter trees, relatively dense shrub layer, and lack of nearby row crop production (USFWS, 1993b). The Delmarva fox squirrel is unlikely to occur on the Bainbridge Naval Training Center site.

Impacts to federally-protected terrestrial species are unlikely at the Bainbridge Naval Training Center site. There is potential for impacts to the shortnose sturgeon from installation of water intake and discharge structures, but mitigation features designed into the project would minimize that potential. The potential for impacts to federally-protected aquatic species is SMALL.

The potential for impacts to the Delmarva fox squirrel from construction and operation of the facility and from installation of water and electrical transmission lines is SMALL. No other federally-protected terrestrial species would be impacted by the project.

<u>State-Protected Species Occurring in Cecil County, Maryland</u>

There are 24 species tracked by the Maryland Department of Natural Resources with historical records from Cecil County that are classified as extirpated in Maryland (Table 9.3-6). None of these species would be expected to occur on the Bainbridge Naval Training Center.

There are 36 species tracked by the Maryland Department of Natural Resources that are known to occur in Cecil County that are not protected by the State of Maryland (Table 9.3-6). None of these species is further considered, as they have no legal status within the state.

- The least bittern is restricted to marsh habitats (Sibley, 2000) that do not occur on the Bainbridge Naval Training Center site. This species would not occur on the site because there are no marshes present.

- There are 29 state-protected plant species that are known to occur in Cecil County that are restricted to wetland habitats (Table 9.3-6 in ER; Rhoads and Block, 2007; Weakley, 2009). There are no wetlands on the Bainbridge Naval Training Center. None of these 29 species would be expected to occur on the site.

- Sandbar willow, broad-glumed brome, halberd-leaved greenbrier, sweet-scented Indian plantain, and veined skullcap are restricted to alluvial habitats or riverbanks (Rhoads and Block, 2007; Weakley, 2009). No alluvial habitats occur on the Bainbridge Naval Training Center and none of these species would be expected to occur on the site. The species could occur along the Susquehanna River where the water intake and cooling water outfall would be placed. Site selection would avoid impacts to these species should they occur there.

- Leonard's skullcap, fringed gentian, purple clematis, rustling wild petunia, tall tickseed, leatherwood, Darlington's spurge, Torrey's mountain-mint, dwarf prairie willow, tufted hairgrass, serpentine aster, northern dropseed, Seneca snakeroot, Hitchcock's sedge, and Indian paintbrush are restricted to circumneutral to ultramafic soils (Rhoads and Block, 2007; Weakley, 2009). No soils of these types occur on the Bainbridge Naval Training Center and these species would not be expected to occur on the site.

- Fameflower, Standley's goosefoot, and rock sandwort are restricted to exposed rock outcrops (Rhoads and Block, 2007; Weakley, 2009). These specialized habitats do not occur on the Bainbridge Naval Training Center. Neither of these species would be likely to occur there.

- Velvety sedge occurs only in low moist woods (Rhoads and Block, 2007; Weakley, 2009). There is no suitable habitat for this species on the Bainbridge Naval Training Center site.

Of the state-protected plants known to occur in Cecil County, there are 32 species that could potentially occur on the proposed facility site at the Bainbridge Naval Training Center, and these species are included in Table 9.3-6. Of these species, it is unlikely that many, if any, of these species would actually occur on the site. Mitigation measures that would be implemented during construction would minimize the potential for direct impacts. Any impacts to state-protected terrestrial species would likely be SMALL.

There is potential for impacts to the logperch, creeper, and map turtle, but mitigation features designed into the project would minimize that potential. The potential for impacts to state-protected aquatic species is SMALL.

The proposed water lines for the Bainbridge Naval Training Center site would follow U.S. Highway 222 and be within or adjacent to previously disturbed land for most of their length. The potential for impacts to state-protected species from installation of the water lines would be SMALL.

Impacts of construction on the terrestrial ecosystem include noise, clearing and grading and the aforementioned potential hydrological changes. Construction of the facility could result in the direct mortality of some common species and available habitat would be reduced but would not adversely affect local or regional populations of wildlife species. Species that are mobile are likely to relocate to adjacent lands.

There are four existing 500Kv transmission lines available for possible interconnection: one is 5 mi north of the site and the other three are between 10 mi (16 km) and 20 mi (32 km) away from the site. There are five existing 230Kv transmission lines within 5 mi (8 km) of the proposed Bainbridge Naval Training site, and there are six 230Kv transmission lines between

10 mi (16 km) and 20 mi (32 km) away from the site. Because new right-of-way (ROW) would need to be constructed to accommodate the new transmission lines, it is anticipated that there would be terrestrial ecology impacts from the development of new transmission corridors requiring long-term standard ROW vegetation management (from the regional transmission utility). The terrestrial ecology impacts from construction of the facility and the ancillary water pipeline and transmission line corridors are anticipated to be MODERATE but would be minimized by searching for sensitive species and complying with permit and mitigation requirements before beginning work.

9.3.2.2.5 Aquatic Ecology and Sensitive Species

The site is located approximately a tenth of a mile from the Susquehanna River, contains several small ponds and no streams or other wetlands onsite. See Table 9.3-12, Table 9.3-13, and Table 9.3-14 for wetlands/waterways information. This site would use the freshwater portion of the Susquehanna River for cooling water. The segment of the Susquehanna River proposed to be the source of cooling water is designated as tidal fresh water estuary.

Maryland's variety of freshwater, saltwater, and estuarine habitats has created several commercially and recreationally important fisheries. The freshwater fisheries are primarily recreationally important and include the following species: largemouth and smallmouth bass, channel catfish, madtoms, chain pickerel (pike), crappie (white and black), eels, herring (alewife and blueback), muskellunge/tiger muskie, northern pike, shad (American and hickory), striped bass, sunfish, trout, walleye and yellow perch. Most of these species would likely occur in the rivers and large streams adjacent to the three proposed alternative sites. Trout species prefer colder water habitats and would not occur within the vicinity of the proposed sites.

The blue crab, oyster, and striped bass are the primary commercially important fisheries in Maryland. Blue crab and oysters prefer the brackish waters of the Chesapeake Bay and would not likely occur at or adjacent to the proposed sites. The striped bass is an anadromous species, meaning they live most of their lives in marine habitats and migrate up large rivers to spawn in freshwater habitats (MDNR, 2007f). The striped bass could occur in the Susquehanna River adjacent to the Bainbridge Naval Training Center.

Federally-Protected Species Occurring in Cecil County, Maryland

- The shortnose sturgeon would not occur on the Bainbridge Naval Training Center, but is known to occur in the Susquehanna and Sassafras Rivers and downstream in Chesapeake Bay (MDNR, 2009g). Installation of water intake structure and cooling water discharge structure could impact shortnose sturgeon, but the species would likely avoid the area during construction and thereby avoid direct impacts from construction, and compliance with CWA 316b regulations and thermal effluent mitigation would minimize the potential for long-term impacts to the species.

State-Protected Species Occurring in Cecil County, Maryland

- The hellbender, logperch, and creeper are aquatic animals and would not occur on the Bainbridge Naval Training Center as there are no aquatic habitats on the site. The map turtle is associated with river systems and adjacent lands. The map turtle would not occur on the Bainbridge Naval Training Center as it is separated from the Susquehanna River by a bluff and railroad track. The hellbender is only known from Cecil County from historical records and would not occur in the Susquehanna River downstream of the site. The logperch, creeper, and map turtle could occur in the

Susquehanna River downstream of the site (MDNRd, 2009b; NatureServe Explorer, 2009b; NatureServe Explorer, 2009c; NatureServe Explorer, 2009d). Installation of water intake structure and cooling water discharge structure could impact these three species, but they would likely avoid the area during construction and thereby avoid direct impacts from construction. Compliance with CWA 316b regulations and thermal effluent mitigation would minimize the potential for long-term impacts to the logperch, creeper, and map turtle.

Construction related aquatic ecological impacts would include temporary loss of habitat and short term degradation of water quality as a result of in-river and shoreline construction of water intake and discharge structures. Some amount of dredging in the river will be necessary and best practices for minimizing turbidity and for the containment of sediments would be implemented to minimize the impacts on benthic and other organisms. Removed dredge spoil from a small area will remove some benthic organisms but this represents a small impact. During dredging operations fin fish would tend to avoid the immediate area perhaps feeding on entrained organisms downstream of the construction location.

The use of water withdrawn from the Susquehanna River through a waterfront intake structure will entail impingement and entrainment impacts to aquatic organisms. The use of Cooling Towers at the site along with intake structures designed to mitigate such impacts would allow the plant to comply with CWA, 316b regulations.

Construction of a nuclear power plant with closed cycle cooling will introduce thermal discharges to the receiving waters in the form of cooling tower blowdown assuming that it is discharged directly to the river. Blowdown would represent only a small fraction of the water withdrawn from the river and its impact would be mitigated by the use of engineered diffusers or other means.

Adverse aquatic ecology impacts associated with construction and operation are anticipated to be SMALL to MODERATE based on the ability to avoid impacts to threatened and endangered species and through use of best management practices to reduce impacts to common aquatic species.

9.3.2.2.6 Socioeconomics

According to the 2000 census, Port Deposit had a population of 676 people and Cecil County had a population of 85,951. In 2008, the population of Port Deposit was estimated to have grown to 701 people and the County to 98,358 (2005-2007) (City Data, 2009; USCB, 2009). The population density of Port Deposit in 2000 was 404 people per square mile and had increased to about 411 ppsm in 2005-2007. The population density of Cecil County in 2007 was 246 ppsm. Population density within 20 miles of the site was estimated to be approximately 395 ppsm based on total area (ESRI, 2009).

The median household income in Port Deposit was $34,167 in 2000 and was estimated to have grown to $42,723 in 2007. Cecil County median household incomes were $50,510 and $63,159 in 2000 and 2007, respectively. The median residence value was $149,667 in 2007 compared to $77,500 in 2000. Comparable house values in Maryland during 2007 were $347,000 (City Data, 2009; USCB, 2009).

The influx of 3,950 construction workers and the subsequent in-migration of 363 operations workers may impact availability of public services, housing and tax revenues. For purposes of the evaluation, an approach was used similar to that for CCNPP Unit 3. A range of in-migration between 20 and 35% was assumed for the County. Based on these in-migration scenarios, between 1,880 and 3,285 additional people would migrate into the affected areas. These estimates include the direct workforce and family members. Given that Cecil County had a population of 98,358 in 2005-2007, the population increase due to in-migration of construction workers and their families would represent an increase of between 1.9 and 3.3%. Any impacts that may occur during construction would have been addressed prior to operation when there would be a lower rate on in-migration. The population of this 50 mi (80 km) geographic area is 5,220,713 (USCB, 2000f).

It is estimated that a workforce of approximately 3,950 would be employed during construction of the facility (the same for each alternative site). According to occupational projections for 2004 through 2014, there appears to be a general upward trend for construction and extraction employment within the area (MDDOL, 2008a). Availability of a suitable workforce within Cecil County from which to draw the construction workforce appears limited. However, within the 50 mile radius of the potential alternative site, the construction workforce would represent less than 2% of the available construction workforce (DOL, 2008).

According to the 2005 through 2007 estimate (USCB, 2009), a total of 3,703 housing units are vacant in Cecil County. Applying the analysis for CCNPP Unit 3, an estimated 720 to 1,260 direct workers (households) would in-migrate. As a result, the increase in housing demand within Cecil County would be less than the existing availability of housing units and would be a small fraction of the 243,587 vacant housing units within the 50 mile area (ESRI, 2009).

The distance of population centers greater than 25,000 in size was also assessed to determine the probable availability of shopping and other services for the construction and operation workforce. There were no population centers greater than 25,000 people within 5 miles of the Bainbridge Naval Training Center. The nearest population center is Bel Air South which is just over 10 (16 km) miles away.

With respect to public services, approximately three hospitals, six police stations, and 17 fire stations or departments (including volunteer stations) are located within Cecil County. Cecil County has an office of emergency services that coordinates disaster, mitigation, preparedness response, and recovery (CCDES, 2009).

Cecil County has four public water supply systems and provides treated water to over 24,000 people. In addition, the County has five public wastewater/sanitary sewer treatment plants. A growth study indicates that water and wastewater infrastructure is a limit to growth. The current average daily wastewater flow to the County's public sewer systems (including systems operated by municipalities and private utilities) is approximately 5.4 MGD. These systems have capacity to accommodate approximately 3.1 MGD of additional flow before additional wastewater system capacity will be required. In 2030, wastewater flows to the County's public systems (including existing demand) would be approximately 10.5 MGD, leaving a need for an additional 2.0 MGD of capacity. Planned or potential system improvements, including upgrades and expansions of the Seneca Point, Meadowview, Port Deposit, and Chesapeake City Wastewater Treatment Plants (WWTP) will be sufficient to provide this additional capacity (CC GOV, 2009).

An increase in tax revenues in Cecil County is to be expected from the construction and operation of a nuclear plant at the Bainbridge site. Actual tax revenues for the County in fiscal year 2007 totaled $148.5 million. While the actual increase in tax revenues from a new unit is yet unknown, the increase would be comparable to that at Calvert (CCGDB, 2009).

Cecil County provides numerous recreational opportunities including upwards of 40 town parks, nine public boat ramps, 37 marinas, three boat charters, horseback riding, five golf courses, eleven camping and RV resorts, 12 hunting lands and over 20 fishing lakes (CCMT, 2009).

Road data was reviewed to determine the level of available access to the site during construction activities. State Highway 276 is adjacent to the north of the site and U.S. Highway 222 is adjacent to the south of the site. Other roads within 1.0 mi (1.6 km) of the site include State Highway 275, State Highway 269. Interstate 95 is also located within 5.0 mi (8.0 km) southeast of the site. Existing roads are present and in close proximity to the site. It appears that the existing transportation infrastructure may be able to support construction traffic.

The cooling tower plume from the proposed facility would likely be visible at a considerable distance. The facility would be somewhat hidden by wooded areas and therefore would have some viewshed protection.

Overall impacts to the area population from construction and operation of a new reactor would be SMALL.

9.3.2.2.7 Transportation

There is existing barge access at the Bainbridge Naval Training Center site on the Susquehanna River.

Transportation infrastructure in Cecil County includes Interstate Route 95 which enters northeastern Maryland from Delaware and continues through Washington, DC, and into Virginia. State routes are also available in the area.

There is railroad access (Consolidated Rail Corporation) along the Susquehanna River on the western border of the site.

Good workforce road access is located to within approximately 3.0 mi (4.8 km) of the site via 1-95. The local roads around the site are two-lane. During the period of construction the use of these roads by both workforce and construction vehicles will have large impacts on congestion. Ultimately the use of these roads by the operations workforces will have minimal impact.

Overall impacts to the area's transportation infrastructure from construction and operation of a new reactor would be SMALL due to availability of railroad access, barge access, and roadways.

9.3.2.2.8 Historic, Cultural, and Archeological Resources

The Bainbridge site is located in Port Deposit, Cecil County, Maryland. The county is located in the northeast corner of Maryland. The Susquehanna River runs along the western boundary of the county. Port Deposit, located on the Susquehanna River in the western portion of the county, is considered an incorporated town of Maryland. Port Deposit is the furthest navigable point upstream for ships from the Chesapeake Bay and has traditionally served as an important trading point. Although the town was given the name Port Deposit in 1813, it existed under several other names prior to that time.

There are a total of 12 National Register of Historic Places (NRHP) listed properties within 5 mi (8 km) of the site; two properties are within 1.0 mi (1.6 km) of the site (NPS, 2009b). The two properties located within 1.0 mi (1.6 km) of the site are: the Paw Paw Building, located northwest of the site, and the Edward W. Haviland House, located south of the site. This result is based on data available from the Maryland Historic Trust and the NRHP (MHT, 2008). There are four NRHP listed historic districts within 5 mi (8 km) of the site, two of which are less than 1.0 mi (1.6 km) from the site (MHT, 2008; NPS, 2009b). The two NRHP-listed historic districts are the Port Deposit Historic District, located to the northwest of the site and the Tome School for Boys Historic District to the southwest of the site.

Additionally the Bainbridge Naval Training Center which encompassed the larger property was established in 1942 and saw over 500,000 sailors receive recruit or specialty training on its grounds before closure in 1976. A complete cultural resources investigation of both the archaeological and architectural resources onsite would be needed before construction activities begin. This work would be done in consultation with the Maryland State Historic Preservation Officer and should any significant cultural resources be identified, appropriate mitigation measures would be negotiated prior to construction and operation.

Impacts to cultural resources from construction and operation are likely to be SMALL to MODERATE because of the presence of two NRHP-listed properties and two NRHP-listed historic districts within one mile of the site, as well as the prsence of 10 additional NRHP-listed properties and two NRHP-listed historic districts within five miles of the site.

9.3.2.2.9 Environmental Justice

The demographic characteristics surrounding the Bainbridge project site were evaluated to determine the potential for disproportionate impacts to minority or low-income populations. Demographic information used for this study was obtained from the *2000 U.S. Census* (ESRI, 2009). Analysis included Cecil County and areas encompassed by the 50 mile radius. For purposes of comparison to the Calvert site, a region of influence was selected that included Cecil County and Harford County.

Criteria established in NRR Office Instruction LIC 203 were used to classify census block groups as having minority or low income populations. A "minority" racial population is defined as: American Indian or Alaskan Native; Asian, Native Hawaiian, or other Pacific Islander; Black (African-American) races; and multi-racial, or "some other race". The racial population is expressed in terms of the number and/or percentage of people that are minorities in an area. The sum of these racial minority populations is referred to, within this section, as the aggregate racial minority population. Persons of Hispanic/Latino origin are the ethnic minority, may be of any race including the identified racial populations, and thus are identified as a separate subcategory.

The NRC guidance indicates that a minority population exists if either of the following two criteria is met:

1. The minority population of the census block group or environmental impact area (in this case the 50 mi (80 km) comparative geographic area) exceeds 50%; or

2. The minority population percentage of the environmental impact area is significantly greater (typically at least 20 percentage points) than the minority population percentage in the geographic area chosen for comparative analysis (in this case the 50-mile comparative geographic area).

Within the 50 mile radius, there were a total of 3,821 census block groups and included portions of Delaware, Maryland, New Jersey and Pennsylvania. Of this total, there was an aggregate 808 census block groups that classified as minority populations. A total of 785 were African American populations, mostly located within the Baltimore metropolitan area (Table 9.3-10). In Cecil County, there were no census block groups that classified as having minority populations. Out of the 142 census block groups in the adjacent Harford County, there were seven census block groups with an aggregate minority population and two Hispanic. Four classified as having African American populations. Maryland has a total of 1,871 census block groups within the 50-mile radius of the site. 609 of these are classified as minority census blocks groups and eight as Hispanic census block groups.

The Census Bureau definition of a low income household is based on governmental statistical poverty thresholds. For the purpose of conducting this analysis, a block group is considered to be low income if either of the following two criteria are met:

1. The number of low income households in the census block group or the environmental impact site (in this case the 50 mi (80 km) geographic area) exceeds 50%; or

2. The percentage of households below the poverty level in an environmental impact area is significantly greater (typically at least 20 percentage points) than the low income population percentage in the geographic area chosen for comparative analysis (in this case, the 50 mi (80 km) comparative geographic area).

A total of 73 census block groups classified as low income within the 50-mile radius of the Bainbridge site. Cecil and Harford counties had no low income populations. Within the 50-mile radius, Maryland has 56 census block groups classified as low income.

Based on the data presented in Table 9.3-10, the percent of minority and low income populations within close proximity to the site is low. As a result, no disproportionate minority or low-income residents is expected from construction and operation of the proposed project.

It is anticipated that environmental justice impacts would be SMALL.

9.3.2.2.10 Transmission Corridors

There are four existing 500Kv transmission lines available for possible interconnection: one is 5 mi (8 km) north of the site and the other three are between 10 mi (16 km) and 20 mi (32 km) away from the site. There are five existing 230Kv transmission lines within 5 mi (8 km) of the proposed Bainbridge Naval Training site, and there are six 230Kv transmission lines between 10 mi (16 km) and 20 mi (32 km) away from the site. Because new ROW would need to be constructed to accommodate the new transmission lines, it is anticipated that there would be ecological impacts from the development of new transmission corridors.

Construction and operation transmission impacts are anticipated to be SMALL to MODERATE because of the ecological impacts associated with constructing new transmission corridors.

9.3.2.3 EASTALCO (Alternative Site 2)

The EASTALCO Site is located at a closed aluminum production plant located in Frederick County Maryland. The plant structures still exist, occupying a relatively small portion of the overall site. No aluminum production has occurred at this facility since 2005, when production was curtailed due to the high cost of electric energy at this location.

9.3.2.3.1 Land Use

The EASTALCO property has an overall area of approximately 2,200 acres. The existing structures which were used for aluminum production occupy only a small portion of the property (approximately 400 acres). It is located in a relatively flat, primarily agricultural area about 10 miles southwest of the City of Frederick. However, there is some light industry located nearby. According to the Frederick County zoning map, the site itself is zoned as GI – General Industry and A – Agricultural (FCDOP, 2009). However, the County has proposed a designated land use for the entire site as Agricultural/Rural, with a corresponding rezoning to A – Agricultural, as part of the Countywide Comprehensive Plan Update and associated Countywide Zoning Process, which is expected to be finalized in early 2010 (Frederick County Government, 2009). There is an airport located at the eastern boundary of the City of Frederick.

Aside from the industrialized area, the property consists principally of open grasslands and agricultural fields with small wooded patches. The site consists primarily of agricultural fields and includes a ball field and pavilion used by the City of Frederick with the permission of the property owner. The site topography, using GIS contours, indicates a relief across the site of approximately 33 ft, hence the cut and fill requirements for construction would be small.

The property can easily accommodate the 420 acres needed for the construction of an EPR Nuclear Power Plant. Figure 9.3-14 shows the map location of the site. Figure 9.3-15 is an aerial photograph of the site showing the existing plant structures. Both Figures show a 420 acre footprint comparable to the proposed Calvert Cliffs Unit 3 footprint superimposed to demonstrate the adequacy of the location to accommodate the proposed nuclear power plant. The footprint is within the overall property boundary but is not intended to show the actual location of the power plant on the site. Although nuclear power plant structures would occupy only a portion of the 420 acre area, the construction process would result in some impact to the entire area.

Although hazardous waste can be found at most aluminum production facilities, the EASTALCO plant site, while included in the State of Maryland Master List, is not designated as either a National Priority List (NPL) or Voluntary Cleanup Program Site (MDE, 2009). Nevertheless extensive demolition and some environmental remediation would be required to prepare the site for EPR construction.

Based upon available GIS data, the nearest (Federal, State, or Tribal) dedicated land, the State-owned Monocacy Natural Resources Management Area, is approximately 3.5 miles from the site. This is somewhat less than the five mile radius designated by NRC regulation as optimal for plant siting.

Because the site is approximately 5.8 miles from its potential source of water (the Potomac River), it would be necessary to acquire riverfront land sufficient for an intake, major pumping station and ancillary structures as well as additional land for the construction of a pipeline of capacity to provide approximately 50 million gallons per day (mgd) of river water to the plant site. A pipeline would necessarily cross railroad, numerous local roads, and the Chesapeake and Ohio (C&O) Canal and towpath; however, no major roads are located between the river and the plant site.

Overall land use impacts are expected to be SMALL due to the large area available for site construction and the limited changes needed prior to construction initiation.

9.3.2.3.2 Air Quality

The EASTALCO site lies in a non-attainment area for 8 hour ozone and Particulate Matter 2.5 (EPA, 2009b). Typically, the emissions from nuclear power plants are low enough to avoid triggering Nonattainment Area New Source Review under the CAA regulations administered by USEPA. However, emissions from auxiliary equipment including Emergency Diesel Electric Generators and Diesel driven Fire Water Pumps will likely require an Air Quality Permit from the MDE. The air quality impacts of construction both from offsite transportation and on site activities would also require regulatory consideration. Once the plant was completed ongoing emission contributions associated with transportation of operating staff and periodic outage workers are expected to be small.

Among the sites evaluated, the EASTALCO site is the closest to a Class 1 PSD area (EPA, 2009c; NPS, 2009a). It is 45 miles from the site to the Shenandoah National Park, the closest area.

Overall air quality impacts to the surrounding area attributable to the construction and operation of the proposed facility would be SMALL due to adherence to regulatory requirements during construction and the typically low emissions for an operating nuclear power plant.

9.3.2.3.3 Water

The EASTALCO site lies approximately 5.8 miles from the Potomac River, which represents the nearest waterway capable of providing the necessary cooling water volume. The area of the Middle Potomac River closest to the site has a special water quality use classification, indicating it is suitable for drinking water. The City of Frederick withdraws water for potable use from this reach of the river. The Surface Water Use Designation for the Middle Potomac River Area Sub-Basin is Use I-P (Water Contact Recreation, Protection of Nontidal Warmwater Aquatic Life and Public Water Supply) (COMAR, 2009a; COMAR, 2009b).

Impacts to hydrology are principally associated with consumptive water use for evaporative cooling attributable to the use of closed cycle cooling systems which require the use of cooling towers for heat rejection from both the main steam condensers and plant auxiliary heat exchangers. The total use of an EPR Nuclear power Plant at this site would be approximately 50 million gallons per day (mgd), with a consumptive use of approximately 27 mgd. The nearest USGS gaging station located at Point of Rocks, MD (01638500) has recorded a low flow of 343 mgd during 114 years of monitoring (USGS, 2009). Hence, a Nuclear Power Plant at the EASTALCO site could consume as much as 15% of the extreme low river flow.

In addition to requiring approval from the MDE Water Management Administration, withdrawals from the Potomac River basin, which includes the EASTALCO site, must comply with an agreement signed by the Interstate Commission on the Potomac River Basin, which includes Maryland. The Water Supply Coordination Agreement requires the major water suppliers to coordinate their operations during droughts in order to minimize the possibility of having to implement the restrictive stages of the Low Flow Allocation Agreement (LFAA). The LFAA allows for the restriction of water withdrawals to maintain a minimum flow in the Potomac River that would be sufficient to sustain aquatic resources during times of drought. The LFAA also established a formula for allocating Potomac River water during times of shortage. (Metropolitan Washington Council of Governments [MWCOG], 2009; Interstate Commission on the Potomac River Basin [ICPRB], 2009). The Code of Maryland Regulations (COMAR) requires large consumptive water users to maintain storage for low flow augmentation to meet the requirements of the LFAA. The amount of required storage is based on the amount of consumptive use, and this may be a significant consideration for development of the EASTALCO site (COMAR, 2009c).

Because the EASTALCO site is comparatively remote from its closest suitable water supply, other hydrological impacts could be associated with the creation of a significant impoundment on the site to assure plant reliability and for safety as an Ultimate Heat Sink (UHS). A detailed analysis would be required to determine the design of such an impoundment based upon local site geology and hydrology. The reservoir will be designed and configured to avoid interface with the groundwater table. Final design will address soil type and depth to water table. Measures such as clay liners will be used as appropriate. Based upon studies performed for the Calvert Cliffs Unit 3 plant, it was determined that considering allowances for evaporative losses, seepage and constructability, a UHS impoundment with a surface area of approximately 4.7 acres, 25 feet deep with 3:1 horizontal to vertical sloping sides would be required. A pond of these dimensions could be built within the 420 acre plant footprint.

The existing hydrology would also be altered by the construction of temporary roads, parking areas, areas for stockpiling and assembly of construction materials, the development of measures for storm water control, erosion and sediment control and the construction of a major river waterfront intake structure, pumphouse, and pipeline corridor.

Groundwater impacts at this site would be minimal. It is unlikely that Groundwater would be needed for plant operations, however, it may be necessary to temporarily utilize groundwater during construction. The quantities of construction water needed have not been determined for this site.

Water discharges from the plant would include cooling tower blowdown, treated process wastewater, treated sanitary wastewater and small amounts of radioactive water. The introduction of cooling tower blowndown to the receiving waters represents a thermal discharge. The manner of return of these effluents to the river has not been established at this time; however, all effluents will comply with the requirements of the Clean Water Act.

The hydrology impacts are expected to be MODERATE due to the potential to withdraw a significant portion of the Potomac River during low flow river conditions.

9.3.2.3.4 *Terrestrial Ecology and Sensitive Species*

The 2200 acre site is relatively flat consisting principally of active agricultural fields, with a complement of regularly mown grasslands. The site has small patches and windrows of forest, many of which appear to be supplemented with screening plantings installed by the property owner. The area surrounding the plant site is approximately 90% agricultural and about 10% undeveloped. Agricultural activity typical for the area is principally the production of corn, soybeans and winter wheat. Wooded upland areas are mostly oak, maple and tulip poplar. The site is outside of any FEMA identified 100 or 500 year floodplain (USFWS, 2009c).

A listing of current and historical rare, threatened, and endangered species of Frederick County is provided in Table 9.3-7. According to the Maryland Department of Natural Resources, Frederick County has no Federally listed special status species (MDNR, 2009a; MDNR, 2009b). There are 18 animal species and 57 plant species with state status, including both terrestrial and aquatic species. One known observance of a state-listed terrestrial species is documented to occur approximately one mile south of the site boundary (MDNR, 2009c; MDNR, 2009d).

No known threatened or endangered aquatic animal species or habitats are known to exist on the EASTALCO site. One known state-listed species was identified approximately 1 mile south of the site in a location that encompasses mapped aquatic stream habitat (MDNR, 2009c; MDNR, 2009d).

The Maryland Department of Natural Resources states that Frederick County has historic records of five threatened or endangered aquatic animal species and 13 threatened or endangered aquatic plant species in the county (MDNR, 2009a; MDNR, 2009d).

To aid in estimation of which species listed in Table 9.3-7 may actually exist on the EASTALCO site, a screening level evaluation of the site as compared to the known and documented habitat and life cycle requirements of the individual species was completed. Using this approach, many of the potential species listed may be considered highly unlikely to exist on the site or be potentially affected by nuclear facility construction and operation. The following key factors are presented to support the likely presence or absence of the species included in Table 9.3-7:

Federally-Protected Species Occurring in Fredrick County, Maryland

- The bald eagle is the only federally-protected species that may occur on or adjacent to the EASTALCO site and may occur along the Potomac River as a transient or to forage. There are no suitable nest or roost trees on the EASTALCO site and the site contains no open water areas that would be suitable for foraging. Therefore, the bald eagle would not be expected to occur on the site. The bald eagle may forage along the Potomac River, but would not be impacted by the construction and operation of the facility. NO impacts to federally-protected terrestrial species would be likely.
- No federally-protected aquatic species occur near the proposed intake and discharge locations on the Potomac River. NO impacts to federally-protected aquatic species would be likely.

State-Protected Species Occurring in Frederick County Maryland

There are eight plant species tracked by the Maryland Department of Natural Resources with historical records from Fredrick County that are classified as extirpated in Maryland (Table 9.3-7 in ER). None of these species would be expected to occur on the EASTALCO site.

There are 8 animal and 17 plant species tracked by the Maryland Department of Natural Resources that are known to occur in Fredrick County that are not protected by the state of Maryland (Table 9.3-7 in ER). None of these species is further considered, as they have no legal status within the state.

Of the 18 remaining animal species protected by the state of Maryland that are known to occur in Frederick County, 7 are aquatic and would not occur on the EASTALCO site. These seven aquatic species may occur at the water intake and cooling water discharge locations in the Potomac River. Installation of water intake structure and cooling water discharge structure could impact these three species, but they would likely avoid the area during construction and thereby avoid direct impacts from construction. Compliance with CWA 316b regulations and thermal effluent mitigation would minimize the potential for long-term impacts to the seven state-protected species. The potential for impacts to state-protected aquatic species at the EASTALCO site is SMALL.

Of the 11 terrestrial state-protected animal species, only three may occur on the site (Butterflies and Moths of North America, 2009; Sibley, 2000; Whitaker and Hamilton, 1998).

- The green tiger beetle may occur along the bank of the Potomac River where pipes would be placed to reach the water intake and cooling water discharge locations. Pre-construction surveys, site design modifications, and implementation of mitigation measures would minimize the potential for impacts to this species.
- Bewick's wren may forage on the EASTALCO site, but there is no suitable nesting habitat on the site. Bewick's wren would be expected to leave the area during construction and no impacts to this species would be expected.
- The upland sandpiper may forage or nest on the site. Pre-construction surveys, site design modifications, and implementation of mitigation measures would minimize the potential for impacts to this species and no disturbance would occur until after young had fledged if active nests are found.

The EASTALCO site is highly disturbed, consisting primarily of row crop fields and fence rows. Only three of the 48 state-protected plant species that are known to occur in Frederick County could occur in these disturbed habitats (narrow-leaved horse gentian, potato dandelion, and tall dock), and none is likely to occur there (Table 9.3-7 in ER; Rhoads and Block, 2007; Weakley, 2009). The potential for impacts to state-protected terrestrial species from development and operation of the site is SMALL. There are few state-protected species that could occur in the disturbed habitats present and none would be likely to occur. Implementation of mitigation measures would minimize the potential for impacts to state-protected species.

Proposed water intake lines, cooling water discharge lines, and electrical transmission lines to serve the EASTALCO site would likely cross undeveloped habitats and multiple streams. Because these lines would disturb more natural communities than occur on the EASTALCO site, there would be a greater potential for impacts to state-protected species. Route adjustments to water lines and electrical transmission lines based on data from pre-construction surveys and mitigation measures that would be implemented during construction would minimize the potential for impacts. Any impacts to state-protected aquatic or terrestrial species from construction of the proposed water intake and cooling water discharge lines and from construction of electrical transmission lines would likely be SMALL to MODERATE.

Impacts of construction on the terrestrial ecosystem include noise, clearing and grading and the aforementioned hydrological changes. Construction of the facility could result in the direct mortality of some common species and available undisturbed habitat may be reduced, but the direct impact at this site is expected to be minimal.

Because the aluminum production facility relied on extensive use of electric power, there is a large transmission corridor leading to the plant. It is assumed that this corridor is appropriate to construct the necessary transmission lines associated with the proposed large Nuclear Power Plant. This corridor is currently maintained by the local transmission utility. It cannot be stated with complete assurance, however, that there will not be additional terrestrial disturbance associated with transmission line ROW expansion or creation without the completion of significant engineering studies.

9.3.2.3.5 Aquatic Ecology

According to the National Wetlands Inventory, the site has two streams (Tuscarora Creek and an unnamed stream) and minimal other wetlands (USFWS, 2008a). See Table 9.3-12, Table 9.3-13, and Table 9.3-14 for wetlands/waterways information. On-site construction related impacts to these resources would therefore be expected to be minimal. Construction of a cross-country water pipeline would, however, be expected to cross several small streams and wetland complexes and would have commensurate temporary impacts to these areas during construction. Table 9.3-12, Table 9.3-13, and Table 9.3-14 provide summaries of wetland and stream areas on the site.

Tuscarora Creek is a subwatershed of the Upper Monocacy River (UMR) watershed system. The Maryland Department of Natural Resources (MDNR) conducted a Stream Corridor Assessment of the UMR watershed and surveyed a 21 mile reach of Tuscarora Creek (MDNR, 2004). The results indicated the Tuscarora Creek watershed had the highest percentage of urban land use and eroded areas when compared to the 5 other subwatersheds (MDNR, 2004). Large areas of inadequate stream buffers and several fish barriers were also observed during the survey.

The EASTALCO site is predominately agricultural lands. Trout prefer clean, cold water streams, and to maintain cooler stream temperatures and filter agricultural and urban runoff a large riparian buffer is ideal (MDNR, 2007g and Watershed and Clean Water Grants Program [WCWGP], 2002). For example, Baltimore County, Maryland passed an ordinance requiring maintenance of a 100 ft. riparian buffer around trout streams (Baltimore County, no date). The agricultural lands on the EASTALCO site have led to narrow riparian buffers. As a result, the Tuscarora stream is poorly shaded and stream temperatures would likely be warmer than trout preferred cold habitats. The small riparian buffer, along with the results of the UMR watershed assessment, indicates trout species are not likely to occur on the EASTALCO site.

Construction related aquatic ecological impacts would include temporary loss of habitat and short term degradation of water quality as a result of in-river and shoreline construction of water intake and discharge structures. An undetermined amount of dredging in the Potomac River would be necessary for cooling water intake structure installation, and best practices for minimizing turbidity and for the containment of sediments would be implemented to minimize the impacts on benthic and other organisms. Removed dredged material from a limited footprint will directly impact benthic organisms, but this represents a small impact based upon aerial and temporal extent of the disturbance. During dredging operations fin fish would tend to avoid the immediate area, perhaps feeding on dislodged organisms downstream of the construction location.

Withdrawal of cooling water from the Potomac River will result in impacts resulting from the entrainment and impingement of aquatic organisms. The use of cooling towers which minimizes the volume of water used for cooling and the use of state-of the-art features in the design of the intake structure would allow the plant to meet all requirement of section 316B of the Clean Water Act.

Construction of a nuclear power plant with closed cycle cooling will introduce a thermal discharge to the receiving water in the form of cooling tower blowdown assuming that it is discharged directly to the river. Blowdown would represent only a small fraction of the water withdrawn from the river and its impact would be mitigated by the use of engineered diffusers.

Minor, localized impacts to water quality would be expected to occur during cooling water intake system in-water component construction, and no impact to threatened or endangered species would be expected from project construction or operation. Based on the ability to control impacts to water quality and aquatic life through compliance with Clean Water Act 316(a) and (b) requirements and in consideration of the fact that all designated uses would be maintained, the impacts on aquatic ecology and sensitive species are expected to be SMALL.

The ecologically important species identified in Maryland include the mountain laurel, tulip poplar, chestnut oak, New York Fern, and Eastern hemlocks. The EASTALCO site does not contain habitat types optimal for these species, and they have not been observed on the site during site inspecions. The Eastern Hemlock is not likely to occur at any of the proposed sites due to impacts from the woolly adelgid invasion (MISC, 2003).

Common recreationally important terrestrial species potentially occurring within the vicinity of the three alternative sites, including the pipeline corridor, are the white-tail deer, wild turkey, northern bobwhite, and ring-necked pheasant. The white-tail deer occupies a variety of habitats (including forests, farms, wetlands, and other rural and urban areas), and would likely occur at all three proposed alternative sites (MDNR, 2009e). Wild turkeys are typically found in mature hardwood and pine forests and grassy fields (MDNR, 2009f). The occupied wild turkey range in Maryland includes the EASTALCO site, and the turkey would likely occur within the area of these proposed locations (MDNR, 2009f). The northern bobwhite and ringnecked pheasant both occupy recently disturbed and early-successional habitats such as fallowed fields, brushy fencerows, and recently cleared forests (MDNR, 2007a). These species would likely occur at or in the immediate vicinity of the EASTALCO site as a result of the agricultural land use in the area.

Maryland's variety of freshwater, saltwater, and estuarine habitats has created several commercially and recreationally important fisheries. The freshwater fisheries are primarily recreationally important and include the following species: Largemouth and Smallmouth Bass, Channel Catfish, Madtoms, Chain Pickerel (Pike), Crappie (white and black), Eels, Herring (alewife and blueback), Muskellunge/Tiger Muskie, Northern Pike, Shad (American and hickory), Striped Bass, Sunfish, Trout, Walleye and Yellow Perch. Some of these species would likely occur in large freshwater streams in the vicinity of the EASTALCO site and in the Potomac River.

The U.S. Fish and Wildlife Service (USFWS) and the U.S. Park Service conducted a study from May 2004 to July 2007 to assess the status and life history of the shortnose sturgeon in the Potomac River (USFWS, 2009a). The results indicated adult habitat for the sturgeon is present in the Potomac River, and several individuals have been detected in different reaches of the river using telemetry methods (USFWS, 2009a; USFWS, 2009b). A female shortnose sturgeon was captured at Cole's Point in Virginia within 10 miles of the Thiokol Site (USFWS, 2009a). The other telemetry observations were further upstream from the site between the Route 301 Bridge and Chain Bridge located north of Washington DC (USFWS, 2009a). However, the study failed to prove whether shortnose sturgeon spawning occurs in the river (USFWS, 2009a).

As described in the previous section, trout species prefer colder water habitats and would not be expected to occur within the vicinity of the EASTALCO site. The smallmouth bass prefers smaller stream habitats and could occur in Tuscarora Creek (MDNR, 2007b). The chain pickerel, sunfish (bluegill), and large mouth bass occupy a variety of freshwater habitats and could also occur in Tuscarora Creek (MDNR, 2007c; MDNR, 2007d; MDNR, 2007e).

The blue crab, oyster, and striped bass are the primary commercially important fisheries in Maryland. Blue crab and oysters prefer the brackish waters of the Chesapeake Bay and would not likely occur at the EASTALCO site or in the cooling water body (Potomac River). The striped bass is an anadromous species, meaning they live most of their lives in marine habitats and migrate up large rivers to spawn in freshwater habitats (MDNR, 2007f). Given the distance from the nearest saltwater influence, however, the striped bass is unlikely to represent a significant species in the Potomac at the point of withdrawal for the EASTALCO site.

9.3.2.3.6 Socioeconomics

According to the 2000 census, Frederick County had a population of 195,277 people. The county had significant population growth since the last census and reached just over 222,034 people based on the 2005-2007 census estimates. The EASTALCO site is located in District 1 Buckeystown, MD which had a 2007 population density of 177 ppsm. The District 2007 Population was 7,145 persons. Population density in Frederick County was approximately 295 ppsm based on the 2005-2007 census estimates. Within 20 miles of the EASTALCO site, the population density in 2007 was about 474 ppsm. The City of Frederick is the single population center larger than 25,000 persons that could support provide retail and other services for the workforce. Frederick City is approximately four miles from the EASTALCO site (ESRI, 2009).

The median household income in Buckeystown during 2007 was $85,745 compared to a median household income in Frederick County of $77,027. Median residence value in Buckeystown was $371,917 (City Data, 2009).

The impact of 3,950 construction workers and the subsequent in-migration of 363 operations workers on public services, housing and tax revenues was evaluated using an approach similar to that for Calvert Cliffs. A range of in-migration of between 20 and 35% was assumed for the County and for the 50 mile area. Based on these in-migration scenarios, between 1,880 and 3,285 additional people would migrate into the affected areas. These estimates include the direct workforce and family members. Given that Frederick County had a population of 222,034 people in 2005-2007, the population increase due to in-migration of construction workers and their families would represent an increase of between 0.8% and 1.5%. Any impacts that may occur during construction would have been addressed prior to operation when there would be a lower rate on in-migration. The population of this 50 mi (80 km) geographic area is 6,735,261 (USCBa, 2000f).

The availability of construction workers was evaluated based on current employment within the greater metropolitan areas. As of May 2008, there were a total of 66,280 construction workers employed in the Baltimore-Towson area, 133,560 within the Washington-Arlington area and 29,900 construction workers employed within Bethesda-Gaithersburg-Frederick area. Within 50 miles of the site, the required project workforce would represent less than 2% of the total construction workforce (MDLLR, 2009). As a result, the employment of 3,950 construction workers at the EASTALCO site would represent a small percentage of the workforce available.

Frederick County has a well developed system of Emergency Services. There are five hospitals, five police stations and 25 fire stations or departments (including volunteer stations). The County has a division of emergency management that coordinates disaster mitigation, preparedness and recovery. The influx of workers during the period of construction would have only minor impacts on these resources (Reference).

American Survey data from the US Census Bureau was consulted to determine the availability of sufficient housing to accommodate the workforce influx for construction and operation that would be expected. According to data for 2005 through 2007, a total of 4,386 housing units were vacant in Frederick County. Assuming up to 1,260 direct workers (households) may in-migrate, there appears to be adequate housing within the County. Within 50 miles of the site, there were an estimated 189,404 housing units vacant (USCB, 2009).

Fredrick County has 19 elementary, 13 middle, and 10 high schools (FCPS, 2009). Frederick County also hosts six vocational institutions, colleges or universities. The impact of increased school enrollment resulting from this project would not have a major impact upon the Frederick County or surrounding Maryland, Virginia, or West Virginia counties from which the construction work force would commute.

Frederick County also provides public water supply and waste water treatment facilities. There are a total of 14 water treatment plants capable of providing up to 1,700 mgd. There are also 14 waste water treatment plants with a capacity of up to 7.7 mgd.

Tax revenues within Frederick County totaled $601,526 and $583,070 in 2008 and 2007 respectively. The potential contribution from construction of a nuclear unit at EASTALCO would represent only a small percentage increase but would be large enough to offset any impact on public services (FCGFR 2008).

Recreation includes the minor league Frederick Keys baseball team along with 63 parks and other recreational areas within a 10 mile radius of the EASTALCO site. Included within Frederick County are five national parks, five state parks, and 21 county parks (MDBED, 2009b).

Construction of a hybrid tower on the site would have some impact on the viewshed. However, while much of the area is in farming, regional land contours would help limit the aesthetic impact. In addition, the site use would be similar to that of the existing EASTALCO plant.

The impacts on socioeconomic factors is expected to be SMALL as sufficient capacity in housing, public services and labor appears to exist in the region.

9.3.2.3.7 Transportation

Transportation infrastructure in Frederick county includes Interstate Route 70 which extends from Baltimore to Pennsylvania. Interstate Route 270 extends from Frederick to Virginia by connection to Interstate Route 495. Other major roads in the area connect to Pennsylvania, Virginia and West Virginia. Consequently, roadway infrastructure supporting EPR development on the EASTALCO site is good.

There is no practical water (barge) transportation that is accessible to the site. There is no barge access within five miles of the site (MPA, 2009).

There is good railroad access to the site. The Baltimore and Ohio (B&O) main line, part of the CSX Transportation System is located approximately 0.7 miles from the site. A spur from the B&O is located about 0.5 miles from the site.

Good workforce road access is located to within approximately one mile of the site; however many of the roads in the area are heavily congested by commuters to Frederick and Washington DC, and its suburbs.

Transportation impacts are expected to be MODERATE because of the lack of barge access to the vicinity of the site.

9.3.2.3.8 Historic, Cultural, and Archeological Resources

The EASTALCO site is located approximately five miles south of Frederick, Maryland, in Frederick County. Although settlers began coming to the area in the 1720s, Frederick County was not formed until 1748. Frederick Town (later the City of Frederick) was named the county seat at the same time. The county is located north of Washington, D.C. and northwest of Baltimore and borders Pennsylvania. The City of Frederick is at the center of the county.

According to data available from the MHT and the NRHP, 16 NRHP listed properties and one NRHP-listed historic district are within five miles of the site (MHT, 2008; NPS, 2009b). One NRHP-listed property is within 1.0 mi (1.6 km) of the site: Carrollton Manor. This property is located at 5809 Manor Woods Road, south of the site.

A complete cultural resources investigation of both the archaeological and architectural resources would be needed before construction activities begin. This work would be done in consultation with the Maryland State Historic Preservation Officer and should any significant cultural resources be identified, appropriate mitigation measures would be negotiated prior to construction and operation.

The construction of a pipeline to the Potomac River would necessarily entail a crossing of the historic C&O Canal and Towpath which, in the area of interest, is used principally for hiking and biking. General operating procedures for pipeline construction include the use of horizontal directional drilling (HDD) to avoid impacts to linear features such as roadways, waterways, and active railroad tracks. The C&O Canal and Towpath is a narrow linear feature nearby the Potomac River, and it is assumed for the evaluation of the EASTALCO site that HDD or the related technology microtunneling would be capable of being employed to prevent any direct disturbance of the C&O Canal and Towpath. This may entail a drill path being initiated or ending within the Potomac River itself, and present a potential risk of the loss of drilling fluids to the environment.

Any construction at or in the vicinity of the C&O Canal would require the concurrence of the U.S. Department of the Interior, National Park Service. All possible care and mitigation measures as well as measures for restoration would be employed to minimize impacts during and after construction. The impact of this construction would be temporary.

The construction of a river front cooling water intake structure with the associated pump house, access road, and cooling water discharge in close proximity to the Canal and Towpath is not without precedent. Within ten miles downstream of the Point of Rocks all of these features are present at the Dickerson Power Plant. The Canal often experiences damage from flooding leading to washout of sections leading to interruptions in recreational use and since neither of the proposed pipeline locations would be in the vicinity of any historic Locks or other Structures, it is concluded that the overall impacts from this aspect of the project would be small. The impacts on historic, cultural and archeological resources are expected to be SMALL to MODERATE due to the presence of an NRHP-listed property within one mile of the site and 16 additional NRHP-listed properties and one NRHP-listed historic district within five miles of the site.

9.3.2.3.9 Environmental Justice

Analysis of minority and low income populations within the vicinity of the EASTALCO site were also evaluated based on the classification of census block groups. Within the 50 mile area, there were a total 4.533 census block groups encompassing portions of Washington DC, Maryland, Pennsylvania, Virginia and West Virginia (Table 9.3-11). Of these, 1,484 are classified as having aggregate minority populations. Of these, 1,171 are African American minority census block groups and are located in Washington-Baltimore metropolitan areas.

The region of influence (ROI) includes Frederick and Montgomery County, Maryland and Loudon County, Virginia. The borders of these counties extend approximately 30 mi (50 km) from the EASTALCO site. These three counties are located on the border between Maryland and Virginia.

Out of a total of 127 census block groups in Frederick County, two census block groups were classified as having aggregate minority populations and one as having African American minority populations. Of these 552 census block groups in Montgomery County, there were 119 classified as having aggregate minority populations of which 14 census block groups were classified as having African minority populations and 29 Asian. A total of 55 census block groups classified as Hispanic populations. Within Loudon County, there were 67 census block groups and only one classifed as having a minority population, this being Hispanic. The State of Maryland had a total of 2,640 census block groups of which 1,065 classified as minority populations and 91 as Hispanic.

Low income populations were mostly distributed within the Washington D.C. area and in Baltimore City. There were no low income census block groups within Frederick, Montgomery or Loudon Counties. Maryland has 57 low income census block groups.

Based upon the data presented in Table 9.3-11, no disproportionately high percentage of minority or low income residents would be adversely directly impacted by construction and operation of the proposed project.

There are expected to be SMALL impacts on environmental justice factors, primarily the high percentage of local minority population.

9.3.2.3.10 Transmission Corridors

There are seven existing 500Kv transmission lines within 5 miles of the EASTALCO site. There is a 345 Kv transmission line about 12.7 miles northwest of the site. There are also nine 230 Kv transmission lines available for interconnection: one line about 0.5 miles, another line 1.8 miles, two lines 2.2 miles and another five lines more than four miles from the site. In order to connect to any of these lines some new right of way would be necessary. Some level of ecological impact would result from the construction of new connecting transmission lines.

The environmental impacts from transmission corridors are expected to be SMALL to MODERATE due to ecological impacts of constructing new connecting transmission lines.

9.3.2.4 Thiokol Site (Alternative Site 3)

The former Thiokol site is a 620-ac (250.9-ha) property located near Mechanicsville in St. Mary's County, Maryland. Figure 9.3-16 shows the location of the former Thiokol site and Figure 9.3-17 shows the site vicinity.

9.3.2.4.1 Land Use

The former Thiokol site is located in St. Mary's County, Maryland, less than 3 mi (4.8 km) south of the Patuxent River. The site is bordered by Maryland State Route 235 to the north and Friendship School Road to the west. Woodlands are located to the east and south. Washington D.C. is the closest major city and is located approximately 40 mi (64.3 km) north of the site.

The property has an overall area of 620 acres which is sufficient to accommodate the 420 acres that would be affected by the construction of the proposed nuclear power plant. The use of 420 acres is based upon the area that would be impacted based upon the U.S. EPR nuclear power plant footprint. Although nuclear power plant structures would occupy only a portion of the 420 acre area, the construction process would result in some impact to the entire area.

The former Thiokol site is currently undeveloped and covered in vegetation including trees and shrubs. According to the St. Mary's County Department of Land Use & Growth Management, the Thiokol Site is zoned as a Rural Preservation District (McCauley, 2009). The surrounding area is a mix of suburban and agricultural development with a portion of the land being undeveloped. There are no population centers, parks, airports, or other major destinations located in the vicinity. Land to the east of the site is generally comprised of low-density residential development that includes residential subdivisions. Most of the land to the north of the site is also in residential development and has a lower density than lands to the east. Lands west of the site contain a mix of low-density residential development and agriculture. The areas south of the site are generally undeveloped but also contain some low-density residential development.

The site topography using GIS countours indicates a relief across the site of approximately thirty-three feet, hence the cut and fill requirements for construction would be small.

The site was formerly used for the manufacturing of munitions up until the late 1950s. In the early 1980s, buildings were removed from the site, timber was harvested, and the site was reforested. The property contains covenants (i.e., deed restrictions) that restrict residential, educational, or day care development in two areas that amount to a total of approximately 67.3 ac (27.2 ha). Notwithstanding the implications of the provisions of the Covenant, several surveys and remediation activities to identify and remove unexploded ordnance (UXO) and hazardous materials were conducted at the Thiokol site between 1992 and 2000. Upon completion of the final clearance activities in 2000, Certification Letters documenting the site free of UXO in accordance with US Department of Defense Guidelines were submitted by the remediation specialist contractor. The site is currently being monitored by the Maryland Department of the Environment (MDE), Land Restoration Program (MDE, 2009), to determine the appropriate measures necessary to finish remediation of the site.

Based upon available GIS data, the nearest (Federal, State, or Tribal) dedicated land, Greenwell State Park, is approximately 4.3 miles from the site. This is slightly less than the five mile radius designated by NRC regulation as optimal for plant siting.

Overall land use impacts are expected to be SMALL to MODERATE due to the proximity of residential developments, required rezoning, and lack of industrial and manufacturing facilities.

9.3.2.4.2 Air Quality

The former Thiokol site is located in St. Mary's County, Maryland. St. Mary's County is currently designated as being in attainment of all air pollutants regulated by the U.S. Environmental

Protection Agency (EPA) (EPA, 2008). Any air emissions that would occur as a result of the operation of the proposed new facility will be low enough that they would not cause or contribute to a significant change in local or regional air quality levels at any location.

Construction activities at the site have the potential to temporarily impact the ambient air quality in the immediate vicinity of construction due to emissions from onsite construction equipment. These emissions are expected to be consistent with emissions from other construction projects of this magnitude. It is anticipated that there should be no significant impacts on air quality at offsite locations during the construction period due to the relatively long distance from the center of the site (where most construction and equipment laydown will occur) to the site boundaries. Overall air quality impacts to the surrounding area attributable to the construction of the proposed facility would be SMALL due to adherence to regulatory requirements.

With the exception of some relatively small diesel-fueled emergency power generating equipment and fire pumps, operation of the proposed facility will not have any significant sources of emissions attributable to the combustion of fossil or other fuels. The proposed facility will contain a cooling tower that will emit water vapor and particulate matter to the atmosphere. Because of the exceptionally low level of emissions, operation activities are not expected to cause or contribute to a violation of any state or federal ambient air quality standards. There would be a small increase in regional and local air emissions as a result of increased vehicular traffic associated with workforce employed for plant operations. It is anticipated that overall air quality impacts associated with operation of the proposed facility will be SMALL due to typically low emissions for an operating nuclear power plant.

9.3.2.4.3 Water

The main source of water for the former Thiokol site would be the Patuxent River. The proposed nuclear facility would require a cooling water system and it would include a circulating water system (CWS) and a service water system. The CWS circulates cool water through the main condensers to condense steam after it passes through the turbine. The service water system circulates cooling water through heat exchangers that serve various plant components. The CWS for the proposed unit would be a closed-cycle system that uses a cooling tower. The proposed new unit would have a separate intake and discharge structures located offshore in the river, and a screenwell and pumphouse structure located onshore. The proposed plant would require approximately 50 million gpd for cooling and other purposes (total use).

The site location is approximately three miles from the Patuxent River, hence it would be necessary to construct a lengthy pipeline to provide cooling water for the proposed nuclear power plant. With the water supply remote from the plant, it would be necessary to construct an onsite impoundment in order to provide a secure UHS. The reservoir will be designed and configured to avoid interface with the groundwater table. Final design will address soil type and depth to water table. Measures such as clay liners will be used as appropriate. Studies performed for the proposed Calvert Cliffs Nuclear Power Plant Unit 3 demonstrated the need for a UHS water supply pond of approximately 4.7 acres, 25 feet deep with sloped sides at a 3:1 horizontal to vertical ratio. Site conditions including geology and hydrology would dictate the actual impoundment configuration. A cooling water impoundment of this size could be accommodated within the projected 420 acre plant footprint.

Hydrologic impacts associated with construction activities include alteration of the existing watershed surface; disturbance of the ground surface for stockpiles, material storage, and construction of temporary access roads; construction of water intake and discharge structures; construction of cofferdams and storm sewers; construction of piers, jetties, basins, or other structures that might alter shoreline processes; dredging operations; temporary dewatering activities; construction activities contributing to sediment runoff; changes in surface water drainage characteristics; decreases in surface water infiltration (increases of impervious surfaces); and increased erosion and sedimentation. Water will be used for construction activities. A specific quantity of water usage is not known at this time. However, proper mitigation and management methods implemented during construction will limit the potential water quantity and quality effects to surface water and groundwater.

Construction-related water use impacts will be minimized through the implementation of best management practices (BMPs) including erosion, grading, and sediment control measures; stormwater control measures; spill prevention plan; and observance of federal, state, regional, and local regulations pertaining to nonpoint source discharges. Overall construction-related water impacts will be SMALL primarily due to the abundance of available water.

Plant operation will result in a number of aqueous effluents. The largest effluent discharge would be cooling tower blowdown. Treated plant process wastewater, treated sanitary wastewater and small amounts of radioactive liquids could be discharged to the Patuxent River. All effluents would be treated prior to discharge to acceptable levels defined under the Clean Water Act. Cooling tower blowdown would be discharged at temperatures above ambient river temperatures; however engineered diffusers will be employed to mitigate any thermal effects.

Ensuring permitted limits for water withdrawal and discharge are met through operational controls and monitoring would minimize the potential for adverse impacts to water availability and water quality. It is anticipated that there would be site-specific water treatment systems or the use of a municipal system, if available. Therefore, it is anticipated that overall water use impacts from operation activities would be SMALL primarily due to the abundance of available water.

9.3.2.4.4 Terrestrial Ecology and Sensitive Species

This site is relatively flat area surrounded by deciduous forests. A listing of current and historical rare, threatened, and endangered species of St. Mary's County is provided in Table 9.3-8. There are 10 animal and 21 plant species listed as having state threatened or endangered status in St. Mary's County, Maryland (MDDNR, 2008).

Ecologically important species indentified in Maryland include the mountain laurel, tulip poplar, chestnut oak, New York Fern, and Eastern hemlocks. The mixed-deciduous forests at the Thiokol site would likely include the tulip poplar, chestnut oak, mountain laurel, and New York Fern. The Eastern Hemlock is not likely to occur at any of the proposed sites due to impacts from the woolly adelgid invasion (MISC, 2003).

Common recreationally important terrestrial species potentially occurring within the vicinity of the three alternative sites, including the pipeline corridor, are the white-tail deer, wild turkey, northern bobwhite, and ring-necked pheasant. The white-tail deer occupies a variety of habitats (including forests, farms, wetlands, and other rural and urban areas), and would likely occur at all three proposed alternative sites (MDNR, 2009a). Wild turkeys are typically found in mature hardwood and pine forests and grassy fields (MDNR, 2209b). The occupied wild turkey range in Maryland includes the Thiokol site (MDNR, 2009b). The northern bobwhite and ring-necked pheasant both occupy recently disturbed and early-successional habitats such as fallowed fields, brushy fencerows, and recently cleared forests (MDNR, 2007a). These species may occur at or in the immediated vicinity of the Thiokol site, however habitat in the area does not include significant early successional habitats or agricultural lands, and is not optimal.

To aid in estimation of which species listed in Table 9.3-8 may actually exist on the former Thiokol site, a screening level evaluation of the site as compared to the known and documented habitat and life cycle requirements of the individual species was completed. Using this approach, many of the potential species listed may be considered highly unlikely to exist on the site or be potentially affected by nuclear facility construction and operation. The following key factors are presented to support the likely presence or absence of the species included in Table 9.3-8.

Federally-Protected Species Occurring in St. Mary's County, Maryland

The dwarf wedge mussel, northeastern beach tiger beetle, and the bald eagle are the only federally-protected species known from St. Mary's County in Maryland (Table 9.3-8 in ER).

- The northeastern tiger beetle occurs in sand and dune habitats (NatureServe Explorer, 2009e). No suitable habitat for this species occurs on the Thiokol site or along the proposed water intake and cooling water discharge route. NO impacts to this species would be expected.
- The bald eagle may occur along Tuscarora Creek or the Patuxent River on or near the Thiokol site. Because of lack of suitability of trees for nests and roosts in this area, any occurrences would likely be as transients or to forage (Sibley, 2000). The bald eagle may forage along the Tuscarora Creek or the Patuxent River, but would not be impacted by the construction and operation of the facility.

State-Protected Species Occurring in St. Mary's County Maryland

There are two plant species tracked by the Maryland Department of Natural Resources with historical records from Frederick County that are classified as extirpated in Maryland (Table 9.3-8 in ER). None of these species would be expected to occur on the Thiokol site.

There are five animal and 11 plant species tracked by the Maryland Department of Natural Resources that are known to occur in Frederick County that are not protected by the state of Maryland (Table 9.3-8 in ER). None of these species is further considered, as they have no legal status within the state.

Four of the state-protected species known from St. Mary's County would not occur on the Thiokol site due to lack of habitat.

- The sedge wren inhabits open marshland, which does not occur on the site (Sibley, 2000). The sedge wren could, however, occur along the proposed water intake and cooling water discharge lines.
- White spikerush and seaside knotweed occur in brackish waters or at the sea coast and would not occur on the Thiokol site (Table 9.3-8 in ER; Rhoads and Block, 2007; Weakley, 2009).

- Seaside plum is restricted to sandy dune areas, which do not occur on the Thiokol site (Table 9.3-8 in ER; Rhoads and Block, 2007; Weakley, 2009).

There are 18 state-protected plant species and six state-protected animal species that are known from St. Mary's County that could occur on the Thiokol site or at the water intake structure and cooling water discharge structure (Table 9.3-8 in ER).

Four of the state-protected animal species and one state-protected plant species that may occur on the site are aquatic (Table 9.3-8; Rhoads and Block, 2007; Weakley, 2009).

- Swollen bladderwort could occur in wet ditches or other standing water areas on the site.

- The flier, Atlantic spike, comely shiner, and ironcolor shiner may occur in streams on or near the Thiokol site and along proposed water intake and cooling water discharge lines. Route adjustments to water lines and electrical transmission lines based on data from pre-construction surveys and mitigation measures that would be implemented during construction would minimize the potential for impacts.

There are 17 state-protected terrestrial animal and plant species known to occur in Cecil County with potential to occur within the Thiokol site (NatureServe Explorer, 2009f; Rhoads and Block, 2007; Sibley, 2000; Weakley, 2009). Route adjustments to water lines and electrical transmission lines based on data from pre-construction surveys and mitigation measures that would be implemented during construction would minimize the potential for impacts. Any impacts to state-protected terrestrial species on the site, from the proposed water intake and cooling water discharge lines, and from construction of electrical transmission lines would likely be SMALL to MODERATE.

Impacts on the terrestrial ecosystem associated with construction of the proposed facility include noise, clearing and grading, and potential collisions of birds with new structures. Construction of the proposed facility would result in direct mortality for certain wildlife and would reduce the available habitat area but would not adversely affect local or regional populations of wildlife species. Species that are mobile are likely to preferentially use less-disturbed habitats on adjacent lands. The terrestrial ecology impacts from construction of the facility and the ancillary water pipeline and transmission line corridors are anticipated to be MODERATE but would be minimized by minimizing impacts to sensitive species habitat and complying with permit and mitigation requirements. Because no land will be disturbed once construction is complete, the impacts of operation would be SMALL.

9.3.2.4.5 Aquatic Ecology and Sensitive Species

The Rich Neck Creek and Tom Swamp Run, including interim tributaries, are located on the Thiokol site. According to the USFWS National Wetlands Inventory (NWI), the site contains approximately 49.2 ac (19.9 ha) of non-tidal wetlands and approximately 14,411 linear feet (lf) (4,392 m) of stream channel (USFWS, 2008b).

Construction-related impacts to the aquatic ecology would include temporary loss of habitat and short-term degradation of water quality in isolated areas due to inwater and shoreline construction of the cooling water intake structure (CWIS) and other appurtenant structures (such as blowdown and discharge pipelines). The total area of the pipe corridor and associated structures would be approximately 25.1 acres (10.2 ha), including approximately 0.4 ac (0.2 ha) of wetlands. The right-of-way for the 500 kV transmission line would include approximately 15.8 ac (6.4 ha) of wetlands and 4,200.8 (1,280.4 m) of stream channel. The proposed project would permanently impact wetlands and stream features, and the ROW would be permanently maintained by the local transmission utility.

National Wetland Inventory maps show palustrine forested wetlands associated with streams to the east and west of the Thiokol site (USFWS, 2008b). See Table 9.3-12, Table 9.3-13, and Table 9.3-14 for wetlands/waterways information. Some wetlands would probably be impacted given the large footprint needed to construct the proposed facility. Federal Emergency Management Agency (FEMA) floodplain maps show no flood zones within the study area (FEMA, 2008).

Maryland's variety of freshwater, saltwater, and estuarine habitats has created several commercially and recreationally important fisheries. The freshwater fisheries are primarily recreationally important and include the following species: largemouth and smallmouth bass, channel catfish, madtoms, chain pickerel (pike), crappie (white and black), eels, herring (alewife and blueback), muskellunge/tiger muskie, northern pike, shad (American and hickory), striped bass, sunfish, trout, walleye and yellow perch. Most of these species would likely occur in the rivers and large streams adjacent to the three proposed alternative sites.

Trout species prefer colder water habitats and would not occur within the vicinity of the proposed sites. The chain pickerel, sunfish (bluegill), and largemouth bass occupy a variety of freshwater habitats and could also occur in the small streams on the Thiokol site (MDNR, 2007c, 2007d, 2007e).

The blue crab, oyster, and striped bass are the primary commercially important fisheries in Maryland. Blue crab and oysters prefer the brackish waters of the Chesapeake Bay and would not likely occur at or adjacent to the proposed site. The striped bass is an anadromous species, meaning they live most of their lives in marine habitats and migrate up large rivers to spawn in freshwater habitats (MDNR, 2007f). The striped bass could occur in the large rivers and streams in the region of the Thiokol site.

As described in the preceding section, the Federally Endangered Dwarf Wedge Mussel is known to occur in a small stream downstream of the Thiokol site. Mitigating measures associated with erosion and sediment control are expected to be sufficient to avoid impacting this species. While much of the supporting CWIS structure will be located onshore, a portion will extend a short distance into the waterway and will likely involve the dredging of sediment to allow for the construction of the concrete structure on the bottom of the river. The dredging of sediment during construction of the CWIS and pipeline will result in the temporary suspension and redeposition of the sediment, as well as the removal of those benthic organisms living in or on the removed sediment. It is anticipated that the suspended sediment will quickly redeposit in the immediate area, however, and that protective measures such as siltation curtains and coffer dams may substantially control migration of suspended sediment outside of the work area.

No construction effluents are anticipated from in-water construction activities. BMPs and compliance with permit requirements will be used to minimize runoff volumes and impacts. The use of a cofferdam to facilitate construction of the inwater portions of the CWIS will minimize releases of sediment. Prior to commencement of dredging, sediment in those areas proposed to be dredged will be sampled and analyzed to obtain detailed chemical characterizations according to the requirements of dredging permits; special sediment handling requirements suggested by the sediment sampling results and required by the dredging permit will be followed.

CWIS and pipeline construction-related impacts on aquatic species are anticipated to be minor because the area of impacts is limited to the immediate vicinity of the construction activities. Because the potential impacts will be localized and given the short-term nature of the construction activities and the relatively short-term recovery periods for disturbed benthic species within and near the dredged area, no long-term effects on important species and their habitats are anticipated to occur. Therefore, the adverse aquatic ecology impacts associated with construction of the CWIS and other appurtenant structures (such as blowdown and discharge pipelines) are anticipated to be SMALL to MODERATE.

Any impacts to state-protected aquatic species on the site, from the proposed water intake and cooling water discharge lines, and from construction of electrical transmission lines would likely be SMALL to MODERATE. Operation of the proposed new reactor is expected to have a SMALL impact on the aquatic ecology in the area.

9.3.2.4.6 Socioeconomics

The former Thiokol site is located within census tract (CT) 995600 block group (BG) 3, St. Mary's County, Maryland. In 2007 St. Mary's County had a population of approximately 100,262, a 16.0 percent increase from 2000. In 2000 and 2005 the population within CT 995600 BG 3 was 812 and 817, respectively. The population density for CT 995600 BG 3 in 2000 and 2005 was 125 ppsm and 134 ppsm, respectively. The population density of St. Mary's County in 2000 and 2005 was 139 ppsm and 152 ppsm, respectively. The 2005 and 2007 population data presented is projected and therefore an estimated value (MDSDC, 2009; USCB, 2009).

Census tract data from 2000 were reviewed to determine the average population density within a 20-mi (32.2-km) radius of the former Thiokol site. Based on these data, there are 150 ppsm within this area (USCB, 2000d). The 150 ppsm includes seasonal transient populations. When using population data from the year 2000 as a baseline, St. Mary's County is estimated to have experienced a population increase of 25.0 percent by 2010, 38.6 percent by 2015, and 51.7 percent by 2020 (MDSDC, 2007).

There were no population centers having greater than 25,000 people within 5 miles of the former Thiokol site. The nearest large town greater than 25,000 people was St. Charles approximately 20.3 miles away.

Assuming an estimated in-migration range of approximately 1,880 and 3,245 people into St. Mary's County during construction, the increase in population size would be approximately 1.8% and 3.2%. The increase due to operations workers would be considerably less. For purposes of evaluating the Calvert site, the region of influence (ROI) included St. Mary's and Calvert Counties. If in-migrating households associated with the Thiokol site were distributed within this larger ROI, any impacts on public services would be further reduced.

Median household income in St. Mary's County based on the 2005-2007 U.S Census estimates was $71,559. This compared to $66,783 for the state of Maryland. The median value of owner occupied homes was $312,300 and $323,400 for St. Mary's County and the state, respectively (USCB, 2009).

Employment projections within the area indicate a general upward trend in the availability of various construction jobs. The Maryland Occupational Projections for 2004 to 2014 for construction trades workers estimates an increase of 52,000 openings from 135,000 in 2004 to 163,000 in 2014 (MDLLR, 2009). In 2007, the unemployment rate in St. Mary's County and in the southern Maryland area was 3.0%. There were 49,571 people employed in St. Mary's

County, of which 1,830 were in construction. The southern Maryland area, encompassing Calvert, Charles and St. Mary's Counties, employed 167,800 people, of which 8,600 were in construction jobs (MDLLR, 2008a). There were 5,180 peopled unemployment during that same period in southern Maryland (MDLLR, 2009). Within a 50 mile radius of the site, the project construction work force would represent less than 2% of the total construction workforce. The population of this 50 mi (80 km) geographic area is 3,702,936 (USCB, 2000f). An increase of available jobs indicates competition in acquiring a workforce for the construction of the project depending on the region from which workers in-migrate. The employer tax credits available include: federal, state, work opportunity, employment opportunity, welfare to work, enterprise zone, Maryland disability employment, and individuals with barriers to employment (MDLLR, 2008b).

According to 2005-2007 American Survey data, approximately 3,808 housing units were vacant, representing 9.5 percent of the total housing units within St. Mary's County (USCB, 2009). Within the 50 mile radius, there were an estimated 145,957 housing units available. Since only a portion of the construction workers and their families would in-migrate, there should be ample housing for the construction and operational phases of the nuclear plant if located in the region.

Public water and wastewater treatment facilities are available within St. Mary's County. A total of over 40,000 people are served through ground water sources derived from 27 water systems. Water treatment capacity is over 12 mgd and average daily flow about 5.4 mgd. Four waste water treatment facilities provided a total capacity of 6.3 mgd with an average daily flow of 5 mgd serving 36,000 people. Additional information is found in ER Section 2.5.2.9 for St. Mary's County. Emergency services are found in ER Section 2.5.2.9 as well.

Information regarding recreational opportunities and open space in St. Mary's and the region are found in ER Section 2.2 and 2.5.2. Public facilities include boat ramps, beaches, fishing piers, local playgrounds, recreational centers and over 20 public parks. There are also four state parks.

Information on the tax base in St. Mary's County is found in ER Section 2.5.2.7. St. Mary's had a 0.872 percent property tax rate in 2006 and a 3.00 percent income tax rate. Total tax revenues in 2005 were about $145.2 million. By way of comparison, $16.2 million in property taxes were paid by Calvert Cliffs Units 1 and 2 in 2007.

The cooling tower plume from the proposed facility would likely be visible at a considerable distance. The proposed facility, however, is predominately wooded and therefore would have some viewshed protection.

Overall impacts to the area population from construction and operation of a new reactor would be SMALL due to proximity of workforce, positive employer environment, and aesthetics.

9.3.2.4.7 Transportation

Maryland State Route 235 / Three Notch Road (MD 235) runs along the northern border of the site. Access to the site must be from MD 235 because all other roads near the site are local residential roads. MD 235 is an important north/south road connecting many of the smaller communities in the county. It is the main transportation route in this area of the county. MD 245 / Hollywood Road is the closest east-west transportation route south of the site and MD

5 / Loveville Road is the closest east-west transportation route north of the site. Many of the local roads surrounding the site do not have good connections with other roads.

The closest airport is the St. Mary's County Airport located approximately 5 mi (8.0 km) south of the site off of MD 235. The site is less than 3 mi (4.8 km) from the Patuxent River but it has no immediate barge access (MPA, 2009). The site is approximately 17 mi (27.3 km) from the nearest active rail line.

It is anticipated that there will be traffic impacts on local roads during construction and operation activities. The development of a traffic management plan prior to construction would aid in identifying and mitigating potential traffic impacts. The following mitigation measures will be considered in the traffic management plan:

Workforce shift changes and delivery options: Scheduling shift changes and the delivery of large items during off-peak hours could reduce potential impacts on local roads.

Carpooling: The use of carpooling and providing transit services (buses) during construction and operation of the facility could be considered.

Coordination with local planning authorities: If necessary, the upgrading of local roads, intersections, and signals to handle increased traffic loads could be considered. Implementing the appropriate mitigation measures would result in SMALL to MODERATE impacts on transportation systems during construction activities and SMALL impacts during operation of the proposed facility.

9.3.2.4.8 Historic, Cultural, and Archeological Resources

The former Thiokol Site is located in Mechanicsville, St. Mary's County, Maryland. The county, the first established in Maryland, is located on a peninsula between the Patuxent and Potomac Rivers in southern Maryland. Mechanicsville, located in the northern portion of the county, is considered an unincorporated area of Maryland. St. Mary's City, more than 20 mi SSW of the site, was settled by colonists from England in 1634. St. Mary's City was the provincial capital of Maryland until 1695; the seat is now Leonardtown.

There are no NRHP-listed properties in Mechanicsville (NPS, 2008b). According to data available from the MHT and the NRHP, three NRHP-listed properties are within five miles of the site (MHT, 2008; NPS, 2009b). There are no NRHP-listed properties or NRHP-listed historic districts within one mi (1.6 km) of the site.

This county contains some of the earliest settlements in the country, an indication that historic archaeological sites may be present on the site. However, removal of a number of buildings in the 1950s followed by razing of all remaining buildings in the early 1980's, and subsequent soil removal between 1992 and 2000, reduce the potential for finding significant archaeological and above ground architectural resources on the site.

A complete cultural resources investigation of both the archaeological and architectural resources would be needed before construction activities begin. This work would be done in consultation with the Maryland State Historic Preservation Officer and should any significant cultural resources be identified, appropriate mitigation measures would be negotiated prior to construction and operation. Impacts to cultural resources are likely to SMALL, based on no NRHP-listed properties on NRHP-listed historic districts within one mi (1.6 km) of the site and the low number of NRHP-listed historic properties within five miles of the site.

9.3.2.4.9 Environmental Justice

The 50 mile radius of the former Thiokol site included portions of Washington DC, Maryland and Virginia. There were a total of 2,385 census block groups. Of these, 873 classified as aggregate minority populations (Table 9.3-11). African American minority census block groups totaled 665. There were 116 census block groups that classified as Hispanic populations. The region of influence for this site was considered to be St. Mary's County and Calvert County similar to that used to evaluate the socioeconomic impacts of the Calvert site. As discussed in ER Section 9.3.2.1.9 and 4.4.3, there were no minority census block groups in Calvert County and two in St. Mary's County. One of these two classified as an African American population. Similarly, there were no low income census block groups in Calvert County or St. Mary's County.

Based on the data presented in Table 9.3-11, no disproportionately high percentage of minority or low income residents would be directly impacted by construction and operation of the proposed project. The economic benefits of the facility to the region would likely benefit minority and low-income populations to some extent, either directly by offering new jobs or indirectly through secondary job creation and increased services from the increased tax revenue. It is anticipated therefore, that environmental justice impacts would be SMALL.

9.3.2.4.10 Transmission Corridors

The former Thiokol site was not used for power generation and has no existing power transmission lines or corridors. New transmission corridors would be necessary to connect with existing or proposed transmission lines. Specific monitoring requirements for new transmission lines and corridors and associated switchyards would be designed to satisfy conditions of applicable federal, state, and local permits, to minimize adverse environmental impacts, and to ensure that organisms are protected against transmission line alterations.

Most transmission corridors would pass through land that is primarily agricultural and forest land. New transmission corridors would result in some ecological impacts from potential surface water and wetlands crossings. The areas are mostly rural and remote with low population densities. The effect of these corridors on land usage is minimal; farmlands that have corridors passing through them generally continue to be used as farmland. Because new right-of ways would need to be constructed to accommodate the new transmission lines, it is anticipated that construction impacts from the development of new transmission corridors would be MODERATE to LARGE due to the commitment of land and construction impacts on ecological resources.

Operational activities within the transmission corridors might include visual inspection and appropriate maintenance of transmission line ROWs. Maintenance activities might include reclearing vegetation, tree trimming/removal, and encroachment licensing/removal. For maintenance purposes, wooded sections of the ROW would be recleared to the full width through mechanical clearing, hand cutting, or herbicide application. Overall operation transmission impacts are anticipated to be SMALL.

9.3.2.5 Generic Greenfield Site

A greenfield site is one that is undeveloped, not having been used previously for any industrial purpose (NRC, 1996). As such, it is possible that some portion of the greenfield site has been disturbed, for example, for agricultural use. It would, therefore, have no likely history of industrial legacy contamination, no prior NRC review, and limited or no data collected regarding characterization.

No specific location for the hypothetical greenfield site was selected; however, a qualitative analysis can be done regardless. In general, it could be postulated that the hypothetical site would be situated such that water resources are not challenged (e.g., the site is located near the Chesapeake Bay or the lower reaches of the main rivers within this ROI) and that the site would not be detrimentally challenged with grid interconnection issues. Guided by relevant impact areas suggested in the NRC's Table 9.3-2, NUREG-1555 (NRC, 1999) for alternative site reviews, the following qualitative analysis is provided. Expected impacts associated with siting the new facility at the CCNPP site are summarized in ER Table 10.1-1 (for unavoidable adverse impacts). This table is the primary source for impact information used in the following discussion. For impacts not expected to result in unavoidable adverse impacts, Sections 4 and 5 of this report were consulted.

9.3.2.5.1 Land Use

Relative to the proposed site, land use for a new nuclear facility would likely require more land commitment at a greenfield site due to exclusion area requirements. A new nuclear facility takes substantial advantage of the currently existing 2070 acre (838 hectare) site with adequate (residence free) area for an exclusion area boundary, which is wholly within the CCNPP site property boundary.

A new nuclear facility would use a portion of the current site switchyard to connect to the transmission system for offsite independent circuit requirements in addition to having a new switchyard for the new unit. For the greenfield site, additional land would be required to meet this need. It is also likely that additional land would be required, overall, for transmission line corridors to support the greenfield site. It is conceivable that the greenfield site may be located near a well-developed transmission system.

In addition, depending on the extent to which the greenfield site has been disturbed (from prior non-industrial use), it is possible that its larger land use demands could impact a greater amount of undisturbed land as well.

The need to obtain land, including easements, from third parties, as well as the considerable size of property that would need to be obtained, would also make greenfield sites less favorable. A greenfield site is most likely currently zoned as agricultural, forest or natural resource management. This consideration also holds true for existing nuclear facilities for which additional land must be obtained.

The impact on land use for a greenfield site for construction and operation of a nuclear power plant would be SMALL to MODERATE because of the likely need to acquire, rezone, and disturb the land. Based on this expected greater land use demand, the greenfield site alternative would neither be "Environmentally Preferable" nor obviously superior.

9.3.2.5.2 Air Quality

Air quality impacts of construction and operation of a new nuclear unit would likely be similar at the CCNPP site and the alternative sites. The construction impacts would include dust from disturbed land, roads, and construction activities and emissions from construction equipment. These impacts would be similar to the impacts associated with any large construction project. A discussion of measures that UniStar Nuclear Operating Services, LLC and Calvert Cliffs 3 Nuclear Project, LLC would take to mitigate air quality impacts at the proposed CCNPP site is provided in Chapters 4 and 5. The same or similar measures would be taken if a new nuclear unit were to be constructed at any of the alternative sites. For purposes of the evaluation of the greenfield site, it is reasonable to assume that the air quality impacts of emissions from vehicles used for construction worker transportation likely would be similar at all sites and temporary.

Impacts of operation of a new nuclear plant on air quality are related primarily to the operation of standby generators and cooling towers. The operation of standby generators is independent of the site. Similarly, the quantity of cooling tower drift is generally a function of cooling tower design, not the site. The assumption is made that UniStar Nuclear Operating Services, LLC and Calvert Cliffs 3 Nuclear Project, LLC would comply with all regulations related to emissions from generators. Cooling towers would use current technology to minimize drift. Based on identified limiting meteorological parameters at the CCNPP site, aspects of drift are assumed to be generally equivalent for the generic greenfield site.

The physical impacts of construction would be similar at all of the alternative sites. People who work or live around the alternative sites could be exposed to noise, fugitive dust, and gaseous emissions from construction activities. Construction workers and personnel working on-site could be the most impacted. Air pollution emissions are expected to be controlled by applicable best management practices and federal, state, and local regulations.

During station operation, standby diesel generators used for auxiliary power would have air pollution emissions. It is expected that these generators would see limited use and, if used, would be used for only short time periods. Applicable federal, state, and local air pollution requirements would apply to all fuel-burning engines. At the site boundary, the annual average exposure from gaseous emission sources is anticipated not to exceed applicable regulations during normal operations. The impacts of station operations on air quality are expected to be minimal. As with construction impacts, potential offsite receptors are generally located well away from the site boundaries.

In summary, air quality impacts would be expected to be SMALL and comparable to other candidate sites during construction due to the adherence to regulatory requirements and SMALL during operation due to typically low emissions for an operating nuclear power plant. Therefore, the greenfield alternative may be generally equivalent but not obviously superior.

9.3.2.5.3 Water

Overall, lasting impacts to the CCNPP site from a new nuclear facility to local streams would be minimal. Some sedimentation is expected during construction but would not be expected to change the current characteristics of the streams. Impacts to groundwater from a new nuclear facility are minor and localized; and no impact to offsite users is expected. The largest portion of raw water makeup for a new facility is to be drawn from the Chesapeake Bay. Raw water makeup withdrawal is a very small percentage of Susquehanna River inflow to the Chesapeake Bay. In general, similar levels of impact could be expected from construction and operation of a new facility at a greenfield site located near the Maryland shore, but the relative impacts would also depend on surface water availability and layout of streams and topography at that site. In fact, if the greenfield site did not use the Chesapeake Bay, and instead used groundwater or small rivers or ponds for cooling, then relative water use impacts could be significantly greater than that assumed for a typical nuclear plant site.

In summary, assuming the greenfield site uses the Chesapeake Bay or lower reaches of major rivers, large water sources, for raw water, the impact on water use and water quality would be SMALL for construction and SMALL to MODERATE for operation. Given the overall minimal impact of the proposed project to surface water and ground water, the greenfield site alternative would neither be "Environmentally Preferable" nor obviously superior.

9.3.2.5.4 Terrestrial Ecology and Sensitive Species

Approximately 460 acres (186 hectares) of land would be impacted by construction of the new facility. About 320 acres (129 hectares) of land would be occupied by permanent structures for a new nuclear facility. The remaining land (i.e., about 140 acres (57 hectares)) would be revegetated and allowed to revert to a natural state.

Given the likely increased land use required at a greenfield site related to undisturbed areas and switchyard/transmission needs, a corresponding larger impact to terrestrial resources is expected. It can be assumed that greater land use would likely translate into greater permanent displacement of wildlife and impact to habitats. It is assumed that there are no endangered, threatened or sensitive species present at the greenfield site.

The impact on terrestrial ecology and sensitive species for a greenfield site is expected to be SMALL to MODERATE for construction due to the increased land use related to undisturbed areas and SMALL for operation due to return of part of the land disturbed by construction to a natural state. Therefore, a greenfield site would not be "Environmentally Preferable" or obviously superior to other sites.

9.3.2.5.5 Aquatic Ecology and Sensitive Species

Overall, due to construction and operation, siting of a new facility at the CCNPP Site was demonstrated to have no more than a SMALL to MODERATE impact to aquatic biological resources, including consideration of intake impacts, thermal discharge plumes, stream alteration, sedimentation, etc.

Ten operational impacts of cooling water systems on aquatic ecology (including issues concerning gas supersaturation, water quality, nuisance organisms, and others) determined to be applicable to current operating nuclear power plants were evaluated in NUREG-1437. These impacts were found to be minimal for all currently operating plants and, based on the nature of these ecological effects, it is expected that they would also be minimal for the next generation of nuclear plants. However, other potential impacts of water intake and discharge systems on aquatic ecosystems at nuclear power plants such as impingement and entrainment of fish and shellfish are site-specific and depend on factors related to specific features of the design and construction of these systems.

Construction activities would likely result in only temporary disturbance to most aquatic resources. However, alterations to any water bodies or wetlands within the construction footprint would likely result in permanent impacts. Depending on the location of the greenfield site, impacts may be equivalent or greater.

The expected impact on aquatic ecology and sensitive species for a greenfield site may range from SMALL to MODERATE for construction (intake impacts, stream alteration) and SMALL for operation as any impacts would already have been made during construction. Therefore, the greenfield alternative may be generally equivalent but not obviously superior.

9.3.2.5.6 Socioeconomics

Regarding impacts to housing, public services, transportation networks, etc., relative assessments of the CCNPP site vs. a hypothetical greenfield site are dependent on the specific greenfield site location. However, such socioeconomic impacts from a new nuclear facility on the CCNPP site and surrounding area were assumed, in general, to be distributed throughout a relatively large area with minor localized impacts to the communities in which the construction or operating workers (and their families) reside. Impacts to principally used transportation routes (i.e., State Highways and Interstates) during commuting periods are expected to be SMALL and within the capacity of the transportation networks. Impacts to local town and county roads used during construction to gain site access are expected to be SMALL to MODERATE, depending on the extent of local infrastructure. Given the likelihood of selecting a similarly located greenfield site in a relatively remote, non-urban setting, impacts would be expected to be roughly equivalent assuming the existing nuclear plant site is not located next to a highway.

The most prominent additional visual features, from an aesthetic perspective, are the natural or mechanical draft cooling towers (and associated plumes). Given that the CCNPP site already includes two nuclear power plants with tall structures, the additional tower is not considered to have substantial, additional aesthetic impact. A greenfield site could be designed to include low profile cooling towers and could be a sufficient distance away from nearest residence or public area to minimize aesthetic impacts from this and other structures (such as containment building, transmission lines and towers). Therefore, aesthetic impacts to the greenfield site would be SMALL to MODERATE.

In addition, the existing CCNPP facility is already integrated into the socioeconomic, land use, and aesthetic environment of the area. It is reasonable to assume that an additional unit would be consistent with this baseline and result in a SMALL impact. With a greenfield site, depending on its location, the impacts would be new and may have SMALL to MODERATE impacts on the area.

Based on the above considerations, it is not likely that the greenfield site alternative would be evaluated as environmentally preferable or obviously superior in any of these socioeconomic related impact areas.

9.3.2.5.7 Transportation

Regarding impacts to transportation networks, etc., relative assessments of the CCNPP site vs. a hypothetical greenfield site are dependent on the specific greenfield site location. However, such socioeconomic impacts from a new nuclear facility on the CCNPP site and surrounding area were evaluated, in general, to be distributed throughout a relatively large area with minor localized impacts to the communities in which the construction or operating workers (and their families) reside. Impacts to principally used transportation routes during commuting periods are expected to be SMALL and within the capacity of the transportation networks. Given the likelihood of selecting a similarly located greenfield site in a relatively remote, non-urban setting, transportation networks may have to be substantially improved for various reasons. The use of a greenfield site may not have the advantage of these improved roadways, thus resulting in greater transportation related impacts. Therefore, the impact on transportation for a generic greenfield site is SMALL to MODERATE. Therefore, the greenfield alternative environmental impact may be larger and not obviously superior.

9.3.2.5.8 Historic, Cultural, and Archeological Resources

Regarding impacts to historic, cultural, and archeological resources, relative assessments of the CCNPP site vs. a hypothetical greenfield site are dependent on the specific greenfield site location. However, such an impact from a new nuclear facility on the CCNPP site and surrounding area were evaluated, in general, to be SMALL. Given the likelihood of selecting a similarly located greenfield site in a relatively remote, non-urban setting, historic, cultural and archeological resources impacts are expected to be SMALL. Therefore, the greenfield alternative may be generally equivalent but not obviously superior.

9.3.2.5.9 Environmental Justice

The environmental justice analysis of the CCNPP site identified the presence of minority and low income groups residing in communities within a 50 mile radius of the CCNPP site. Calvert County had no minority or low income populations. A new facility at Calvert was determined to have no significant adverse environmental impacts and, as such, would not result in a disproportionate impact to the minority and/or low income populations. It is likely that a similar conclusion would be reached regarding a greenfield site as the site would likely be located in a largely rural area. Therefore, the environmental justice impacts for the greenfield alternative would be similar to the CCNPP site and be SMALL. Therefore, the greenfield alternative may be generally equivalent but not obviously superior.

9.3.2.5.10 Transmission Corridors

A new nuclear facility at the proposed site would connect to the current switchyard. For the greenfield site, additional land would be required to meet this need. It is also likely that additional land would be required, overall, for transmission line corridors to support the greenfield site. It is conceivable that the greenfield site may be located near a well-developed transmission system. However, General Design Criteria 17 (GDC 17) of Appendix A to 10 CFR 50 contains demanding requirements for offsite physical independence and the number of separate transmission lines. This requirement may not be met by a greenfield site simply located near a transmission line or even near a typical industrial site that is not subject to GDC 17. The criteria related to physical independence and the number of separate transmission lines would likely require additional transmission corridors to support most greenfield sites. While a new nuclear facility at the CCNPP site may require additional transmission line support in the existing right of way (ROW), it is likely that most greenfield sites, in meeting GDC 17 requirements, would require substantially more transmission line construction and, therefore, have greater related land use impacts.

For impacts resulting from transmission line operation and transmission line ROW maintenance, the assumption is made in the Generic Environmental Impact Statement (NRC, 1996) that any existing transmission lines at a greenfield site would not have the capacity to carry the power that would be generated by a new nuclear unit. Therefore, it is assumed that any transmission system upgrades would require the addition of new lines that would result in expansions of the existing ROWs and that such expansions could consist of doubling current corridor widths.

Given these assumptions, the need for new transmission corridors for a generic greenfield site would result in a SMALL to MODERATE environmental impact. Therefore, the greenfield alternative environmental impact may be larger and not obviously superior.

9.3.3 Summary and Conclusions

The detailed site evaluations are contained in the Calvert Cliffs Alternate Site Evaluation, October 2009 (UniStar, 2009). Table 9.3-5, Weighted Scoring of Candidate Sites, compares the weighted numerical scores of the Selected and Candidate sites derived from the above referenced Alternate Site Evaluation. Table 9.3-9 is a Comparison of Proposed and Alternate Sites using the NRC Three-level Standard of significance. The Summary and Conclusions based upon the foregoing are discussed below.

The advantages of the CCNPP site over the alternative sites are summarized as follows:

- The postulated consumptive use of water by a new unit at the CCNPP site would be no greater than water use at the alternative sites.

- The CCNPP3 project site contains habitat suitable for the federally-listed endangered Puritan tiger beetle and the federally protected bald eagle. Four bald eagle nests are present on the CCNPP site, although all may not be active. One nest is in the CCNPP3 project construction footprint and would be impacted by the development.

- The CCNPP site does not contain spawning grounds for any threatened or endangered species. Thus, the impacts on spawning areas are not greater than impacts at the alternative sites.

- The CCNPP site impact review does not postulate effluent discharge beyond the limits of existing National Pollutant Discharge Elimination System permits or regulations. Based on the information available for the alternative sites, the impacts from effluent discharge at the proposed site would be no greater than impacts at the alternative sites.

- The siting of the new unit at the CCNPP site would require the pre-emption of lands currently zoned farm and forest district, and light industrial for construction and operation. Because siting of a new unit at most of the alternative sites would require pre-emption of lands currently zoned for agriculture or rural preservation district, land impacts at the proposed site would be no greater than the impacts at the alternative sites.

- The potential impacts of a new nuclear facility on terrestrial and aquatic environments at the CCNPP site would be no greater than the impacts at the alternative sites.

- The CCNPP site is in a generally rural setting and has a population density that meets the population criteria of 10 CFR Part 100.

- The CCNPP site does not require decommissioning or dismantlement of an existing facility, aswould be required for the Bainbridge or Thiokol Sites.

As summarized in , no alternative sites are "Environmentally Preferable," and therefore cannot be considered obviously superior, to the CCNPP site. Development of a greenfield or brownfield site would offer no advantages and would increase both the cost of the new facility and the severity of impacts. Collocation of the new reactor unit at an existing site would allow existing infrastructure and transmission lines to be used.

The existing facility currently operates under an NRC license, and the proposed location has already been found acceptable under the requirements for that license. Further, operational experience at the CCNPP site has shown that the environmental impacts are SMALL, and operation of a new unit at the site should have essentially the same environmental impacts.

9.3.4 References

BDC, 2009. Bainbridge Development Corporation. Website: http://www.msa.md.gov/msa/mdmanual/25ind/html/08bain.html. Accessed May 5, 2009.

Butterflies and Moths of North America, 2009. Occurrence maps, species accounts, checklists, and photographs: Species detail, Edward's hairstreak, available at: http://www.butterfliesandmoths.org/species?l=1499, accessed August 24, 2009.

CCDES, 2009. Cecil County Department of Emergency Services, 2009. Website: http://www.ccdes.org/emergencymanagement.cfm, accessed July 11, 2009.

CCGDB, 2009. Cecil County, MD, Government Department of Budget, 2009 Approved Budget. Website accessed 8/24/09. http://www.ccgov.org/dept_budget/index.cfm.

CCMT, 2009. Cecil County, Maryland Tourism. Website accessed 8/24/09. http://www.ccgov/tourism.cfm.

CCOED, 2009. Cecil County Enterprise Zones, Website: http://www.ccgov.org/dept_ecdev/business_enterprise.cfm, accessed August 24, 2009.

CFR, 2007. Title 10, Code of Federal Regulations, Part 51, Appendix B to Subpart A, Environmental Effect of Renewing the Operating License of a Nuclear Power Plant, 2007.

City Data, 2009. Port Deposit, Maryland Detailed Profile. Website accessed 8/24/09. http://www.city-data.com/city//Port-Deosit-Maryland.html

COMAR, 2009a. Code of Maryland Regulations. Office of the Secretary of State, Division of State Documents. Title 26 Department of Environment, Subtitle 08 Water Pollution, 02 Water Quality, 08 Stream Segment Designations (COMAR 26.08.02.08). Website: http://www.dsd.state.md.us/comar/26/26.08.02.08.htm.

COMAR, 2009b. Code of Maryland Regulations, Office of the Secretary of State, Division of State Documents, Title 26 Department of Environment, Subtitle 08 Water Pollution, 02 Water Quality, 03-3 Water Quality Criteria Specific to Designated Uses (COMAR 26.08.02.03-3). Website: http://www.dsd.state.md.us/comar/26/26.08.02.03-3.htm.

COMAR, 2009c. Code of Maryland Regulations, Office of the Secretary of State, Division of State Documents, Title 26 Department of Natural Resources, Subtitle 17 Water Management, 07 Consumptive Use of Surface Water in the Potomac River Basin, 03 Conditions and Procedures (COMAR 26.17.07.03), available at: http://www.dsd.state.md.us/comar/getfile.aspx?file=26.17.07.03.htm, accessed on June 26, 2009.

DOL, 2009. Department of Labor, Bureau of Labor Statistics, 2008. May 2008 Metropolitan and Nonmetropolitan Area Occupational Employment and Wage Estimates: 47-000 Construction and Extraction Occupations, Website accessed July 1, 2009. http://www.bls.gov.oes/curent/county_links.htm.

EPA, 2000. EPA/ROD/R03-00/007, EPA Superfund Record of Decision: Naval Training Center Bainbridge, EPA ID: MDD985397256, OU 01, 02, Bainbridge, MD, U.S. Environmental Protection Agency, February 10, 2000.

EPA, 2008. EPA Green Book for Currently Designated Nonattainment Areas for All Criteria Pollutants, U.S. Environmental Protection Agency, Website: www.epa.gov/oar/oaqps/greenbk/ancl.html. Accessed June 20, 2008.

EPA, 2009a. Superfund Information Systems, Record of Decision System, Naval Training Center Bainbridge, U.S. Environmental Protection Agency. Website http://cfpub.epa.gov/superrods/index.cfm?fuseaction=data.rodinfo&id=0304605&mRod=03046052000ROD007, accessed July 11, 2009.

EPA, 2009b. Nonattainment area information (by county) obtained from USEPA in the "EPA Green Book", Website: www.epa.gov/oar/oaqps/greenbk/ancl.html. Accessed July 13, 2009.

EPA, 2009c. PSD Class I area list obtained from USEPA, Website: http://www.epa.gov/visibility/class1.html

EPRI, 2002. Electric Power Research Institute Siting Guide: Site Selection and Evaluation Criteria for an Early Site Permit Application, Final Report, March 2002.

ESRI, 2009. Census Tract Boundaries (Layer), Metadata, 2005 Edition, Website http://www.esri.com/metadata/esriprof80.html

FCDOP, 2009. Frederick County Division of Planning, 2009. Generalized Zoning Map.

FCPS, 2009. Frederick County Public Schools, 2009. Website: http://fcps.schoolwires.com/15291076154630333/site/default.asp

FEMA, 2008. Map Service Center, Federal Emergency Management Agency, Website: http://msc.fema.gov/webapp/wcs/stores/servlet/FemaWelcomeView?storeld=10001&catalogId=10001&langId=-1. Accessed June 20, 2008.

Frederick County Government, 2009. Frederick County, Maryland, Countywide Zoning Map Update Process, website: http://www.co.frederick.md.us/index.aspx?NID=2793, accessed August 24, 2009.

Google Earth, 2009. National Register Listed Properties in Google Earth, South Region, website: http://nrhp.focus.nps.gov/natreg/docs/Download.html, accessed on June 18, 19, 25, and August 14, 2009.

ICPRB, 2009. Interstate Commission on the Potomac River Basin, available at: http://www.potomacriver.org/cms/index.php?option=com_content&view=article&id=1&Itemid= 28, accessed August 24, 2009.

McCauley, 2009. Conversation record between Charles Donaldson, CH2M HILL, and Ms. Susan McCauley, St. Mary's County Department of Land Use and Growth Management. June 22, 2009.

MDBED, 2009a. Enterprise Zone Tax Credits, Maryland Department of Business and Economic Development, website: http://www.choosemaryland.org/businessservices/taxincentives/enterprisezone.html, accessed August 26, 2009.

MDBED, 2009b. Maryland Department of Business and Economic Development. Website accessed 8/24/2009. http://www.choosemaryland.org.

MDDNR, 2008. Endangered Species Natural Heritage Program, Maryland Department of Natural Resources. Website: http://www.dnr.state.md.us/wildlife/espaa.asp. Accessed July 16, 2009.

MDDOL, 2008a. Susquehanna WIA Occupational Projections: 2004-2014; Construction and Extraction Occupations, Maryland Department of Labor - Licensing and Regulation. Website: http://dllr.maryland.gov/lmi/iandoproj/susquehanna/occgroup47.shtml.

MDDOL, 2008b. Frederick WIA Occupational Projections: 2004-2014; Construction and Extraction Occupations, Maryland Department of Labor - Licensing and Regulation. Website: http://dllr.maryland.gov/lmi/iandoproj/frederick/occgroup47.shtml.

MDE, 2009. Land Restoration Program, Maryland Department of the Environment. Website: http://mdeerrp.towson.edu/ERRP/. Accessed July 11, 2009.

MDLLR, 2008a. St. Mary's County Fact Sheet. Division of Workforce Development Office of Workforce Information and Performance, Maryland Department of Labor, Licensing and Regulation, July 2007.

MDLLR, 2008b. Maryland Tax Credit Programs, Division of Workforce Development, Maryland Department of Labor, Licensing and Regulation, 2008. Website: http://dllr.maryland.gov/employment/taxcredits.shtml. Accessed August 2008.

MDLLR, 2009. Southern Maryland WIA Occupational Projections: 2004-2014; Construction and Extraction Occupations, Maryland Department of Labor - Licensing and Regulation, Website: http://dllr.maryland.gov/lmi/iandoproj/southern/. Accessed July 16, 2009.

MDNR, 2004. Upper Monocacy River Stream Corridor Assessment Survey, Watershed Assessment and Targeting Division, Watershed Services.

MDNR, 2007a. 2006-2007 Maryland Game Program Annual Report – Wild Turkey and Upland Game Birds, available at: http://www.dnr.maryland.gov/wildlife/gpar/gpupland.asp, accessed August 21, 2009.

MDNR, 2007b. Maryland DNR – Fisheries Service – Fish Facts: Smallmouth Bass, available at: http://www.dnr.state.md.us/fisheries/fishfacts/smallmouthbass.asp, accessed August 24, 2009.

MDNR, 2007c. Maryland DNR – Fisheries Service – Fish Facts: Chain Pickerel, available at: http://www.dnr.state.md.us/fisheries/fishfacts/chainpickerel.asp, accessed August 24, 2009.

MDNR, 2007d. Maryland DNR – Fisheries Service – Fish Facts: Bluegill, available at: http://www.dnr.state.md.us/fisheries/fishfacts/bluegill.asp, accessed August 24, 2009.

MDNR, 2007e. Maryland DNR – Fisheries Service – Fish Facts: Largemouth Bass, available at: http://www.dnr.state.md.us/fisheries/fishfacts/lgmouthbass.asp, accessed August 24, 2009.

MDNR, 2007f. Maryland DNR – Fisheries Service – Fish Facts: Striped Bass, available at: http://www.dnr.state.md.us/fisheries/fishfacts/stripedbass.asp, accessed August 24, 2009.

MDNR, 2007g. Maryland DNR – Fisheries Service – Fish Facts: Brook Trout, available at: http://www.dnr.state.md.us/fisheries/fishfacts/brooktrout.asp, accessed August 24, 2009.

MDNR, 2009a. Endangered Animals of Maryland, Wildlife and Heritage Service. Maryland Department of Natural Resources, Website: http://www.dnr.state.md.us/wildlife/rteanimals.asp. Accessed June 26, 2009.

MDNR, 2009b. Endangered Plants of Maryland, Wildlife and Heritage Service Maryland Department of Natural Resources. Website: http://www.dnr.state.md.us/wildlife/rteplants.asp. Accessed June 26, 2009.

MDNR, 2009c. Wildlife & Heritage Service (MD DNR WHS), Maryland's Natural Heritage Areas, Maryland Department of Natural Resources. Website: http://dnrweb.dnr.state.md.us/gis/data/sampledata.asp?data=NHA. Accessed June 19 & 26, 2009.

MDNR, 2009d. Wildlife & Heritage Service (MD DNR WHS), Sensitive Species Project Review Areas, Maryland Department of Natural Resources. Website: http://dnrweb.dnr.state.md.us/gis/data/sampledata.asp?data=SSPRA. Accessed June 19 & 26, 2009.

MDNR, 2009e. White-tailed Deer Fact Sheet, available at: http://www.dnr.state.md.us/wildlife/wtailfs.html, accessed August 21, 2009.

MDNR, 2009f. Eastern Wild Turkey Fact Sheet, available at: http://www.dnr.maryland.gov/wildlife/wildturkey.html, accessed August 21, 2009.

MDNR, 2009g. Natural Heritage Program – RTE Animals – Shortnose Sturgeon, available at: http://www.dnr.state.md.us/wildlife/rtesnsturgeon.asp, accessed August 21, 2009.

MDNR, 2009h. Natural Heritage Program – RTE Animals – Dwarf Wedge Mussel, available at: http://www.dnr.state.md.us/wildlife/dwm.asp, accessed August 24, 2009.

MDPSC, 2007. Interim Report Of The Public Service Commission Of Maryland To The Maryland General Assembly, Maryland Public Service Commission (PSC), dated December 3, 2007.

MDSDC, 2007. Maryland State Data Center, 2007. Website Accessed 8/25/09. www.mdp.state.me.us/MSD/bea/ca07/View Summary 02-07/Table2a.xls

MHT, 2008. Patterson Archeological District, Maryland Historical Trust, 2008. Website. http://www.marylandhistoricaltrust.net/nr/NRDetail.aspx?HDID=677&FROM=NRMapCV.html, Accessed June 20, 2008.

MHT, 2009. Maryland Historical Trust, National Register Listings in Maryland. Website: http://www.marylandhistoricaltrust.net/nr/, accessed on June 18, 19, 25, and August 14, 2009.

MISC, 2003. Invasive Species of Concern in Maryland, available at: http://www.mdinvasivesp.org/archived_invaders/archived_invaders_2003_03.html, accessed August 24, 2009.

MPA, 2009. Maryland Port Administration, Maryland Department of Transportation, Website: http://www.marylandports.com/. Accessed June 26, 2009.

MWCOG, 2009. Environment, Water Resources, Water Supply, Regional Agreements, available at: http://www.mwcog.org/environment/water/watersupply/aggreements.asp, accessed August 24, 2009.

NatureServe Explorer, 2009a. Helionas bullata – L, available at: http://www.natureserve.org/explorer/servlet/NatureServe?searchName=Helonias+bullata, accessed August 21, 2009.

NatureServe Explorer, 2009b. Percina caprodes - (Rafinesque, 1818), available at: http://www.natureserve.org/explorer/servlet/NatureServe?sourceTemplate=tabular_report.wmt&loadTemplate=species_RptComprehensive.wmt&selectedReport=RptComprehensive.wmt&summaryView=tabular_report.wmt&elKey=106504&paging=home&save=true&startIndex=1&nextStartIndex=1&reset=false&offPageSelectedElKey=106504&offPageSelectedElType=species&offPageYesNo=true&post_processes=&radiobutton=radiobutton&selectedIndexes=106504, accessed August 24, 2009.

NatureServe Explorer, 2009c. Strophitus undulatus - (Say, 1817), available at: http://www.natureserve.org/explorer/servlet/NatureServe?sourceTemplate=tabular_report.wmt&loadTemplate=species_RptComprehensive.wmt&selectedReport=RptComprehensive.wmt&summaryView=tabular_report.wmt&elKey=107752&paging=home&save=true&startIndex=1&nextStartIndex=1&reset=false&offPageSelectedElKey=107752&offPageSelectedElType=species&offPageYesNo=true&post_processes=&radiobutton=radiobutton&selectedIndexes=107752, accessed August 24, 2009.

NatureServe Explorer, 2009d. Graptemys geographica - (Le Sueur, 1817), available at: http://www.natureserve.org/explorer/servlet/NatureServe?sourceTemplate=tabular_report.wmt&loadTemplate=species_RptComprehensive.wmt&selectedReport=RptComprehensive.wmt&summaryView=tabular_report.wmt&elKey=101200&paging=home&save=true&startIndex=1&nextStartIndex=1&reset=false&offPageSelectedElKey=105092&offPageSelectedElType=species&offPageYesNo=true&post_processes=&radiobutton=radiobutton&selectedIndexes=105092&selectedIndexes=103126&selectedIndexes=103688&selectedIndexes=103582&selectedIndexes=101200&selectedIndexes=105841&selectedIndexes=106155&selectedIndexes=106258&selectedIndexes=104337&selectedIndexes=105779&selectedIndexes=102685&selectedIndexes=817347&selectedIndexes=101897&selectedIndexes=104427&selectedIndexes=104282&selectedIndexes=102795&selectedIndexes=103963&selectedIndexes=103965, accessed August 24, 2009.

NatureServe Explorer, 2009e. Cicindela dorsalis dorsalis Say, 1817, available at: http://www.natureserve.org/explorer/servlet/NatureServe?searchSpeciesUid=ELEMENT_GLOBAL.2.109729, accessed August 24, 2009.

NatureServe Explorer, 2009f. Gastrophryne carolinensis - (Holbrook, 1836) Eastern Narrowmouth Toad, available at: http://www.natureserve.org/explorer/servlet/NatureServe?searchName=Gastrophryne%20carolinensis, accessed August 24, 2009.

NPS, 2008a. National Register of Historic Places, National Park Service, Website. http://www.nr.nps.gov/iwisapi/explorer.dll?IWS_SCHEMA=NRIS1&IWS_LOGIN=1&IWS_REPORT=100000066, MD/St. Mary's County. Accessed June 20, 2008.

NPS, 2008b. National Register of Historic Places, National Park Service, Website. http://www.nr.nps.gov/iwisapi/explorer.dll?IWS_SCHEMA=NRIS1&IWS_LOGIN=1&IWS_REPORT=100000066, MD/Mechanicsville. Accessed June 20, 2008.

NPS, 2009a. PSD Class I Area location map obtained from National Parks Service, Website: http://www.nature.nps.gov/air/maps/images/ClassIAreas.jpg. Accessed July 13, 2009.

NPS, 2009b. The National Register of Historic Places, National Park Service, Website: http://www.nps.gov/history/nr/research/index.htm. Accessed June 18, 19, 25, and August 14, 2009.

NRC, 1976. Preparation of Environmental Reports for Nuclear Power Stations, Regulatory Guide 4.2. Revision 2, Nuclear Regulatory Commission, 1976.

NRC, 1996. Generic Environmental Impact Statement for License Renewal of Nuclear Plants, NUREG-1437, Volumes 1 and 2, Nuclear Regulatory Commission, 1996.

NRC, 1998. General Site Suitability for Nuclear Power Stations, Regulatory Guide 4.7, Nuclear Regulatory Commission, 1998.

NRC, 1999. Standard Review Plan for Environmental Reviews of Nuclear Power Plants, NUREG-1555, Nuclear Regulatory Commission, October 1999.

NRC, 2007. Standard Review Plan for Environmental Reviews of Nuclear Power Plants, NUREG-1555, Nuclear Regulatory Commission, July 2007.

Scholer, 2007. Analysis of Options for Maryland's Energy Future, Kaye Scholer LLP, Levitan & Associates, Inc., and Semcas Consulting Associates, for the Maryland Public Service Commission, dated November 30, 2007.

Sibley, D.A., 2000. The Sibley Guide to Birds of Eastern North America, The Audubon Society, 490 p. Note: Copyright protected. Electronic version not available for printing. Reference available for purchase.

Town of Port Deposit, 2009. Bainbridge Development News, Website: http://www.portdeposit.org/?a=bainbridge1. Accessed June 18, 2009.

UniStar, 2009. Calvert Cliffs Nuclear Power Plant Unit 3 Alternate Site Evaluation, UniStar Nuclear Energy. October 2009.

USCB, 2000a. Race and Poverty Status in 1999 by Age, Cecil County, U.S. Census Bureau, Website: http://factfinder.census.gov/servlet/DTTable?_bm=y&-context=dt&-ds_name=DEC_2000_SF3_U&-CONTEXT=dt&-mt_name=DEC_2000_SF3_U_P006&-mt_name=DEC_2000_SF3_U_P007&-mt_name=DEC_2000_SF3_U_P087&-tree_id=403&-redoLog=true&-all_geo_types=N&-_caller=geoselect&-geo_id=04000US24&-geo_id=05000US24015&-geo_id=15000US240150312012&-geo_id=15000US240150312013&-geo_id=15000US240150312014&-search_results=05000US24015&-format=&-_lang=en. Accessed July 15, 2009.

USCB, 2000b. Race and Poverty Status in 1999 by Age, Block Group 2, Frederick County, U.S. Census Bureau, Website: http://factfinder.census.gov/servlet/DTTable?_bm=y&-context=dt&-ds_name=DEC_2000_SF3_U&-CONTEXT=dt&-mt_name=DEC_2000_SF3_U_P006&-mt_name=DEC_2000_SF3_U_P007&-mt_name=DEC_2000_SF3_U_P087&-tree_id=403&- redoLog=true&-all_geo_types=N&-_caller=geoselect&-geo_id=04000US24&-geo_id=05000US24021&- geo_id=15000US240217522002&-geo_id=15000US240217522003&- geo_id=15000US240217523001&-eo_id=15000US240217523002&- geo_id=15000US240217523003&-geo_id=15000US240217523004&-geo_id=15000US511076103001&-search_results=15000US240217522002&-format=&-_lang=en. Accessed July 15, 2009.

USCB, 2000c. Race and Poverty Status in 1999 by Age, Block Group 3, Frederick County, U.S. Census Bureau, Website: http://factfinder.census.gov/servlet/DTTable?_bm=y&-context=dt&-ds_name=DEC_2000_SF3_U&-mt_name=DEC_2000_SF3_U_P006&-mt_name=DEC_2000_SF3_U_P007&-mt_name=DEC_2000_SF3_U_P087&-CONTEXT=dt&-tree_id=403&-all_geo_types=N&-geo_id=15000US240217510003&-geo_id=15000US240217510004&-search_results=01000US&-format=&-_lang=en.Accessed July 15, 2009.

USCB, 2000d. Race, Block Group 3 and Block Group 4, St. Mary's County, U.S. Census Bureau, Website: http://factfinder.census.gov/servlet/DTTable?_bm=y&-context=dt&-ds_name=DEC_2000_SF1_U&-CONTEXT=dt&-mt_name=DEC_2000_SF1_U_P007&-mt_name=DEC_2000_SF1_U_P011&-tree_id=4001&-redoLog=true&-all_geo_types=N&-_caller=geoselect&-geo_id=04000US24&-geo_id=05000US24037&-geo_id=15000US240379955001&-geo_id=15000US240379955003&-geo_id=15000US240379956002&-geo_id=15000US240379956003&-geo_id=15000US240379956004&-geo_id=15000US240379957004&-search_results=15000US240379957004&-format=&-_lang=en. Accessed July 15, 2009.

USCB, 2000e. Poverty Status in 1999 by Age, Block Groups 1, 3 (two tracts), and 4, St.Mary's County, U.S. Census Bureau, Website:http://factfinder.census.gov/servlet/DTTable?_bm=y&-context=dt&-ds_name=DEC_2000_SF3_U&-CONTEXT=dt&-mt_name=DEC_2000_SF3_U_P087&-tree_id=403&-redoLog=true&-all_geo_types=N&-_caller=geoselect&-geo_id=04000US24&- geo_id=05000US24037&-geo_id=15000US240379955001&-geo_id=15000US240379955003&- geo_id=15000US240379956002&-geo_id=15000US240379956003&- geo_id=15000US240379956004&-geo_id=15000US240379957004&-search_results=15000US240379955003&-format=&-_lang=en. Accessed July 15, 2009.

USCB, 2000f. Race [71] – Universe: Total Population, Census 2000 Summary File 1 (SF 1), Page 3, U.S. Census Bureau, Website: http://factfinder.census.gov. Accessed on August 24, 2009.

USCB, 2006. American Community Service (ACS), U. S. Census Bureau, Website: http://www.census.gov/acs/www/index.html. Accessed June 19, 2008.

USCB, 2009. American Community Survey (ACS), U.S. Census Bureau, Website: http://www.census.gov/acs/www/index.html. Accessed June 19, 2009.

USFWS, 1993a. Puritan Tiger beetle (Cicindela puritana G. Horn.) Recovery Plan, Hadley, Massachusetts, 45 p.

USFWS, 1993b. Delmarva Fox Squirrel (Sciurus niger cinereus) Recovery Plan, Second Revision, Hadley, Massachusetts, 104 p.

USFWS, 2001. Bog Turtle (Clemmys muhlenbergii), Northern Population Recovery Plan, Hadley, Massachusetts, 103 p.

USFWS, 2008a. CONUS_wet_poly, Classification of Wetlands and Deepwater Habitats of the United States, FWS/OBS-79/31, National Wetlands Metadata, U.S. Fish and Wildlife Service, Website: http://www.fws.gov/wetlands/Data/DataDownloadState.html. Accessed: June 17, 2009.

USFWS, 2008b. National Wetlands Inventory, Branch of Resource and Mapping Support, Geospatial Data – The Wetlands Geo-Web; U.S. Fish and Wildlife Service, Website: http://www.fws.gov/wetlands/. Accessed July 2008.

USFWS, 2009a. Shortnose Sturgeon in the Potomac River, U.S. Fish and Wildlife Service Update, Maryland Fishery Resources Office, July 2009, available at: http://www.fws.gov/northeast/marylandfisheries/reports.html, accessed August 25, 2009.

USFWS, 2009b. Maryland Fishery Resources Office Northeast Region , Shortnose Sturgeon Monitoring Program, available at: http://www.fws.gov/northeast/marylandfisheries/projects/Shortnose%20Sturgeon.html, accessed August 24, 2009.

USFWS, 2009. National Wetlands Inventory, State Downloads, U.S. Fish and Wildlife Service, Website: http://www.fws.gov/wetlands/Data/DataDownloadState.html. Accessed June 17, 2009.

USGS, 2009. USGS Real-Time Water Data for Maryland, U.S. Geological Survey, Website: http://waterdata.usgs.gov/md/nwis/rt. Accessed June 19, 2009.

WCWGP, 2002. Riparian Forest Buffers: A Restoration Solution for Maryland's Chesapeake Bay Program, January 2002, available at: http://na.fs.fed.us/watershed/factsheets/Riparian.pdf, accessed August 24, 2009.

Weakley, A.S., 2009. Flora of the Carolinas, Virginia, and Georgia, and Surrounding Areas: Working Draft of 5 August, 2009, UNC Herbarium, North Carolina Botanical Garden, University of North Carolina at Chapel Hill.

Whitaker, J.O., Jr. and W.J. Hamilton, Jr., 1998. Mammals of the Eastern United States, Third Edition, Comstock Publishing Associates, 583 p. Note: Copyright protected. Electronic version not available for printing. Reference available for purchase.

Table 9.3-1— (Not Used)

Table 9.3-2— Site Ranking Criteria
(Page 1 of 9)

Ranking Criteria	Metric	Scoring Basis
1. Land use, including availability, and areas requiring special consideration		
1a. Ability to support the combined EPR footprint including the protected area, cooling towers, ponds, switchyard, construction support areas SCORED BY EXPERT PANEL	Size and configuration of site	5 = No changes needed in layout and no restrictions for construction work area 3 = Limited changes needed in layout and/or some restrictions for construction work area 1 = Substantive changes needed in layout and/or substantive restrictions for construction work area
1b. Hazardous waste or spoils areas SCORED BY EXPERT PANEL	Based on anticipated need for environmental remediation at the site or interconnects due to known current or previous uses (i.e. listed RCRA, CERCLIS, LUST or other designation)	5 = No/limited anticipated environmental remediation necessary 3 = Unknown if site needs environmental remediation 1 = Expected environmental remediation necessary
1c. Zoning SCORED BY EXPERT PANEL	Compatibility with existing land use planning and proposed development	5 = Area zoned for industrial facilities/operations; no zoning restrictions; known ownership 3 = Area unzoned or unclear if zoning would be an issue; no known zoning restrictions for nuclear/industrial facilities; known ownership 1 = Area zoned for use other than industrial facilities/operations; likely zoning restrictions for nuclear/industrial facilities if zoning change is attempted; ownership unclear, or unknown
1d. Dedicated land SCORED BY EXPERT PANEL	Distance to dedicated land (e.g., Federal, State, Tribal) from site	5 = No dedicated land within 10 miles of the site 3 = Dedicated land located greater than or equal to 5 but less than 10 miles of site 1 = Dedicated lands located within 5 miles of the site
1e. Topography SCORED BY EXPERT PANEL	Site topography and resulting cut-and-fill requirements for construction	5 = Site topography is flat or has less than 50 feet of relief; no/limited cut-and-fill required. 3 = Site topography is hilly with greater than or equal to 50 feet but less than 100 feet of relief in the area to be developed; significant amounts of cut-and-fill required 1 = Site has steep topography with greater than 100 feet of relief in the area of the site to be developed
2. Hydrology, water quality, and water availability		
2a. Water Quality (chemistry) SCORED BY EXPERT PANEL	Applicable State water quality standards (salt, brackish, fresh, polluted) as related to condenser CT cycles prior to blowdown and associated increasing PM emissions	5 = Fresh water 4 = Fresh/Tidal water 3 = Oligohaline water 2 = Mesohaline water 1 = Salt or gray water

Table 9.3-2— Site Ranking Criteria
(Page 2 of 9)

Ranking Criteria	Metric	Scoring Basis
2b. Receiving Body Water Quality SCORED BY EXPERT PANEL	Applicable State water quality classification Tier I, Tier II (as described and defined in COMAR 28.02.08.04-1) and Tier III (Outstanding National Resource Waters [ONRW] as described and defined in COMAR 28.02.08.04-2)	5 = Tier 1 waters (i.e., no special state classification) 3 = Tier II waters (i.e., require antidegradation review of new or amended water/ sewer plans and discharges) 1 = Tier III waters (i.e., ONRW)
2c. Water Availability SCORED BY EXPERT PANEL	Metric based on lowest 7-day average flow with a ten year return frequency (i.e., 7Q10) and need for 50 mgd water supply	5 = Source water body exceeds 7Q10 by 6-to 10% or equal to 10 times the needed volume for the annual requirement [182,500 mgd] 3 = Source water body exceeds 7Q10 by 2 to 5% or source water body is less than or equal to 5 times the needed volume for the annual requirement [91,250 mgd] 1 = Source water body 7Q10 does not meet 50 mgd or source water body is below needed volume for the annual requirement [18,250 mgd]
3. Terrestrial resources (including endangered species)		
3a. T&E habitats SCORED USING SCREENING DATA	Existence of mapped Federal and State T&E species habitat on or adjacent to site	5 = No T&E estimated habitat types onsite 3 = T&E estimated habitat types mapped within 1 mile of the site but not onsite 1 = T&E estimated habitat types onsite
3a. Floodplains SCORED USING SCREENING DATA	Existence of mapped Federal Emergency Management Area (FEMA) 100 or 500 year floodplain or State floodplain zones affecting site footprint	5 = No 100 or 500 year FEMA floodplain or State floodplain zones affecting approximate footprint of site 4 = 100 or 500 year FEMA floodplain or State floodplain zones affecting less than 10% of site footprint 3 = 100 or 500 year FEMA floodplain or State floodplain zones affecting 11% to 20% of site footprint 2 = 100 or 500 year FEMA floodplain or State floodplain zones affecting 21% to 30% of site footprint 1 = 100 or 500 year FEMA floodplain or State floodplain zones affecting greater than 30% of site footprint
4. Aquatic biological resources (including endangered species)		
4a. T&E habitats SCORED USING SCREENING DATA	Existence of mapped Federal and State T&E species habitat on or adjacent to site	5 = No T&E estimated habitat types onsite 3 = T&E estimated habitat types mapped within 1 mile of the site but not onsite 1 = T&E estimated habitat types onsite
4b. Thermal Discharge Sensitivity SCORED USING SCREENING DATA	Designated finfish/shellfish and/or other resource areas within intake or discharge waters	5 = No designated aquatic resources or habitats located within intake or discharge waters 3 = Designated warm water aquatic resources located within intake or discharge waters 1 = Designated cold water or marine aquatic resources located within intake or discharge waters

Table 9.3-2— Site Ranking Criteria

(Page 3 of 9)

Ranking Criteria	Metric	Scoring Basis
5. Socioeconomics (including aesthetics, demography, and infrastructure)		
5a. Emergency services SCORED BY EXPERT PANEL	Availability of existing emergency services infrastructure (police, fire, emergency medical service (EMS), and hospital services) to support increased construction and operation workforce	5 = At least two or more of each full time police, fire, EMS, and hospital services within the county of the proposed site 3 = At least one of each police, fire, EMS, and hospital services within the county of the proposed site 1 = At least one of any of the services part-time or volunteer police, fire, EMS, and hospital services within the county of the proposed site. Some services (e.g., hospital may require flights to other communities).
5b. Construction traffic SCORED BY EXPERT PANEL	Ability of existing transportation infrastructure to support construction traffic	5 = State route or interstate highway within 1 mile 3 = State route or interstate highway greater than 1 but less than 5 miles 1 = State route or interstate highway greater than 5 miles
5c. Construction workforce SCORED BY EXPERT PANEL	Availability of local construction workforce based on State, County, or local planning, zoning and industrial development commission databases. Availability of suitable population within commuting distance from which to draw the construction workforce.	5 = Workforce needed represents less than 5% of construction workforce within 50-mile region. 3 = Workforce needed represents 5 to 20% of construction workforce within 50-mile region. 1 = Workforce needed represents greater than 20% of construction workforce within 50-mile region.
5d. Housing and necessities SCORED BY EXPERT PANEL	Availability of housing units, shopping and other services to support the peak construction workforce	5 = Number of vacant housing units is greater than 10 times the projected peak construction workforce within the counties in a 50 mile radius of the site and population centers of 25,000 or more are located within 5 miles of the site 3 = Number of vacant housing units is greater than 5 times but less than 10 times the *projected peak construction workforce within the counties within a 50 mile* radius of the site and population centers of 25,000 or more are located within 10 miles of the site. 1 = Number of vacant housing units is less than 5 times the projected peak construction workforce within the counties in a 50 mile radius of the site and population centers of 25,000 or more are located greater than 10 miles from site.
5e. Schools SCORED BY EXPERT PANEL	Availability of existing schools to support increased construction and operation workforce	5 = Greater than 1,000 public and/or private high, middle, and elementary schools within a 50 mile radius of the site. 4 = 751 to 1,000 public and/or private high, middle, and elementary schools within a 50 mile radius of the site. 3 = 501 to 750 public and/or private high, middle, and elementary schools within a 50 mile radius of the site. 2 = 251 to 500 public and/or private high, middle, and elementary schools within a 50 mile radius of the site. 1 = Less than or equal to 250 public and/or private high, middle, and elementary schools) within a 50 mile radius of the site.

Table 9.3-2— Site Ranking Criteria
(Page 4 of 9)

Ranking Criteria	Metric	Scoring Basis
6. Environmental Justice (EJ)		
6a. Minority population SCORED USING SCREENING DATA	Presence of minority population within or abutting site	5 = Minority population in census block group (or adjacent census block group) less than 5 percent and minority population percentage in census block group less than 5 percentage points higher than county or state minority population percentage 4 = Minority population in census block group (or adjacent census block group) greater than 5 but less than 20 percent or minority population percentage in census block group greater than 5 but less than 10 percentage points higher than county or state minority population percentage 3 = Minority population in census block group (or adjacent census block group) greater than 20 but less than 35 percent or minority population percentage in census block group greater than 10 but less than 15 percentage points higher than county or state minority population percentage 2 = Minority population in census block group (or adjacent census block group) greater than 35 but less than 50 percent or minority population percentage in census block group greater than 15 but less than 20 percentage points higher than county or state minority population percentage 1 = Minority population in census block group (or adjacent census block group) greater than 50 percent or minority population percentage in census block group greater than 20 percentage points higher than county or state minority population percentage

Table 9.3-2— Site Ranking Criteria
(Page 5 of 9)

Ranking Criteria	Metric	Scoring Basis
6b. *Low-income population* SCORED USING SCREENING DATA	*Presence of low-income population within or* abutting site	*5 = Low income population in census block group (or adjacent census block* group) less than 5 percent and low income population percentage in census block group less than 5 percentage points higher than county or state low income population percentage 4 = Low income population in census block group (or adjacent census block group) greater than 5 but less than 20 percent or low income population percentage in census block group greater than 5 but less than 10 percentage points higher than county or state low income population percentage 3 = Low income population in census block group (or adjacent census block group) greater than 20 but less than 35 percent or low income population percentage in census block group greater than 10 but less than 15 percentage points higher than county or state low income population percentage 2 = Low income population in census block group (or adjacent census block group) greater than 35 but less than 50 percent or low income population percentage in census block group greater than 15 but less than 20 percentage points higher than county or state low income population percentage 1 = Low income population in census block group (or adjacent census block group) greater than 50 percent or low income population percentage in census block group greater than 20 percentage points higher than county or state low income population percentage
7. Historic and Cultural Resources		
7a. Historic buildings, structures, objects and sites SCORED USING SCREENING DATA	Distance to site and number of National Register of Historic Places (NRHP) listed buildings, structures, objects and sites	5 = 0 NRHP buildings, structures, objects and sites within 1 mile or less from site 3 = Less than 5 NRHP buildings, structures, objects and sites within >1 to 5 miles from site 1 = 5 or more NRHP buildings, structures, objects and sites within >1 to 5 miles from site
7b. Historic districts SCORED USING SCREENING DATA	Distance to mapped NRHP listed historic districts from site	5 = 0 historic districts within 1 mile or less from site 3 = 1 historic district within >1 to 5 miles from site 1 = Greater than 1 historic district within >1 to 5 miles from site
8. Air Quality (Climate & Meteorology)		
8a. Weather risks/conditions SCORED USING SCREENING DATA	Estimation of potential severe weather impacts on operation of a new nuclear station	5 = Area exposed to a low frequency of occurrence or less severe tornadoes and/ or hurricanes 4 = Low frequency of occurrence of potentially damaging storms 3 = Moderate frequency of occurrence of area storms 2 = High frequency of occurrence of less severe area storms 1 = Area exposed to a high frequency or more severe tornadoes and/or hurricanes

Table 9.3-2— Site Ranking Criteria
(Page 6 of 9)

Ranking Criteria	Metric	Scoring Basis
8b. Prevention of Significant Deterioration (PSD) Class I Area, Attainment / Non-attainment Area SCORED USING SCREENING DATA	In or out of an attainment / non-attainment area and Prevention of Significant Deterioration (PSD) Class I area	5 = In attainment area and outside PSD Class I area 3 = In non-attainment area and not in PSD Class I area 1 = In non-attainment area and/or within PSD Class I area
9. Human Health		
9a. Emergency preparedness program– proximity of residences/businesses for exclusion zone SCORED BY EXPERT PANEL	Ability to evacuate area around site in event of an emergency	5 = 25 or less residences or businesses within 1 mile of site, and no schools or hospitals within 1 mile of site 3 = Greater than 25 and less than or equal to 75 residences or businesses within 1 mile of site, and no schools or hospitals within 1 mile of site 1 = Greater than 75 residences or businesses within 1 mile of site, or one or more schools or hospitals within 1 mile of site
9b. Radiological Pathways - Water SCORED USING SCREENING DATA	Based on distance to drinking water supply from site (ground and surface)	5 = Distance to any primary source aquifer or public water supply intake greater than 5 miles from the site 4= Distance to any primary source aquifer or public water supply intake greater than 3 miles but less than or equal to 5 miles from the site 3 = Distance to any primary source aquifer or public water supply intake greater than 2 miles but less than or equal to 3 miles from the site 2 = Distance to any primary source aquifer or public water supply intake greater than 1 mile but less than or equal to 2 miles from the site 1 = Distance to any primary source aquifer or public water supply intake less than 1 mile from the site
9c. Radiological Pathways - Food SCORED USING SCREENING DATA	Distance to food pathways (e.g., shellfish beds, farms,)	5 = Agricultural land (based on land use/zoning map) or shellfish beds (measured by distance to bay) greater than 5 mile from site 4 = Agricultural land or shellfish beds greater than 3 mile and less than or equal to 5 mi from site 3 = Agricultural land or shellfish beds greater than 2 mile and less than or equal to 3 mi from site 2 = Agricultural land or shellfish beds greater than 1 mi and less than or equal to 2 mile from site 1 = Agricultural land or shellfish beds less than or equal to 1 mile from site

Table 9.3-2— Site Ranking Criteria
(Page 7 of 9)

Ranking Criteria	Metric	Scoring Basis
10. Postulated Accidents		
10a. Distance to nearby potentially hazardous facilities SCORED USING SCREENING DATA	Distance to hazardous facilities (e.g., military facilities, such as munitions storage or ordnance test ranges; chemical plants; refineries; mining and quarrying operations; oil and gas wells; gas and petroleum product installations; or air, waterway, pipeline or rail transport facilities for hazardous materials) and major airports	5 = No potentially hazardous facilities within 5 miles from site or no major airports within 10 miles from site 3 = Potentially hazardous facilities greater than 2 miles but less than 5 miles from site or major airports 5 miles to less than 10 miles from site 1 = Potentially hazardous facilities less than or equal to 2 miles from site or major airports within 5 miles from site
11. Fuel Cycle Impacts (Transport of Radioactive Material)		
11a. Transport of nuclear fuel and wastes SCORED USING SCREENING DATA	Distance and route to low level disposal site(s) and spent fuel repository (i.e., Yucca Mountain) from site	5 = Site is adjacent to disposal sites. 4 = Distance to Yucca Mountain is less than 1000 mi, and distance to low-level waste disposal site(s) is less than 500 mi. 3 = Distance to Yucca Mountain is less than 2000 mi, and distance to low-level waste disposal site(s) is less than 1000 mi. 2 = Distance to Yucca Mountain is greater than 2000 mi, and distance to low-level waste disposal site(s) is greater than 1000 mi. 1 = Distance to Yucca Mountain is greater than 2000 mi, and distance to low-level waste disposal site(s) is greater than 1000 mi, AND population densities within first 10 mi of route(s) are greater than 2,601 person/mi^2.
12. Transmission corridors (land used, feasibility, and resources affected)		
12a. Environmental impact of proposed transmission interconnection SCORED BY EXPERT PANEL	Length of proposed right-of-way (ROW) from site to point of transmission interconnection, including assessment of environmental impact (i.e., existing ROW vs. greenfield)	5 = 345 kV or greater transmission on site. 4 = Point of interconnection (POI) less than or equal to 5 miles with no existing ROW or less than or equal to 10 miles with existing ROW requiring expansion 3 = POI greater than 5 miles but less than or equal to 10 miles with no existing ROW or greater than 10 miles but less than or equal to 30 miles with existing ROW requiring expansion 2 = POI greater than 10 miles but less than or equal to 20 miles with no existing ROW or greater than or equal to 30 miles with existing ROW requiring expansion 1 = POI less than 30 miles with no existing ROW

Table 9.3-2— Site Ranking Criteria

(Page 8 of 9)

Ranking Criteria	Metric	Scoring Basis
13. Population distribution and density		
13a. Distance to population centers SCORED USING SCREENING DATA	Distance to US Census Populated Places population centers of 25,000 or more persons from site	5 = No population centers within 20 miles 4 = One or more population centers greater than 15 miles but less than or equal to 20 miles 3 = One or more population centers greater than 10 miles but less than or equal to 15 miles 2 = One or more population centers greater than 5 miles but less than or equal to 10 miles 1= One or more population centers within 5 miles
13b. Population density SCORED USING SCREENING DATA	Existing population density within 20 mi radius of site	5 = Population density within 20 mi radius less than or equal to 50 persons per square mile (ppsm) 4 = Population density within 20 mi radius greater than 50 ppsm but less than or equal to 200 ppsm 3 = Population density within 20 mi radius greater than 200 ppsm but less than or equal to 350 ppsm 2 = Population density within 20 mi radius greater than 350 ppsm but less than or equal to 500 ppsm 1 = Population density within 20 mi radius greater than 500 ppsm
14. Facility costs [Transportation Access]		
14a. Barge access and capacity – distance, construction, or upgrade requirements SCORED BY EXPERT PANEL	Availability of nearest barge access or ability to construct new barge landing	5 = Viable barge access existing at site 3 = No existing barge access at site, but existing barge access within 5 mi or landing may be built at site 1 = No barge access possible at or within 5 mi of site
14b. Rail line access and capacity – distance, spur requirements, line capacity, or upgrade requirements SCORED BY EXPERT PANEL	Estimated distance and condition of nearest accessible active rail line	5 = Active rail line less than 1 mile from site 4 = Rail line less than 1 mile from site but inactive or needing refurbishment 3 = Active rail line 1 mile to less than 5 mile from site 2 = Rail line 1 mile to less than 5 mile from site but inactive or needing refurbishment and needing refurbishment 1 = Rail line greater than or equal to 5 mile from site
15. Geology/Seismology		
15a. Vibratory ground motion – seismic peak ground acceleration SCORED USING SCREENING DATA	Peak ground acceleration (PGA)	5 = PGA is < 0.10g with a 2% probability of exceedance in 50 years ($4x10^{-4}$) 4 = PGA is 0.10 to 0.15g with a 2% probability of exceedance in 50 years ($4x10^{-4}$) 3 = PGA is 0.15 to 0.25g with a 2% probability of exceedance in 50 years ($4x10^{-4}$) 2 = PGA is 0.25 to 0.30g with a 2% probability of exceedance in 50 years ($4x10^{-4}$) 1 = PGA is > 0.30g with a 2% probability of exceedance in 50 years ($4x\ 10^{-4}$)

Table 9.3-2— Site Ranking Criteria

(Page 9 of 9)

Ranking Criteria	Metric	Scoring Basis
15b. Depth to bedrock soil stability SCORED USING SCREENING DATA	Depth to bedrock; soil stability including liquefaction potential, bearing strength and general foundation conditions	5 = Bedrock or recognized highly competent soil at or within 20 feet of the ground surface 3 = Tertiary-aged or older soil at or within 20 feet of the ground surface 1 = Quaternary-aged soil extends greater than 20 feet below the ground surface
15c. Surface faulting and deformations SCORED USING SCREENING DATA	Presence of surface faulting based on USGS Quaternary fault database	5 = Site greater than 100 mi from any capable fault 4 = Site 100 to 50 mi from any capable fault 3 = Site 50 to 25 mi from any capable fault 2 = Site 25 to 5 mi from any capable fault 1 = Site with capable or questionable aged fault(s) within 5 mi
15d. Other geological hazards SCORED USING SCREENING DATA	Presence of other geologic hazards, such as karst features, subsurface mines, and volcanoes	5 = Hazards present or likely within 50 miles of the site 4 = Hazards present or likely within 20 miles of the site 3 = Hazards present or likely within 10 miles of the site 2 = Hazards present or likely within 3 miles of the site or a moderate risk 1 = Hazards present or likely at or within 0.5 miles of the site or a serious risk
16. Wetlands		
16a. Total Wetlands Within Property Boundary SCORED USING SCREENING DATA	Percent of wetlands within property boundary	5 = Less than 10% of site classified as wetlands based on National Wetland Inventory (NWI) or state-mapped wetlands 4 = Greater than or equal to 10% and less than 20% of site classified as wetlands based on NWI or state-mapped wetlands 3 = Greater than or equal to 20% and less than 30% of site classified as wetlands based on NWI or state-mapped wetlands 2 = Greater than or equal to 30% and less than 40% of site classified as wetlands based on NWI or state-mapped wetlands 1 = Greater than or equal to 40% of site classified as wetlands based on NWI or state-mapped wetlands
16b. Total Acres of Wetlands Within Site SCORED USING SCREENING DATA	Acres of wetlands onsite	5 = Less than 1 acre of site classified as wetlands based on NWI or state-mapped wetlands 3 = Greater than 1 acre and less than 5 acres of site classified as wetlands based on NWI or state-mapped wetlands 1 = Greater than 5 acres of site classified as wetlands based on NWI or state-mapped wetlands
16c. High Quality Wetlands Within Site SCORED USING SCREENING DATA	Presence of state-designated high quality wetlands onsite	5 = No high quality wetlands onsite 1 = High quality wetlands onsite

Table 9.3-3— Site Ranking Rationale
(Page 1 of 5)

Ranking Criteria	Metric	Rationale
1. Land use, including availability, and areas requiring special consideration		
1a. Land Area and Existing Facilities: Ability to support the combined EPR footprint including the protected area, cooling towers, ponds, switchyard, construction support areas	Size and configuration of plot	Adequate land area within a single location to accommodate EPR development is critical to avoiding impacts to greenfield sites, fragmentation of natural habitat, safety during facility construction and operation, and for optimization of plant operations, including appropriately designed features to protect the environment such as stormwater management systems, wastewater treatment facilities, waste storage areas, and emissions control systems.
1b. Hazardous waste or spoils areas	Based on the site's anticipated need for environmental remediation due to known current or previous uses.	Avoidance of unremediated hazardous waste facilities prevents inadvertent release of toxic materials to the environment and disruptions to the site development process resulting from discovery of unanticipated waste sources.
1c. Zoning	Current Zoning and Ownership based on the site's existing zoning classification(s) by area community (ies)	Individual communities implement zoning ordinances to protect the integrity and character of a town, including environmental resources. Conformance with zoning preserves lands with documented values to a community and socioeconomic benefits associated with designated land uses.
1d. Distance to dedicated land	Proximity to federal, state, county and local parks, forests, preserves, historic sites, Native American Reservations, National Parks, Monuments, Forests, wildlife refuges, scenic river parkways, recreation areas and other significant sites based on the linear distance from the site boundary.	In accordance with regulatory standards, the siting of industrial facilities such as a nuclear power station is preferred at locations not encroaching upon dedicated lands whose aesthetics, recreational opportunities, access, or integrity may be diminished in perception or in fact by nearby development.
1e. Topography	Site topography and resulting cut-and-fill requirements for amount of site preparation required for proposed facility construction	Flat to moderate relief is critical to avoidance of large scale land disturbance (cut and fill) actions requiring excessive blasting, earth management including off site materials disposal, and potential secondary impacts such as erosion and sedimentation.
2. Hydrology, water quality, and water availability		
2a. Water Quality	Ground and surface water intake water quality (salt, brackish, fresh, polluted) based on US EPA or State classifications Candidate site must have access to 50 mgd or more makeup	Increased water source purity lends to reduced particulate emissions, and avoids the need to pre-treat the cooling water source via desalinization or other energy-requiring filtration operations.

Table 9.3-3— Site Ranking Rationale
(Page 2 of 5)

Ranking Criteria	Metric	Rationale
2b. Receiving Body Water Quality	Applicable State water quality classification Tier I, Tier II (as described and defined in COMAR 28.02.08.04-1) *and Tier III* (Outstanding National Resource Waters [ONRW] as described and defined in COMAR 28.02.08.04-2)	Consideration of cooling water source quality is made to discourage impacts to protected or high quality water bodies, as well as those waters already impaired *by other uses or contaminant sources.*
2c. Water availability	Metric based on lowest 7-day average flow with a ten year return frequency (i.e., 7Q10) and need for 50 mgd water supply	Adequate water volume is necessary to accommodate the consumptive use proposed and to avoid potential impacts to aquatic biota, wetlands, water quality, and other downstream uses when a water source is drawn beyond its safe yield.
3. Terrestrial resources (including endangered species)		
3a. Endangered/threatened habitats	Existence of mapped T&E species habitat on or adjacent to site	Documented T&E species and their habitats must be avoided in accordance with state and federal law and to respect their intrinsic value.
3b. Floodplains	Existence of mapped FEMA 100 or 500 year floodplain affecting site footprint	Federally mapped floodplains serve to accommodate floodwaters and protect downstream property, and represent a potential safety risk.
4. Aquatic biological resources (including endangered species)		
4a. Endangered/threatened habitats	Existence of mapped T&E species habitat in makeup/cooling water supply, or on or adjacent to site	Documented T&E species and their habitats must be avoided in accordance with state and federal law and to respect their intrinsic value.
4b. Thermal Discharge Sensitivity	Designated finfish/shellfish and/or other resource areas within intake or discharge waters	Considers potential impacts to sensitive aquatic biota that may be impacted by a high temperature discharge to a cooling water a source.
5. Socioeconomics (including aesthetics, demography, and infrastructure)		
5a. Emergency services	Availability of existing emergency services (police, fire, EMS, hospital services) based on full-time, part-time or volunteer local or county police, fire and emergency response services	Emphasizes project siting in communities with increasingly comprehensive emergency services.
5b. Construction traffic	Ability of existing transportation *infrastructure to support construction traffic*	Evaluates the infrastructure and efficacy of existing roadways and traffic to *prioritize siting within areas where construction traffic will not exacerbate poor* transportation infrastructure conditions.

Table 9.3-3— Site Ranking Rationale
(Page 3 of 5)

Ranking Criteria	Metric	Rationale
5c. Construction workforce	Availability of local construction workforce based on State, County, or local planning, zoning and industrial development commission databases. Availability of suitable population within commuting distance from which to draw the construction workforce.	Evaluates construction workforce available and ranks sites based on worker availability, emphasizing use of local labor forces.
5d. Housing and necessities	Availability of housing units, shopping and other services to support the peak construction workforce	Considers existing available housing, prioritizing sites with increasing nearby housing facilities (based on vacancy) and supporting infrastructure availability.
5e. Schools	Availability of existing schools to support increased construction and operation workforce	Prioritizes sites with comprehensive or high ranking educational facilities to accommodate needs of construction workforce.
6. Environmental Justice (EJ)		
6a. Minority population	Presence of minority population within or abutting site	Seeks to avoid unnecessary impacts to minority populations by prioritizing development outside of areas with predominant minority residents based on census block group data.
6b. Low-income population	Presence of low-income population within or abutting site	Seeks to avoid unnecessary impacts to low-income populations by prioritizing development outside of areas with predominant low-income residents based on census block group data.
7. Historic and Cultural Resources		
7a. Historic buildings, structures, objects and sites	Distance to site and number of National Register of Historic Places (NRHP) listed buildings, structures, objects and sites	Considers potential aesthetic and other associated impacts to historic sites based upon nearby facility siting, and prioritizes site selection in areas lacking in documented NHRP listed buildings, structures, objects and sites.
7b. Historic districts	Distance to mapped NRHP listed historic districts from site	Considers potential aesthetic and other associated impacts to a historic district based upon nearby facility siting, and prioritizes site selection in areas lacking in/ further from listed historic districts.
8. Air Quality (Climate &Meteorology)		
8a. Weather risks/conditions	Estimation of potential severe weather impacts on operation of a new nuclear station	Prioritizes plant siting in locations with reduced frequency of weather conditions potentially hazardous to nuclear plant operation.
8b. Prevention of Significant Deterioration (PSD) Class I Area, Attainment / Non-attainment Area	In or out of an attainment / non-attainment area and Prevention of Significant Deterioration (PSD) Class I area	Seeks to preserve air quality by discouraging plant siting within a non-attainment area for one or more pollutants or within a Class I PSD mapped location.

Table 9.3-3— Site Ranking Rationale

(Page 4 of 5)

Ranking Criteria	Metric	Rationale
9. Human Health		
9a. Emergency preparedness program–proximity of residences/businesses for exclusion zone	Ability to evacuate area around site in event of an emergency	Prioritizes plant siting in areas where a full exclusion zone may be established without inclusion of nearby residences or businesses.
9b. Radiological pathways - water	Distance to drinking water supply from site (ground and surface)	Promotes avoidance of potential human ingestion of contaminated water in the case of an accident.
9c. Radiological pathways - food	Distance to food pathways from site (e.g., shellfish beds, farms)	Promotes avoidance of potential human ingestion of contaminated food sources in the case of an accident.
10. Postulated Accidents(a)		
10a. Distance to nearby potentially hazardous facilities	Distance to hazardous facilities (e.g., military facilities, such as munitions storage or ordnance test ranges; chemical plants; refineries; mining and quarrying operations; oil and gas wells; gas and petroleum product installations; or air, waterway, pipeline or rail transport facilities for hazardous materials) and major airports	Prioritizes plant siting in locations where risk of exacerbating an accident starting at the generation facility from a missile impact or inadvertent release of hazardous materials may affect nearby hazardous facilities.
11. Fuel Cycle Impacts (Transport of Radioactive Material)		
11a. Support/challenges to transport of nuclear fuel and wastes	Distance and route to low level disposal site(s) and spent fuel repository (i.e., Yucca Mountain) from site	Ease of transport based on road conditions and distance to disposal locations is evaluated with the assumption that shorter routes on major arteries have less potential hazard to human health and the environment.
12. Transmission corridors (land used, feasibility, and resources affected)		
12a. Proximity/availability of power corridors	Based upon proximity of adequate (345/500 kV) transmission.	Considers the likely potential for expanded land clearing and impact to undeveloped lands and biota resulting from construction of new or significantly widened transmission corridor.
13. Population distribution and density		
13a. Distance to population centers	Distance to US Census Populated Places population centers of 25,000 or more persons from site	In accordance with regulatory standards, the siting of a nuclear power station is discouraged nearby centers of high population.
13b. Population density	Existing population density within 20 mi radius of site	In accordance with regulatory standards, the siting of a nuclear power station is discouraged nearby regions with high population density.

Table 9.3-3— Site Ranking Rationale
(Page 5 of 5)

Ranking Criteria	Metric	Rationale
14. Facility costs [Transportation Access]		
14a. Barge access and capacity – distance, construction, or upgrade requirements	Based upon availability of nearest barge access or ability to construct new barge landing.	Use of existing barge slips reduces environmental impact associated with the need for slip construction of alternate means of site access. Criteria promotes sites with existing barge access.
14b. Rail line access and capacity – distance, spur requirements, line capacity, or upgrade requirements	Based upon estimated distance and condition of nearest active rail line.	Use of existing rail lines reduces environmental impact associated with the need for line construction of alternate means of site access. Criteria promotes sites with existing active rail access.
15. Geology/Seismology		
15a. Vibratory ground motion – seismic peak ground acceleration	Peak ground acceleration (PGA)	Criteria promotes siting in locations where PGA does not represent a significant potential hazard to reactor stability.
15b. Depth to bedrock, soil stability, and compaction	Depth to bedrock; soil stability including liquefaction potential, bearing strength and general foundation conditions	Criteria promotes siting in locations where bedrock and soil conditions are optimal for reactor construction and safety.
15c. Surface faulting and deformations	Presence of surface faulting based on USGS Quaternary fault database	Criteria promotes siting in locations where surface faults and fault activity do not represent a significant potential hazard to reactor stability.
15d. Other geological hazards	Presence of other geologic hazards, such as karst features, subsurface mines, and volcanoes	Criteria promotes avoidance of locations considered intrinsically hazardous based upon subsurface conditions.
16. Wetlands		
16a. Total Wetlands Within Property Boundary	Percent of wetlands within property boundary	Considers net total acreage of wetlands for comparison among sites and prioritization of sites without regulatory wetlands and waterways.
16b. Total Acres of Wetlands Within Site	Acres of wetlands onsite	In order to avoid sites comprised predominantly of wetlands, percent wetlands is considered to allow promotion of locations with reduced wetland acreage in comparison to the entire property.
16c. High Quality Wetlands Within Site	Presence of state-designated high quality wetlands onsite	Considers wetlands of exceptional value and promotes impact avoidance in site selection.

Table 9.3-4— Weighted Scoring of Candidate Site

	CCNPP	Bainbridge	Conowingo	EASTALCO	Thiokol
1. Land Use	26.5	23.7	20.3	22.9	19.4
2. Hydrology	36.0	45.0	42.0	39.0	36.0
3. Terrestrial Resources	21.8	18.2	18.2	29.1	18.2
4. Aquatic Biological Resources	7.3	7.3	7.3	21.8	7.3
5. Socioeconomics	18.7	22.0	24.2	27.5	19.8
6. Environmental Justice	16.5	18.9	18.9	11.8	11.8
7. Historical and Cultural Resources	14.8	4.9	4.9	9.9	19.8
8. Air Quality	14.0	14.0	14.0	16.0	18.0
9. Human Health	18.2	6.1	12.1	16.2	20.2
10. Postulated Accidents	4.6	4.6	4.6	4.6	13.7
11. Transport of Radioactive Material	6.0	6.0	6.0	3.0	6.0
12. Transmission Corridors	34.7	30.9	27.0	30.9	23.2
13. Population	39.0	21.7	21.7	13.0	39.0
14. Facility costs	16.5	25.6	11.8	17.6	8.5
15. Geology	28.4	28.4	32.0	26.7	26.7
16. Wetlands	30.5	41.7	30.5	41.7	30.5
Total:	**333.5**	**316.0**	**295.5**	**331.7**	**318.1**

Note: The scoring for the Proposed Site (CCNPP) is not required when ranking the Candidate Sites to select the Alternative Sites but is included here for reference.

Table 9.3-5— Current and Historical Rare, Threatened, and Endangered Species of Cecil County, Maryland
(Page 1 of 5)

Scientific Name	Common Name	Global Rank	State Rank	State Status	Federal Status
Animals					
Acipenser brevirostrum	Shortnose Sturgeon	G3	S1	E	LE
Cicindela puritana	Puritan Tiger Beetle	G1G2	S1	E	LT
Cryptobranchus alleganiensis	Hellbender	G3G4	S1	E	
Glyptemys muhlenbergii	Bog Turtle	G3	S2	T	LT
Graptemys geographica	Map Turtle	G5	S1	E	
Haliaeetus leucocephalus	Bald Eagle	G5	S2S3B	T	
Ixobrychus exilis	Least Bittern	G5	S2S3B	I	
Lampsilis radiata	Eastern Lampmussel	G5	SU		
Leptodea ochracea	Tidewater Mucket	G3G4	S1S2		
Percina caprodes	Logperch	G5	S1S2	T	
Percopsis omiscomaycus	Trout-perch	G5	SX	X	
Sciurus niger cinereus	Delmarva Fox Squirrel	G5T3	S1	E	LE
Speyeria idalia	Regal Fritillary	G3	SH	X	
Strophitus undulatus	Creeper	G5	S2	I	
Plants					
Agalinis obtusifolia	Blunt-leaved Gerardia	G4G5Q	S1	E	
Agalinis setacea	**Thread-leaved Gerardia**	G5?	S1	E	
Agrimonia microcarpa	Small-fruited Agrimony	G5	SU		
Agrimonia striata	**Woodland Agrimony**	G5	S1	E	
Alnus maritima	Seaside Alder	G3	S3.1		
Ammannia latifolia	Koehne's Ammannia	G5	S2		
Antennaria solitaria	**Single-headed Pussytoes**	G5	S2	T	
Arnica acaulis	**Leopard's-bane**	G4	S1	E	
Asplenium pinnatifidum	**Lobed Spleenwort**	G4	S1	E	
Betula populifolia	Gray Birch	G5	SU		
Bidens bidentoides var. mariana	Maryland Bur-marigold	G3T3	S3.1		
Bromus latiglumis	Broad-glumed Brame	G5	S1	E	
Buchnera americana	Blue-hearts	G5?	SH	X	
Cacalia muehlenbergii	Great Indian-plantain	G4	SH	X	
Campanula rotundifolia	Harebell	G5	S2		
Cardamine longii	Long's Bittercress	G3	S1	E	
Carex buxbaumii	Buxbaum's Sedge	G5	S2	T	
Carex hitchcockiana	Hitchcock's Sedge	G5	S1	E	
Carex hystericina	Porcupine Sedge	G5	S1	E	
Carex interior	Inland Sedge	G5	S1		
Carex lacustris	Lake-bank Sedge	G5	S2		
Carex lucorum	A Sedge	G4	S1		

Table 9.3-5— Current and Historical Rare, Threatened, and Endangered Species of Cecil County, Maryland
(Page 2 of 5)

Scientific Name	Common Name	Global Rank	State Rank	State Status	Federal Status
Carex lupuliformis	Hop-like Sedge	G4	S2		
Carex polymorpha	Variable Sedge	G3	SH	X	
Carex tenera	Slender Sedge	G5	SH	X	
Carex tetanica	Rigid Sedge	G4G5	SH	X	
Carex vestita	Velvety Sedge	G5	S2	T	
Castilleja coccinea	Indian Paintbrush	G5	S1	E	
Chenopodium standleyanum	Standley's Goosefoot	G5	S1	E	
Cicuta bulbifera	Bulb-bearing Water Hemlock	G5	S1	E	
Clematis occidentalis	Purple Clematis	G5	S1	E	
Clematis ochroleuca	Curly-heads	G4	SH	X	
Corallorhiza wisteriana	**Wister's Coralroot**	G5	S1	E	
Coreopsis tripteris	Tall Tickseed	G5	S1	E	
Cyperus dentatus	Toothed Sedge	G4	SH	X	
Cyperus refractus	Reflexed Cyperus	G5	S2?		
Cyperus retrofractus	Rough Cyperus	G5	S2		
Deschampsia cespitosa	Tufted Hairgrass	G5	S1	E	
Desmodium pauciflorum	**Few-flowered Tick-trefoil**	G5	S1	E	
Desmodium rigidum	**Rigid Tick-trefoil**	GNRQ	S1	E	
Desmodium sessilifolium	Sessile-leaved Tick-trefoil	G5	SH	X	
Dichanthelium oligosanthes	Few-flowered Panicgrass	G5	S2S3		
Dirca palustris	Leatherwood	G4	S2	T	
Elatine minima	Small Waterwort	G5	S1	E	
Eleocharis compressa	Flattened Spikerush	G4	S1	E	
Eleocharis halophila	Salt-marsh Spikerush	G4	S1	E	
Epilobium ciliatum	**Northern Willowherb**	G5	S1	E	
Epilobium strictum	**Downy Willowherb**	G5?	S1	E	
Equisetum fluviatile	Water Horsetail	G5	S1	E	
Equisetum sylvaticum	**Wood Horsetail**	G5	S1	E	
Eriocaulon aquaticum	Seven-angled Pipewort	G5	S1	E	
Eriocaulon parkeri	Parker's Pipewort	G3	S2	T	
Erythronium albidum	**White Trout Lily**	G5	S2	T	
Euphorbia purpurea	Darlington's Spurge	G3	S1	E	
Eurybia radula	Rough-leaved Aster	G5	S1	E	
Festuca paradoxa	Cluster Fescue	G5	SU	X	
Galium boreale	**Northern Bedstraw**	G5	S1	E	
Galium trifidum	Small Bedstraw	G5	SU		
Gentiana andrewsii	Fringe-tip Closed Gentian	G5?	S2	T	
Gentiana villosa	**Striped Gentian**	G4	S1	E	

Table 9.3-5— Current and Historical Rare, Threatened, and Endangered Species of Cecil County, Maryland
(Page 3 of 5)

Scientific Name	Common Name	Global Rank	State Rank	State Status	Federal Status
Gentianopsis crinita	Fringed Gentian	G5	S1	E	
Hasteola suaveolens	Sweet-scented Indian-plantain	G4	S1	E	
Helianthemum bicknellii	**Hoary Frostweed**	G5	S1	E	
Helonias bullata	Swamp Pink	G3	S2	E	LT
Hydrastis canadensis	Goldenseal	G4	S2	T	
Iris prismatica	Slender Blue Flag	G4G5	S1	E	
Juglans cinerea	Butternut	G4	S2S3		
Juniperus communis	Juniper	G5	SH	X	
Lathyrus palustris	Vetchling	G5	S1	E	
Leptochloa fascicularis	Long-awned Diplachne	G5	SU		
Lilium philadelphicum	Wood Lily	G5	SH	X	
Limnobium spongia	American Frog's-bit	G4	S1	E	
Limosella australis	Mudwort	G4G5	S2	E	
Linum intercursum	**Sandplain Flax**	G4	S2	T	
Lithospermum latifolium	**American Gromwell**	G4	S1	E	
Lygodium palmatum	**Climbing Fern**	G4	S2	T	
Lysimachia hybrida	Lowland Loosestrife	G5	S2	T	
Matelea carolinensis	**Anglepod**	G4	S1	E	
Matteuccia struthiopteris	Ostrich Fern	G5	S2		
Melanthium latifolium	**Broad-leaved Bunchflower**	G5	S1	E	
Minuartia michauxii	Rock Sandwort	G5	S2	T	
Myosotis macrosperma	Large-seeded Forget-me-not	G5	S2S3		
Najas gracillima	Thread-like Naiad	G5?	SU	X	
Nelumbo lutea	American Lotus	G4	S2		
Oligoneuron rigidum	Hard-leaved Goldenrod	G5	SH	X	
Pedicularis lanceolata	Swamp Lousewort	G5	S1	E	
Platanthera peramoena	Purple Fringeless Orchid	G5	S1	T	
Platanthera psycodes	Small Purple Fringed Orchid	G5	SH	X	
Pluchea camphorata	Marsh Fleabane	G5	S1	E	
Poa alsodes	Grove Meadow-grass	G4G5	S2		
Polygala incarnata	Pink Milkwort	G5	S2S3		
Polygala senega	Seneca Snakeroot	G4G5	S2	T	
Polygonum robustius	Stout Smartweed	G4G5	S1?	X	
Potamogeton amplifolius	Large-leaved Pondweed	G5	SH	X	
Potamogeton perfoliatus	Clasping-leaved Pondweed	G5	S2		
Potamogeton pusillus	Slender Pondweed	G5	S1		
Potamogeton richardsonii	Redheadgrass	G5	SH	X	
Potamogeton robbinsii	Robbins' Pondweed	G5	SH	X	

Table 9.3-5— Current and Historical Rare, Threatened, and Endangered Species of Cecil County, Maryland
(Page 4 of 5)

Scientific Name	Common Name	Global Rank	State Rank	State Status	Federal Status
Potamogeton spirillus	Spiral Pondweed	G5	S1		
Potamogeton zosteriformis	Flatstem Pondweed	G5	S1	E	
Prunus alleghaniensis	**Alleghany Plum**	G4	S2	T	
Pycnanthemum torrei	Torrey's Mountain-mint	G2	S1	E	
Pycnanthemum verticillatum	**Whorled Mountain-mint**	G5	S1	E	
Pycnanthemum virginianum	Virginia Mountain-mint	G5	S2		
Ranunculus ambigens	Water-plantain Spearwort	G4	SH	X	
Ranunculus hederaceus	Long-stalked Crowfoot	G5	S1	X	
Ranunculus hispidus var. nitidus	Hispid Buttercup	G5T5	S1?	X	
Rhynchospora globularis	Grass-like Beakrush	G5?	S1	E	
Ruellia strepens	Rustling Wild-petunia	G4G5	S1	E	
Rumex altissimus	**Tall Dock**	G5	S1	E	
Sagittaria calycina	Spongy Lophotocarpus	G5	S2		
Sagittaria longirastra	Long-beaked Arrowhead	GNRQ	SU		
Salix discolor	Pussy Willow	G5	SU		
Salix exigua	Sandbar Willow	G5	S1	E	
Salix lucida	Shining Willow	G5	SH	X	
Salix tristis	Dwarf Prairie Willow	G4G5	S1		
Sanguisorba canadensis	Canada Burnet	G5	S2	T	
Schoenoplectus novae-angliae	Salt-marsh Bulrush	G5	S2		
Schoenoplectus torreyi	Torrey's Clubrush	G5?	SH	X	
Scleria reticularis	Reticulated Nutrush	G4	S2		
Scutellaria leonardii	Leonard's Skullcap	G4T4	S2	T	
Scutellaria nervosa	Veined Skullcap	G5	S1	E	
Sida hermaphrodita	**Virginia Mallow**	G3	S1	E	
Smilax pseudochina	Halberd-leaved Greenbrier	G4G5	S2	T	
Solidago speciosa	**Showy Goldenrod**	G5	S2	T	
Solidago stricta	Wandlike Goldenrod	G5	SU		
Sphenopholis pensylvanica	Swamp-oats	G4	S2	T	
Spiranthes lucida	Wide-leaved Ladys' Tresses	G5	S1	E	
Sporabolus clandestinus	**Rough Rushgrass**	G5	S2	T	
Sporabolus heterolepis	Northern Dropseed	G5	S1	E	
Stachys aspera	**Rough Hedge-nettle**	G4?	S1	E	
Stachys hyssopifolia	Hyssop-leaved Hedge-nettle	G4G5	SU		
Stellaria alsine	Trailing Stitchwort	G5	S1	E	
Stenanthium gramineum	**Featherbells**	G4G5	S1	T	
Symphyotrichum depauperatum	Serpentine Aster	G2	S1	E	

Table 9.3-5— Current and Historical Rare, Threatened, and Endangered Species of Cecil County, Maryland
(Page 5 of 5)

Scientific Name	Common Name	Global Rank	State Rank	State Status	Federal Status
Symphyotrichum laeve var. concinnum Steele's Aster	G5T4	SH	X		
Talinum teretifolium	Fameflower	G4	S1	T	
Thaspium trifoliatum	**Purple Meadow-parsnip**	G5	S1	E	
Triadenum tubulosum	Large Marsh St. John's-wort	G4?	S1		
Triosteum angustifolium	Narrow-leaved Horse-gentian	G5	S1	E	
Triphora trianthophora	**Nodding Pogonia**	G3G4	S1	E	
Valeriana pauciflora	**Valerian**	G4	S1	E	
Wolffia papulifera	Water-meal	G4	S2		

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Table 9.3-6— Current and Historical Rare, Threatened, and Endangered Species of Frederick County, Maryland
(Page 1 of 3)

Scientific Name	Common Name	Global Rank	State Rank	State Status	Federal Status
Animals					
Alasmidonta undulata	Triangle Floater	G4	S1	E	
Alasmidonta varicosa	Brook Floater	G3	S1	E	
Bartramia longicauda	Upland Sandpiper	G5	S1B	E	
Caecidotea sp. 4	An Isopod	GNR	S1		
Cicindela patruela	Green-patterned Tiger Beetle	G3	S1	E	
Cottus sp. 7	Checkered Sculpin	G4Q	S1S2		
Dendroica fusca	Blackburnian Warbler	G5	S1S2B	T	
Elliptio lanceolata	Yellow Lance	G2G3	SU		
Elliptio producta	Atlantic Spike	G3Q	S2	I	
Gallinula chloropus	Common Moorhen	G5	S2B	I	
Haliaeetus leucocephalus	Bald Eagle	G5	S2S3B	T	
Ixobrychus exilis	Least Bittern	G5	S2S3B	I	
Lampsilis cariosa	Yellow Lampmussel	G3G4	SU		
Lanius ludovicianus	Loggerhead Shrike	G4	S1B	E	
Lasmigona subviridis	Green Floater	G3	S1	E	
Margariscus margarita	Pearl Dace	G5	S1S2	T	
Mustela nivalis	Least Weasel	G5	S2S3	I	
Neotoma magister	Allegheny Woodrat	G3G4	S1	E	
Notropis amoenus	Comely Shiner	G5	S2	T	
Podilymbus podiceps	Pied-billed Grebe	G5	S2B		
Porzana carolina	Sora	G5	S1B		
Satyrium edwardsii	Edwards' Hairstreak	G4	S1	E	
Strophitus undulatus	Creeper	G5	S2	I	
Stygobromus pizzinii	Pizzini's Amphipod	G3G4	S1		
Stygobromus sp. 14	Roundtop Amphipod	GNR	S1		
Thryomanes bewickii altus	Bewick's Wren	G5T2Q	S1B	E	
Plants					
Adlumia fungosa	Climbing Fumitory	G4	S2	T	
Agalinis auriculata	Auricled Gerardia	G3	S1	E	
Agastache scrophulariifolia	Purple Giant Hyssop	G4	S1S2	T	
Agrimonia microcarpa	Small-fruited Agrimony	G5	SU		
Amelanchier stolonifera	Running Juneberry	G5	S2		
Asplenium bradleyi	Bradley's Spleenwort	G4	SH	X	
Asplenium pinnatifidum	Lobed Spleenwort	G4	S1	E	
Azolla caroliniana	Mosquito Fern	G5	SU		
Botrychium oneidense	Blunt-lobe Grape-fern	G4Q	S1	E	
Bromus ciliatus	Fringed Brome	G5	SU	X	

Table 9.3-6— Current and Historical Rare, Threatened, and Endangered Species of Frederick County, Maryland
(Page 2 of 3)

Scientific Name	Common Name	Global Rank	State Rank	State Status	Federal Status
Calopogon tuberosus	Grass-pink	G5	S1	E	
Carex aestivalis	Summer Sedge	G4	S1	E	
Carex davisii	Davis' Sedge	G4	S1	E	
Carex shortiana	Short's Sedge	G5	S2	E	
Castilleja coccinea	Indian Paintbrush	G5	S1	E	
Chelone obliqua	Red Turtlehead	G4	S1	T	
Coeloglossum viride	Long-bracted Orchis	G5	S1	E	
Coptis trifolia	Goldthread	G5	S1	E	
Corallorhiza wisteriana	Wister's Coralroot	G5	S1	E	
Comus rugosa	Round-leaved Dogwood	G5	S1	E	
Cyperus refractus	Reflexed Cyperus	G5	S2?		
Cystopteris tennesseensis	Tennessee Bladder-fern	G5	S1		
Dirca palustris	Leatherwood	G4	S2	T	
Dryopteris campyloptera	Mountain Wood-fern	G5	S1	E	
Epilobium leptophyllum	Linear-leaved Willowherb	G5	S2S3		
Equisetum sylvaticum	Wood Horsetail	G5	S1	E	
Erythronium albidum	White Trout Lily	G5	S2	T	
Eupatorium maculatum	Spotted Joe-pye-weed	G5	SU	X	
Euphorbia purpurea	Darlington's Spurge	G3	S1	E	
Eurybia radula	Rough-leaved Aster	G5	S1	E	
Filipendula rubra	Queen-of-the-prairie	G4G5	S1	E	
Gentiana andrewsii	Fringe-tip Closed Gentian	G5?	S2	T	
Geranium robertianum	Herb-robert	G5	S1		
Glyceria acutiflora	Sharp-scaled Mannagrass	G5	S1	E	
Hasteola suaveolens	Sweet-scented Indian-plantain	G4	S1	E	
Helianthus hirsutus	Hirsute Sunflower	G5	SU		
Helianthus microcephalus	Small-headed Sunflower	G5	S1	E	
Houstonia tenuifolia	Slender-leaved Bluets	G4G5	S1		
Hydrastis canadensis	Goldenseal	G4	S2	T	
Juglans cinerea	Butternut	G4	S2S3		
Krigia dandelion	Potato Dandelion	G5	S1	E	
Ligusticum canadense	American Lovage	G4	SH	X	
Lycopodiella inundata	Bog Clubmoss	G5	S2		
Lythrum alatum	Winged Loosestrife	G5	S1	E	
Melanthium latifolium	Broad-leaved Bunchflower	G5	S1	E	
Minuartia glabra	Mountain Sandwort	G4	S1	E	
Nymphoides cordata	Floating-heart	G5	S1	E	
Oligoneuron rigidum	Hard-leaved Goldenrod	G5	SH	X	

Table 9.3-6— Current and Historical Rare, Threatened, and Endangered Species of Frederick County, Maryland
(Page 3 of 3)

Scientific Name	Common Name	Global Rank	State Rank	State Status	Federal Status
Oryzopsis racemosa	Black-fruited Mountainrice	G5	S2	T	
Platanthera ciliaris	Yellow Fringed Orchid	G5	S2	T	
Platanthera flava	Pale Green Orchid	G4	S2		
Platanthera grandiflora	Large Purple Fringed Orchid	G5	S2	T	
Platanthera peramoena	Purple Fringeless Orchid	G5	S1	T	
Platanthera psycodes	Small Purple Fringed Orchid	G5	SH	X	
Pycnanthemum pycnanthemoides	Southern Mountain-mint	G5	SH	X	
Pycnanthemum torrei	Torrey's Mountain-mint	G2	S1	E	
Quercus macrocarpa	Mossy-cup Oak	G5	S1		
Quercus shumardii	Shumard's Oak	G5	S2	T	
Rhododendron calendulaceum	Flame Azalea	G5	S1		
Rumex altissimus	Tall Dock	G5	S1	E	
Sagittaria rigida	Sessile-fruited Arrowhead	G5	S1	E	
Schoenoplectus smithii	Smith's Clubrush	G5?	SU	X	
Scutellaria leonardii	Leonard's Skullcap	G4T4	S2	T	
Scutellaria nervosa	Veined Skullcap	G5	S1	E	
Scutellaria saxatilis	Rock Skullcap	G3	S1	E	
Sida hermaphrodita	Virginia Mallow	G3	S1	E	
Smilacina stellata	Star-flowered False Solomon's-seal	G5	S1	E	
Spiranthes ochroleuca	Yellow Nodding Ladys' Tresses	G4	S1	E	
Stenanthium gramineum	Featherbells	G4G5	S1	T	
Trichophorum planifolium	Bashful Bulrush	G4G5	S2S3		
Triosteum angustifolium	Narrow-leaved Horse-gentian	G5	S1	E	
Vernonia gigantea	Giant Ironweed	G5	SU		
Viola incognita	Large-leaved White Violet	G4G5	S1		
Zanthoxylum americanum	Northern Prickly-ash	G5	S1	E	

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Table 9.3-7— Current and Historical Rare, Threatened, and Endangered Species of St. Mary's County, Maryland
(Page 1 of 2)

Scientific Name	Common Name	Global Rank	State Rank	State Status	Federal Status
Animals					
Alasmidonta heterodon	Dwarf Wedge Mussel	G1G2	S1	E	LE
Ameiurus catus	White Catfish	G5	SU		
Centrarchus macropterus	Flier	G5	S1S2	T	
Cicindela dorsalis dorsalis	Northeastern Beach Tiger Beetle	G4T2	S1	E	LT
Circus cyaneus	Northern Harrier	G5	S2B		
Cistothorus platensis	Sedge Wren	G5	S1B	E	
Elliptio producta	Atlantic spike	G3Q	S2	I	
Fundulus luciae	Spotfin Killifish	G4	S2?		
Gastrophryne carolinensis	**Eastern Narrow-mouthed Toad**	G5	S1S2	E	
Haliaeetus leucocephalus	Bald Eagle	G5	S2S3B	T	
Lucanus elephus	Giant Stag Beetle	G3G5	SU		
Notropis amoenus	Comely Shiner	G5	S2	T	
Notropis chalybaeus	Ironcolor Shiner	G4	S1	E	
Sternula antillarum	**Least Tern**	G4	S2B	T	
Tachopteryx thoreyi	Gray Petaltail	G4	S2		
Plants					
Ammannia latifolia	Koehne's Ammannia	G5	S2		
Arnica acaulis	**Leopard's-bane**	G4	S1	E	
Azolla caroliniana	Mosquito Fern	G5	SU		
Carex buxbaumii	**Buxbaum's Sedge**	G5	S2	T	
Carex pellita	Woolly Sedge	G5	S2?		
Carex venusta	**Dark Green Sedge**	G4	S2	T	
Centrosema virginianum	Spurred Butterfly-pea	G5	S2		
Chelone obliqua	**Red Turtlehead**	G4	S1	T	
Chenopodium leptophyllum	Narrow-leaved Goosefoot	G5	SX		
Cuscuta coryli	Hazel Dodder	G5	SH	X	
Desmodium pauciflorum	**Few-flowered Tick-trefoil**	G5	S1	E	
Drosera capillaris	**Pink Sundew**	G5	S1	E	
Eleocharis albida	White Spikerush	G4G5	S2	T	
Elephantopus tomentosus	**Tobaccoweed**	G5	S1?	E	
Gratiola viscidula	**Short's Hedge-hyssop**	G4G5	S1	E	
Ilex decidua	Deciduous Holly	G5	S2		
Iris prismatica	**Slender Blue Flag**	G4G5	S1	E	
Juncus brachycarpus	Short-fruited Rush	G4G5	SU		
Kyllinga pumila	**Thin-leaved Flatsedge**	G5	S1	E	
Leptochloa fascicularis	Long-awned Diplachne	G5	SU		
Linum intercursum	**Sandplain Flax**	G4	S2	T	

Table 9.3-7— Current and Historical Rare, Threatened, and Endangered Species of St. Mary's County, Maryland
(Page 2 of 2)

Scientific Name	Common Name	Global Rank	State Rank	State Status	Federal Status
Myosotis macrosperma	Large-seeded Forget-me-not	G5	S2S3		
Polygonum glaucum	Seaside Knotweed	G3	S1	E	
Polygonum ramosissimum	Bushy Knotweed	G5	SH	X	
Potamogeton perfoliatus	Clasping-leaved Pondweed	G5	S2		
Prunus maritima	Beach Plum	G4	S1	E	
Sarracenia purpurea	**Northern Pitcher-plant**	G5	S2	T	
Spiranthes praecox	Grass-leaved Ladys' Tresses	G5	S1		
Symphyotrichum concolor	**Silvery Aster**	G5	S1	E	
Torreyochloa pallida	**Pale Mannagrass**	G5	S1S2	E	
Trachelospermum difforme	**Climbing Dogbane**	G4G5	S1	E	
Utricularia inflata	Swollen Bladderwort	G5	S1	E	

* This report represents a compilation of information in the Wildlife and Heritage Service's Biological and Conservation Data system as of the date on the report. It does not include species considered to be "watchlist" or more common species.

Table 9.3-8— Comparison of Proposed and Alternative Sites

	CCNPP	Bainbridge	EASTALCO	Thiokol	Greenfield
Land Use	Small	Small to Moderate	Small	Small to Moderate	Small to Moderate
Air Quality	Moderate	Small	Small	Small	Small
Water	Small	Moderate	Moderate	Small	Small to Moderate
Terrestrial Ecology and Sensitive Species	Small to Moderate	Small to Moderate	Small to Moderate	Small to Moderate	Small to Moderate
Aquatic Ecology and Sensitive Species	Small	Small to Moderate	Small	Small to Moderate	Small to Moderate
Socioeconomics	Small	Small	Small	Small	Small to Moderate
Transportation	Small to Moderate	Small	Moderate	Small to Moderate	Small to Moderate
Historic, Cultural, and Archeological	Small to Moderate	Small to Moderate	Small to Moderate	Small	Small
Environmental Justice	Small	Small	Small	Small	Small
Transmission Corridors	Small	Small to Moderate	Small to Moderate	Small to Large	Small to Moderate
Environmentally Preferable:	Proposed	No	No	No	No
Obviously Superior:	Proposed	No	No	No	No

Table 9.3-9— Census Block Groups within 50 mi (80 km) of the Bainbridge Naval Training Center with Minority and Low Income Populations

State/County	Total Census Blockgroups	Number of Minority Census Block Groups								
		Black	American Indian or Alaskan Native	Asian	Native Hawaiian or Other Pacific Islander	Some Other Race	Multi-Racial	Aggregate (Total)[1]	Hispanic[2]	Number of Low Income Census Block Groups
Delaware										
Kent	55	4	0	0	0	0	0	5	0	0
New Castle	349	64	0	0	0	7	1	66	16	6
Maryland										
Anne Arundel	258	20	0	1	0	0	0	21	2	2
Baltimore	498	86	0	1	0	0	1	86	0	2
Caroline	9	0	0	0	0	0	0	0	1	0
Carroll	71	0	0	0	0	0	0	0	0	1
Cecil[3]	55	0	0	0	0	0	0	0	0	0
Harford[3]	142	4	0	0	0	0	0	7	2	0
Howard	84	5	0	2	0	0	0	8	0	0
Kent	18	0	0	0	0	0	0	0	0	0
Queen Anne's	23	0	0	0	0	0	0	0	0	0
Talbot	2	0	0	0	0	0	0	0	0	0
Baltimore City	710	497	0	3	0	1	0	487	3	51
New Jersey										
Cumberland	30	8	0	0	0	3	0	11	5	0
Gloucester	39	4	0	0	0	0	0	4	0	0
Salem	48	5	0	0	0	0	0	4	2	0
Pennsylvania										
Adams	5	0	0	0	0	0	0	0	0	0
Berks	83	0	0	0	0	2	0	2	2	1
Chester	248	8	0	1	0	0	0	10	8	2
Dauphin	5	0	0	0	0	0	0	0	0	0
Delaware	424	85	0	1	0	1	0	83	2	4
Lancaster	317	0	0	0	0	18	0	14	27	2
Lebanon	14	0	0	0	0	0	0	0	0	0
Montgomery	30	0	0	0	0	0	0	0	0	0
Philadelphia	10	7	0	0	0	0	0	6	0	1
York	293	7	0	0	0	5	0	14	11	1
Total	**3821**	**785**	**0**	**9**	**0**	**37**	**2**	**808**	**81**	**73**

Notes:
(1) The aggregate or total minority census block group is the total of all minority (Black, American Indian or Alaskan Native. Asian. Native Hawaiian or Pacific Islander. Some Other Race. or Multi-Racial) that exceeds NRC threshold for minority.
(2) A person of Hispanic/Latino origin may be of any race. and therefore may also be included in the aggregate racial minority percentage.
(3) Cecil County and Harford County are the Region of Influence for socioeconomic impact analysis.
Source: US Census Bureau, 2000. Summary File 1 and 3.

Table 9.3-10— Census Block Groups within 50 mi (80 km) of EASTALCO with Minority and Low Income Populations

State/County	Total Census Blockgroups	Number of Minority Census Block Groups: Black	American Indian or Alaskan Native	Asian	Native Hawaiian or Other Pacific Islander	Some Other Race	Multi-Racial	Aggregate (Total)[1]	Hispanic[2]	Number of Low Income Census Block Groups
District of Columbia										
District of Columbia	433	296	0	1	0	6	0	310	24	23
Maryland										
Anne Arundel	165	13	0	1	0	0	0	17	0	1
Baltimore	328	62	0	0	0	0	1	73	0	2
Carroll	92	0	0	0	0	0	0	0	0	1
Charles	1	0	0	0	0	0	0	0	0	0
Frederick[3]	127	1	0	0	0	0	0	2	0	0
Howard	118	2	0	0	0	0	0	8	0	0
Montgomery[3]	552	14	0	29	0	20	0	119	55	0
Prince George's	455	292	1	3	0	11	0	355	34	2
Washington	92	4	0	0	0	0	0	4	0	0
Baltimore City	710	474	0	3	0	1	0	487	2	51
Pennsylvania										
Adams	54	0	0	0	0	0	0	0	0	1
Cumberland	14	0	0	0	0	0	0	0	0	1
Franklin	87	0	0	0	0	0	0	0	1	0
Fulton	6	0	0	0	0	0	0	0	0	0
York	59	0	0	0	0	0	0	0	0	0
Virginia										
Arlington	142	5	0	2	0	6	0	19	26	0
Clarke	11	0	0	0	0	0	0	0	0	0
Fairfax	532	2	0	34	0	12	1	52	41	0
Fauquier	22	0	0	0	0	0	0	0	0	0
Frederick	39	0	0	0	0	0	0	0	0	0
Loudoun[3]	67	0	0	0	0	0	0	0	1	0
Prince William	128	0	0	0	0	3	1	8	7	0
Rappahannock	2	0	0	0	0	0	0	0	0	0
Shenandoah	1	0	0	0	0	0	0	0	0	0
Warren	24	0	0	0	0	0	0	0	0	0
Alexandria City	99	5	0	0	0	3	1	27	8	0
Fairfax City	17	0	0	1	0	0	0	0	1	0
Falls Church	8	0	0	0	0	0	0	0	1	0
Manassas City	25	0	0	0	0	1	0	2	2	0
Manassas Park City	7	0	0	0	0	0	0	0	1	0
Winchester City	24	1	0	0	0	1	0	1	1	0
West Virginia										
Berkeley	48	0	0	0	0	0	0	0	0	0
Jefferson	32	0	0	0	0	0	0	0	0	0
Morgan	12	0	0	0	0	0	0	0	0	0
Total	4533	1171	1	74	0	64	4	1484	205	82

Notes:
(1) The aggregate or total minority census block group is the total of all minority (Black, American Indian or Alaskan Native, Asian, Native Hawaiian or Pacific Islander, Some Other Race, or Multi-Racial) that exceeds NRC threshold for minority.
(2) A person of Hispanic/Latino origin may be of any race, and therefore may also be included in the aggregate racial minority percentage.
(3) Frederick County, Loudoun County, and Montgomery County are the Region of Influence for socioeconomic impact analysis.
Source: US Census Bureau, 2000. Summary File 1 and 3.

Table 9.3-11— Census Block Groups within 50 mi (80 km) of Thiokol with Minority and Low Income Populations

State/County	Total Census Blockgroups	Number of Minority Census Block Groups: Black	American Indian or Alaskan Native	Asian	Native Hawaiian or Other Pacific Islander	Some Other Race	Multi-Racial	Aggregate (Total)[1]	Hispanic[2]	Number of Low Income Census Block Groups
District of Columbia										
District of Columbia	433	296	0	1	0	4	0	310	15	23
Maryland										
Anne Arundel	161	9	0	0	0	0	0	10	1	2
Calvert[3]	41	0	0	0	0	0	0	0	0	0
Caroline	6	0	0	0	0	0	0	0	0	0
Charles	76	6	0	0	0	0	0	8	0	0
Dorchester	30	5	0	0	0	0	0	5	0	0
Kent	2	0	0	0	0	0	0	0	0	0
Montgomery	148	9	0	4	0	7	0	45	13	0
Prince George's	469	312	1	3	0	11	0	373	28	2
Queen Anne's	14	0	0	0	0	0	0	0	0	0
Somerset	10	1	0	0	0	0	0	1	0	0
St. Mary's[3]	55	1	0	0	0	0	0	2	0	0
Talbot	25	1	0	0	0	0	0	2	0	0
Wicomico	9	0	0	0	0	0	0	0	0	0
Virginia										
Alexandria City	99	5	0	0	0	3	1	27	5	0
Arlington	142	5	0	2	0	6	0	19	23	0
Caroline	12	3	0	0	0	0	0	3	0	1
Essex	9	2	0	0	0	0	0	2	0	0
Fairfax	370	2	0	27	0	8	0	43	25	0
Fairfax City	17	0	0	1	0	0	0	0	1	0
Falls Church	8	0	0	0	0	0	0	0	1	0
Fredericksburg City	14	1	0	0	0	0	0	2	0	0
King and Queen	3	0	0	0	0	0	0	0	0	0
King George	11	0	0	0	0	0	0	0	0	0
King William	6	1	0	0	0	0	1	1	0	0
Lancaster	12	2	0	0	0	0	0	2	0	0
Middlesex	4	0	0	0	0	0	0	0	0	0
Northumberland	13	0	0	0	0	0	0	0	0	0
Prince William	100	0	0	0	0	2	0	13	4	0
Richmond	6	0	0	0	0	0	0	0	0	0
Spotsylvania	16	0	0	0	0	0	0	0	0	0
Stafford	48	0	0	0	0	0	0	0	0	0
Westmoreland	16	4	0	0	0	0	0	5	0	0
TOTAL	2385	665	1	38	0	41	2	873	116	28

Notes:
(1) The aggregate or total minority census block group is the total of all minority (Black, American Indian or Alaskan Native, Asian, Native Hawaiian or Pacific Islander, Some Other Race, or Multi-Racial) that exceeds NRC threshold for minority.
(2) A person of Hispanic/Latino origin may be of any race, and therefore may also be included in the aggregate racial minority percentage.
(3) St. Mary's and Calvert County are the Region of Influence for socioeconomic impact analysis.
Source: US Census Bureau, 2000. Summary File 1 and 3.

Table 9.3-12— Comparison of Wetland and Waterway Impacts: from Alternative Site Evaluation Reconnaissance Level Data

(Page 1 of 2)

	Proposed Site		Alternative Sites					
	Calvert Cliffs 3[16]		Bainbridge		EASTALCO		Thiokol[17]	
Property Acreage	2057.2		1068.6		1742.1		620.0	
Wetlands – Total Property[1] (ac)	173.2		4.6		22.0		49.8	
Wetlands – Site[2] (ac)	6.6		0.0		0.0		34.5	
Streams – Total Property[3] (LF)	21805		8654		32944		7055	
Streams – Site[4] (LF)	3604		1557		1311		3435	
Wetlands Affected – Site[5] (ac)	6.6		0.0		0.0		34.5	
Streams Affected – Site[6] (LF)	3604		1557		1311		3435	
Section 10 Waters: Tidal (ac)	5.7[7]		NA		NA		2.25[8]	
Navigable Riverine (ac)	N/A		0.23[9]		0.23[9]		NA	
Off-Site Wetlands/Waterways Affected – ROWs and Interconnects (ac/LF)[10]	**Wetlands**	**Streams**	**Wetlands**	**Streams**	**Wetlands**	**Streams**	**Wetlands**	**Streams**
CWIS (in-water components)(ac)[11]	0.23	0	0.23	0	0.23	0	0.23	0
CW Pump House (ac.)[12]	NA	NA	0	0	0	0	0	0
Water Line ROW (ac)[13]	NA	NA	1.3	0	3.2	865	0.4	0
Transmission Line ROW (ac)[14]	0	0	5.2	3517	0.2	1820	26.6	4051
RR Spur/Improvements (ac)	NA	NA	NA	NA	NA	NA	NA	NA
Access Roadways (ac)	NA	NA	NA	NA	NA	NA	NA	NA
Other Off-Site Uses (ac)[15]								

[1]"Total Property" includes the entirety of the alternate site facility contiguous land holdings (black outline).

[2]"Site" includes the 420 parcel on the Total Property selected for EPR development (red outline).

[3]Describes the total length of all streams on the Total Property in linear feet. Includes both mapped perennial and intermittent waterways and obvious drainage ways observed during site inspections or interpreted from desktop mapping.

[4]Describes streams within the 420 EPR Site, calculated in the same manner as streams for "Total Property".

[5] An assumption has been made that any wetlands within the 420 acre Site would be affected.

[6] An assumption has been made that any streams within the 420 acre Site would be affected by construction.

[7] The actual, not estimated, proposed impacts to Sec. 10 regulated tidal waterways below ordinary high water (OHW) or mean high water shoreline (MHW) is approximately 5.7 acres.

Table 9.3-12— Comparison of Wetland and Waterway Impacts: from Alternative Site Evaluation Reconnaissance Level Data

(Page 2 of 2)

[8] The Thiokol site cooling water intake and discharge structures are located within the Patuxent River. Directional drilling would not be possible based on soft mud substrate, and suitable water depths are located 1000' feet into the river channel seaward of OHW or MHW. Accordingly, dredging of a 1000' x 45' pipe trench (4' deep) in addition to 0.5 acres for aquatic structures is proposed, totaling approximately 2.25 acres. Dredging volume (in place) is estimated to be approximately 8,000 cubic yards.

[9] For both the Bainbridge and EASTALCO Alternative Sites, 0.23 acre (100'x 100') of wetland disturbance below OHW is assumed. This estimation of impact is based upon prior experience in similar environments, and assumes use of directional drilling to approach intake sites, and the ability to contain the intake and discharge structures within a coffer darn or turbidity curtain array with area 0.23 acres.

[10]An assumption has been made that any wetlands or streams within the ROWs or interconnects would be affected by construction. Impacts associated with ROW construction and some in-water construction activities are temporary in nature.

[11]An assumption has been made to allow a 100'x100' area of impact for in-water cooling water intake system (CWIS) components. No alternate sites are proposed to use shoreline intake
structures; all intake/discharge structures are proposed to be sited at a depth of -20' MLW or greater. Horizontal directional drilling (HDD) is proposed to access off shore locations.

[12]A cooling water pump house would be located alongshore to the selected cooling water source, and would occupy 0.5 acre total area.

[13]For the purposes of this evaluation, it has been assumed that any water line ROW would require a 120' width for construction to allow installation of 2-60" pipes.

[14]For new transmission line construction or reconductoring of existing circuits to accommodate the EPR, a 300' wide cleared ROW is assumed to be required. The Transmission Corridor for the Thiokol site is different from the one in the March 2009 Requests for Additional Information Responses (UN#09-140)

[15]Other off-site uses include any required parking, laydown, staging requiring land alteration.
Sources: USFWS, 2008. National Wetlands Inventory, U.S. Fish and Wildlife Service, CONUS_wet_poly, Classification of Wetlands and Deepwater Habitats of the United States, Washington,
DC, FWS/OBS-79/31, National Wetlands Metadata, website: http://www.fws.gov/wetlands/Data/DataDownloadState.html, accessed: June 17, 2009.
MDNR, 2002. Wetlands of Special State Concern Data, Geospatial Data from the Maryland Department of Natural Resources, Metadata, website:
http://dnrweb.dnr.state.md.us/gis/data/data.asp, accessed June 27, 2009.

[16] ER Section 4.1.1.1 (Rev. 5) states the CCNPP3 and supporting facilities will be located on 2,070 acres; ER Section 4.3.1.3 (Rev. 5) states the construction of CCNPP3 will permanently fill approximately 8,350 LF of stream and 11.72 acres of delineated wetland areas. This table provides data primarily for the approximate 420-acre EPR Site (see Footnote 2) for consistent comparison with the alternative sites and, therefore, some data in this table will be different from quantities of affected acreage stated in the ER Rev. 5.

[17] ER Section 9.3.2.4.5 states that the Thiokol site has approximately 49.2 ac of non-tidal wetlands and 14,411 LF of stream within the 619 ac Thiokol site. This table provides data primarily for an approximate 420-acre EPR site within the overall property boundary. Therefore the data on affected wetlands and streams in this table will differ from the data presented in ER Section 9.3.2.4.5.

Table 9.3-13— Summary of Wetlands on Alternate Sites
(Page 1 of 2)

	Number of discrete wetlands or systems	Wetland types (NWI classification)	Description
Calvert Cliffs 3	5	1. Freshwater Forested/Shrub Wetland 2. Freshwater Pond 3. Freshwater Pond 4. Freshwater Forested/Shrub Wetland 5. Freshwater Pond	1. 4.7 ac of PFO[1] 2. 0.5 ac of PUB[2] 3. 0.02 ac of PUB 4. 0.5 ac of PFO 5. 0.9 ac of PUB
Bainbridge	5	1. Freshwater Forested/Shrub Wetland 2. Freshwater Pond 3. Riverine 4. Riverine 5. Freshwater Forested/Shrub	1. 3.7 ac 2. 0.9 ac 3. 1.3 ac 4. 3.2 ac 5. 0.7 ac
EASTALCO	10	1. Freshwater Emergent Wetland 2. Freshwater Emergent Wetland 3. Freshwater Forested/Shrub Wetland 4. Freshwater Forested/Shrub Wetland 5. Freshwater Forested/Shrub Wetland 6. Freshwater Emergent Wetland 7. Riverine 8. Freshwater Emergent Wetland 9. Freshwater Emergent Wetland 10. Freshwater Forested/Shrub Wetland	1. 0.2 ac 2. 0.4 ac 3. 0.1 ac 4. 0.3 ac 5. 0.9 ac 6. 0.03 ac 7. 1.3 ac 8. 0.2 ac 9. 0.3 ac 10. 0.7 ac
Thiokol	14	1. Freshwater Forested/Shrub Wetland 2. Freshwater Forested/Shrub Wetland 3. Freshwater Forested/Shrub Wetland 4. Freshwater Forested/Shrub Wetland 5. Freshwater Forested/Shrub Wetland 6. Freshwater Forested/Shrub Wetland 7. Freshwater Forested/Shrub Wetland 8. Freshwater Pond 9. Freshwater Emergent Wetland 10. Freshwater Forested/Shrub Wetland 11. Freshwater Emergent Wetland 12. Estuarine and Marine Wetland 13. Estuarine and Marine Deepwater 14. Freshwater Emergent Wetland	1. 2.5 ac of PFO 2. 31.9 ac of PFO 3. 0.08 ac 4. 0.3 ac 5. 4.3 ac 6. 0.1 ac 7. 0.1 ac 8. 0.5 ac 9. 1.9 ac 10. 5.2 ac 11. 1.1 ac 12. 6.3 ac 13. 6.8 ac 14. 0.3 ac

[1] PFO is a palustrine forested wetland

[2] PUB is a palustrine unconsolidated bottom wetland

Table 9.3-13— Summary of Wetlands on Alternate Sites

(Page 2 of 2)

	Number of discrete **wetlands or systems**	**Wetland types (NWI classification)**	**Description**

Sources: USFWS, 2008. National Wetlands Inventory, U.S. Fish and Wildlife Service, CONUS_wet_poly, Classification of Wetlands and Deepwater Habitats of the United States, Washington, DC, FWS/OBS-79/31, National Wetlands Metadata, website: http://www.fws.gov/wetlands/Data/DataDownloadState.html, accessed: June 17, 2009.
MDNR, 2002. Wetlands of Special State Concern Data, Geospatial Data from the Maryland Department of Natural Resources, Metadata, website: http://dnrweb.dnr.state.md.us/gis/data/data.asp, accessed June 27, 2009.

Table 9.3-14— Summary of Waterways on Alternate Sites
(Page 1 of 2)

	Number of/names of streams	Stream type	Description
Calvert Cliffs 3	A. Johns Creek	A. Perennial	A. 4661 LF
	B. Tributary to the Bay	B. Perennial	B. 2093 LF
	C. Tributary of Johns Creek	C. Perennial	C. 7400 LF
	D. Goldstein Branch	D. Perennial	D. 2051 LF
	E. Tributary of Perrin Branch	E. Intermittent	E. 4517 LF
	F. Tributary of Perrin Branch	F. Perennial	F. 1083 LF
Bainbridge	A. Tributary of Susquehanna River	A. Perennial	A. 2638 LF
	B. Happy Valley Branch	B. Perennial	B. 6016 LF
	C. Tributary of Susquehanna River	C. Perennial	C. 1279 LF
	D. Tributary of Susquehanna River	D. Perennial	D. 312 LF
	E. Tributary of Susquehanna River	E. Perennial	E. 308 LF
	F. Octoraro Creek	F. Perennial	F. 1433 LF
	G. Tributary of Octoraro Creek	G. Perennial	G. 185 LF
EASTALCO	A. Tributary of Tuscarora Creek	A. Perennial	A.2693 LF
	B. Tuscarora Creek	B. Perennial	B. 12319 LF
	C. Tributary of Tuscarora Creek	C. Intermittent	C. 6001 LF
	D. Tributary of Tuscarora Creek	D. Perennial	D. 3399 LF
	E. Tributary of Tuscarora Creek	E. Intermittent	E. 4634 LF
	F. Horsehead Run	F. Intermittent	F. 3898 LF
	G. Tributary of Tuscarora Creek	G. Intermittent	G. 120 LF
	H. Tuscarora Creek	H. Perennial	H. 745 LF
	I. Tributary of Tuscarora Creek	I. Perennial	I. 395 LF
	J. Tributary of Tuscarora Creek	J. Perennial	J. 327 LF
	K. Tributary of Tuscarora Creek	K. Perennial	K. 378 LF
	L. Tributary of Tuscarora Creek	L. Perennial	L. 403 LF
	M. Tributary of Tuscarora Creek	M. Perennial	M. 317 LF

Table 9.3-14— Summary of Waterways on Alternate Sites

(Page 2 of 2)

	Number of/names of streams	Stream type	Description
Thiokol	A. Tributary of Burnt Mill Creek	A. Perennial	A. 5430 LF
	B. Rich Neck Creek	B. Perennial	B. 2250 LF
	C. Tributary of Burnt Mill Creek	C. Perennial	C. 312 LF
	D. Horse Landing Creek	D. Perennial	D. 486 LF
	E. Tributary of Persimmon Creek	E. Perennial	E. 332 LF
	F. Persimmon Creek	F. Perennial	F. 324 LF
	G. Tributary of Killpeck Creek	G. Perennial	G. 300 LF
	H. Killpeck Creek	H. Perennial	H. 300 LF
	I. Tributary of Patuxent Creek	I. Perennial	I. 445 LF
	J. Tributary of Patuxent Creek	J. Perennial	J. 354 LF
	K. Tributary of Patuxent Creek	K. Perennial	K. 308 LF
	L. Tributary of Patuxent Creek	L. Intermittient	L. 201 LF
	M. Tributary of Patuxent Creek	M. Perennial	M. 310 LF
	L. Swanson Creek	L. Perennial	L. 379 LF

Sources:

USFWS, 2008. National Wetlands Inventory, U.S. Fish and Wildlife Service, CONUS_wet_poly, Classification of Wetlands and Deepwater Habitats of the United States, Washington, DC, FWS/OBS-79/31, National Wetlands Metadata, website: http://www.fws.gov/wetlands/Data/DataDownloadState.html. accessed June 17, 2009.

MDNR, 2002. Wetlands of Special State Concern Data, Geospatial Data from the Maryland Department of Natural Resources, Metadata, website: http://dnrweb.dnr.state.md.us/gis/data/data.asp, accessed June 27,2009.

Figure 9.3-1— Site Selection Process

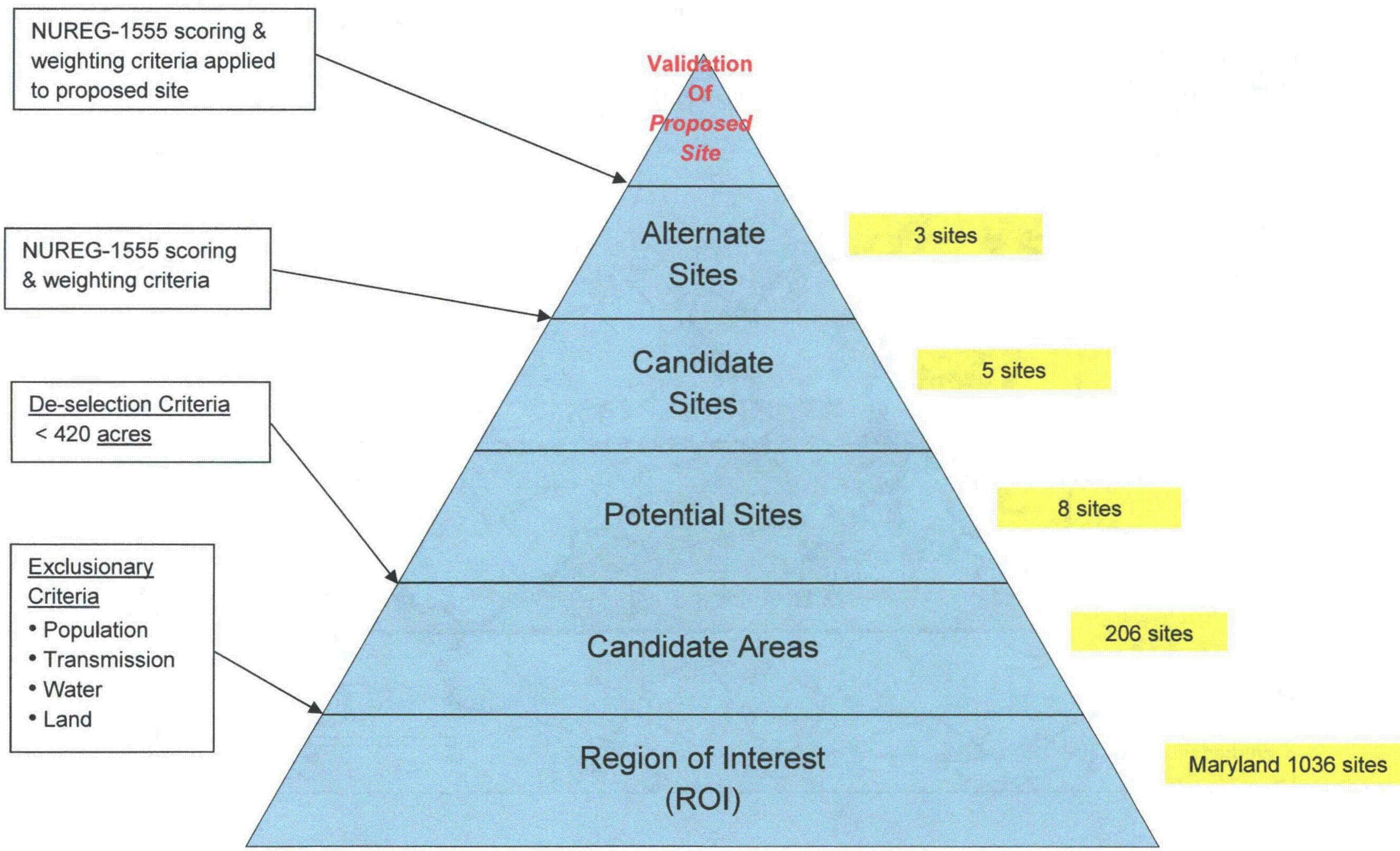


Figure 9.3-2— Region of Interest

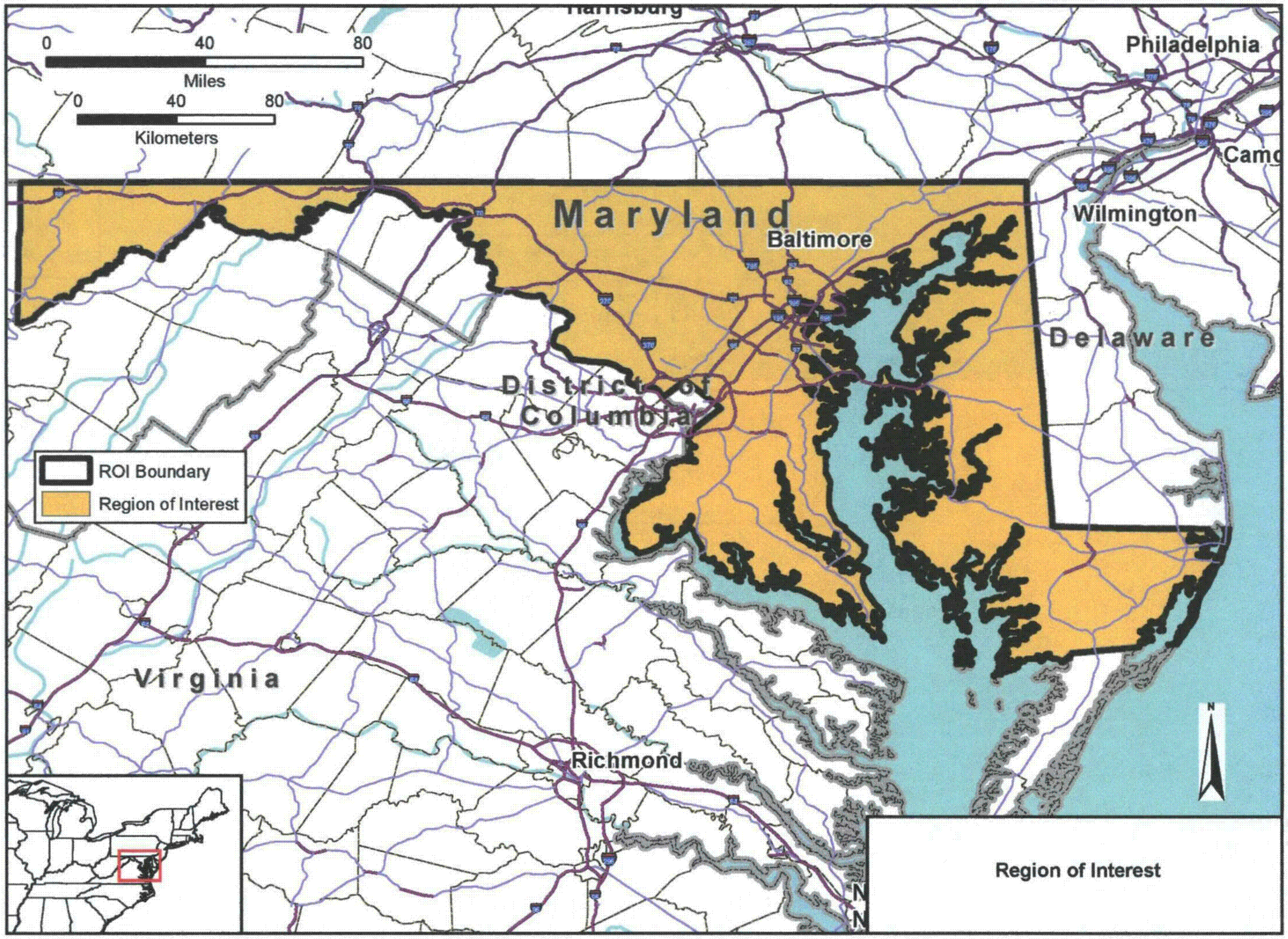


Figure 9.3-3— Candidate Area Exclusionary Criteria – Population Center

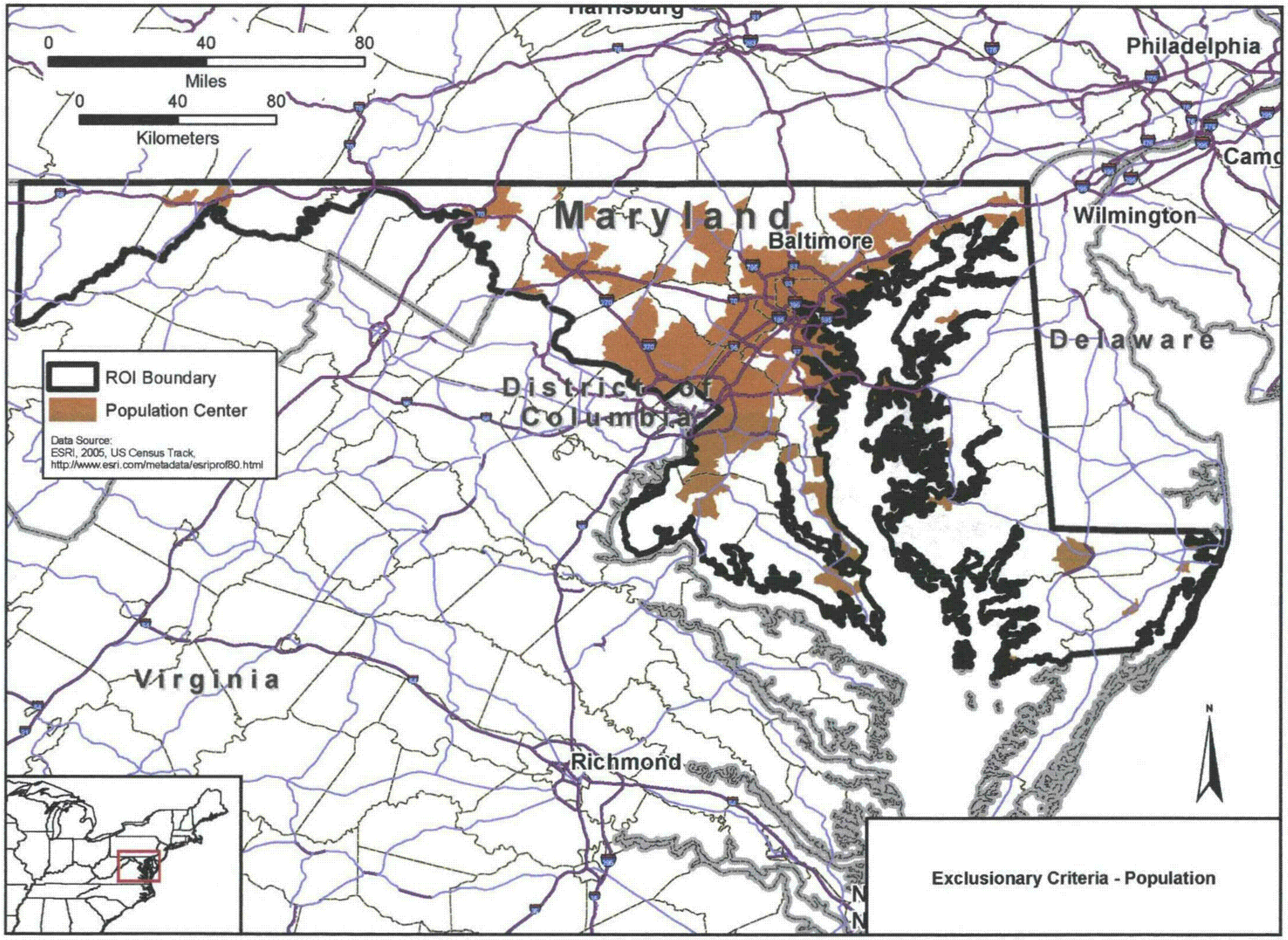


Figure 9.3-4— Candidate Area Exclusionary Criteria – Transmission Lines

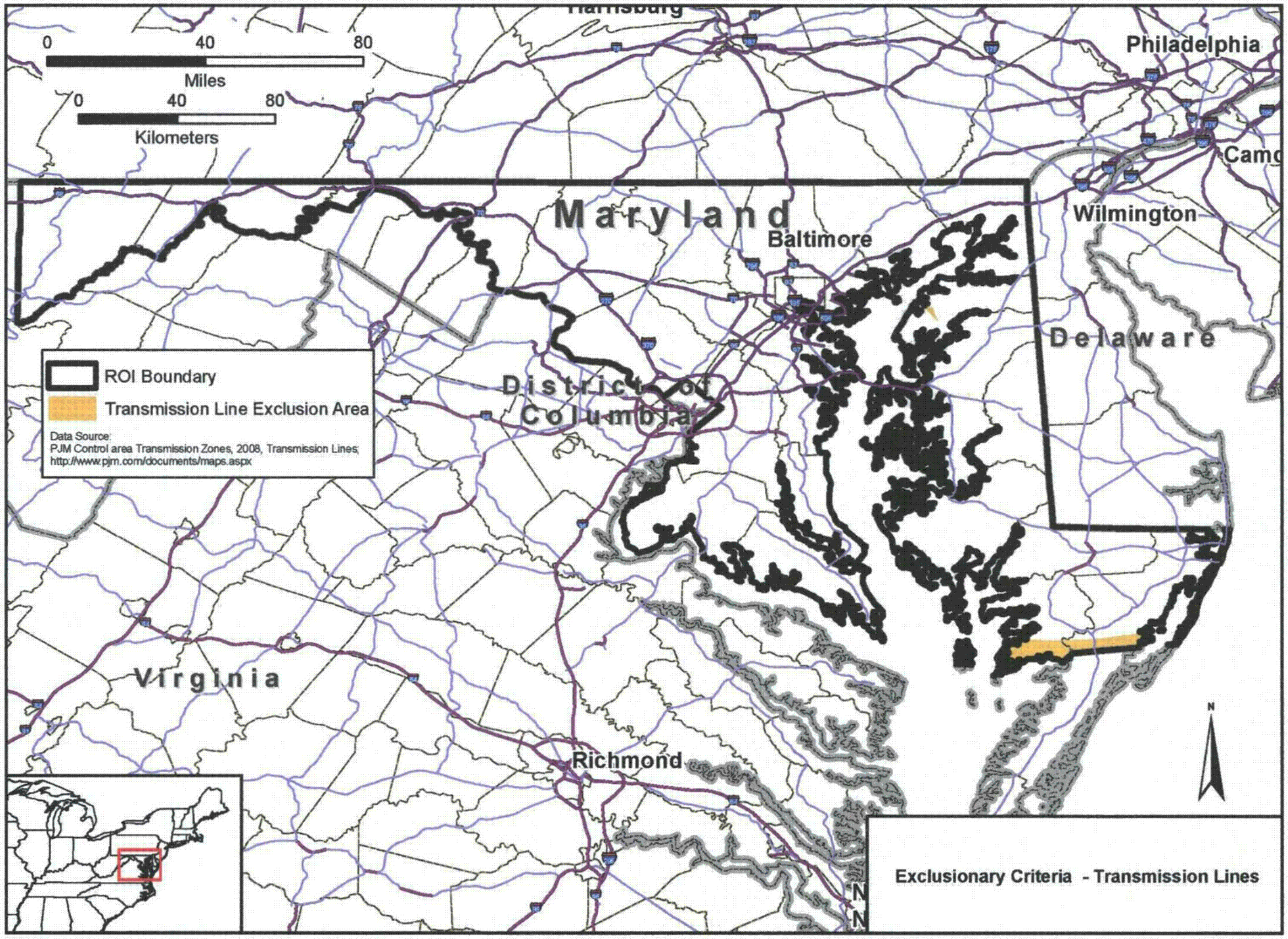


Figure 9.3-5— Candidate Area Exclusionary Criteria – Dedicated Lands

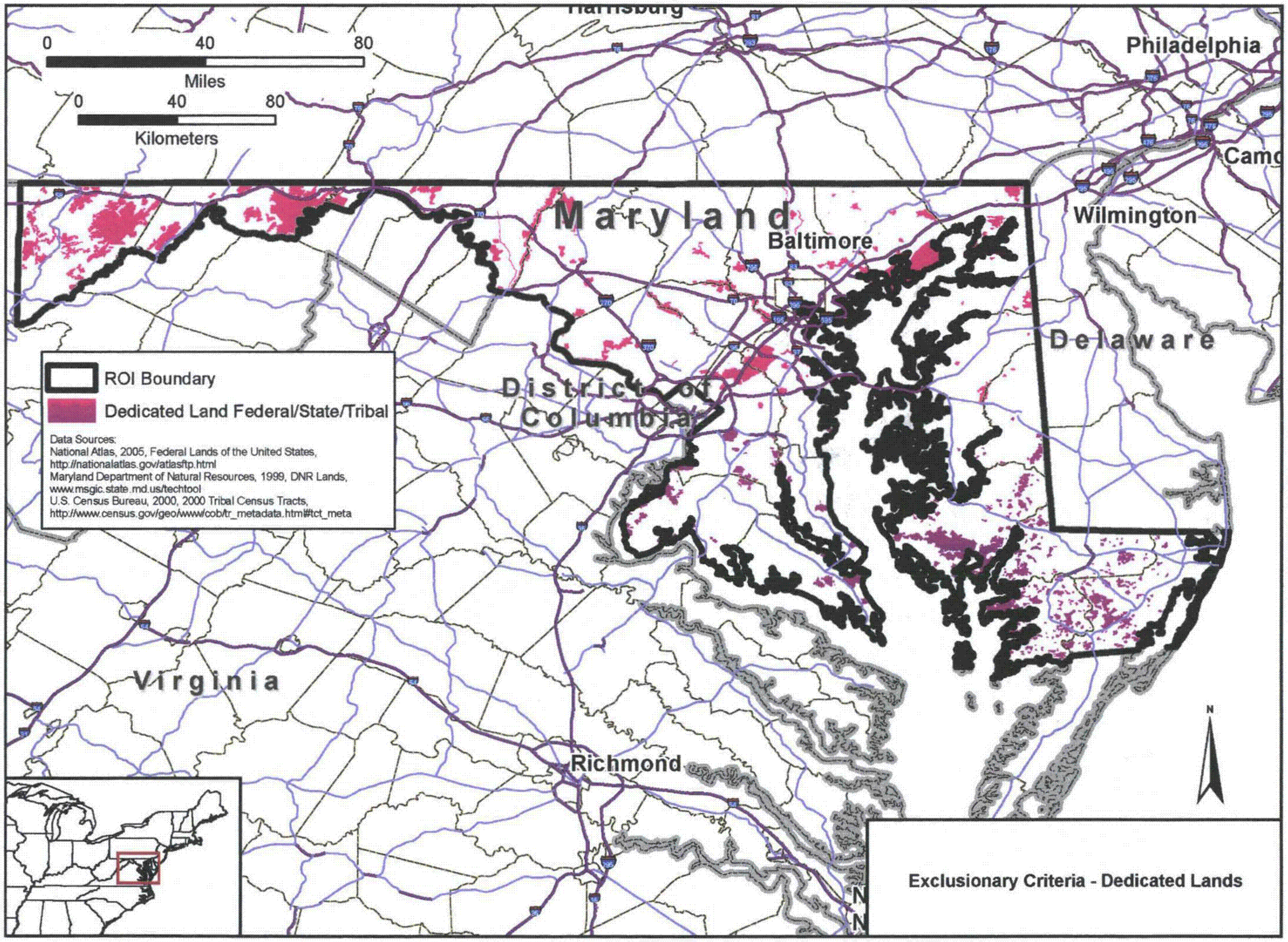


Figure 9.3-6— Candidate Area Exclusionary Criteria – Waterway

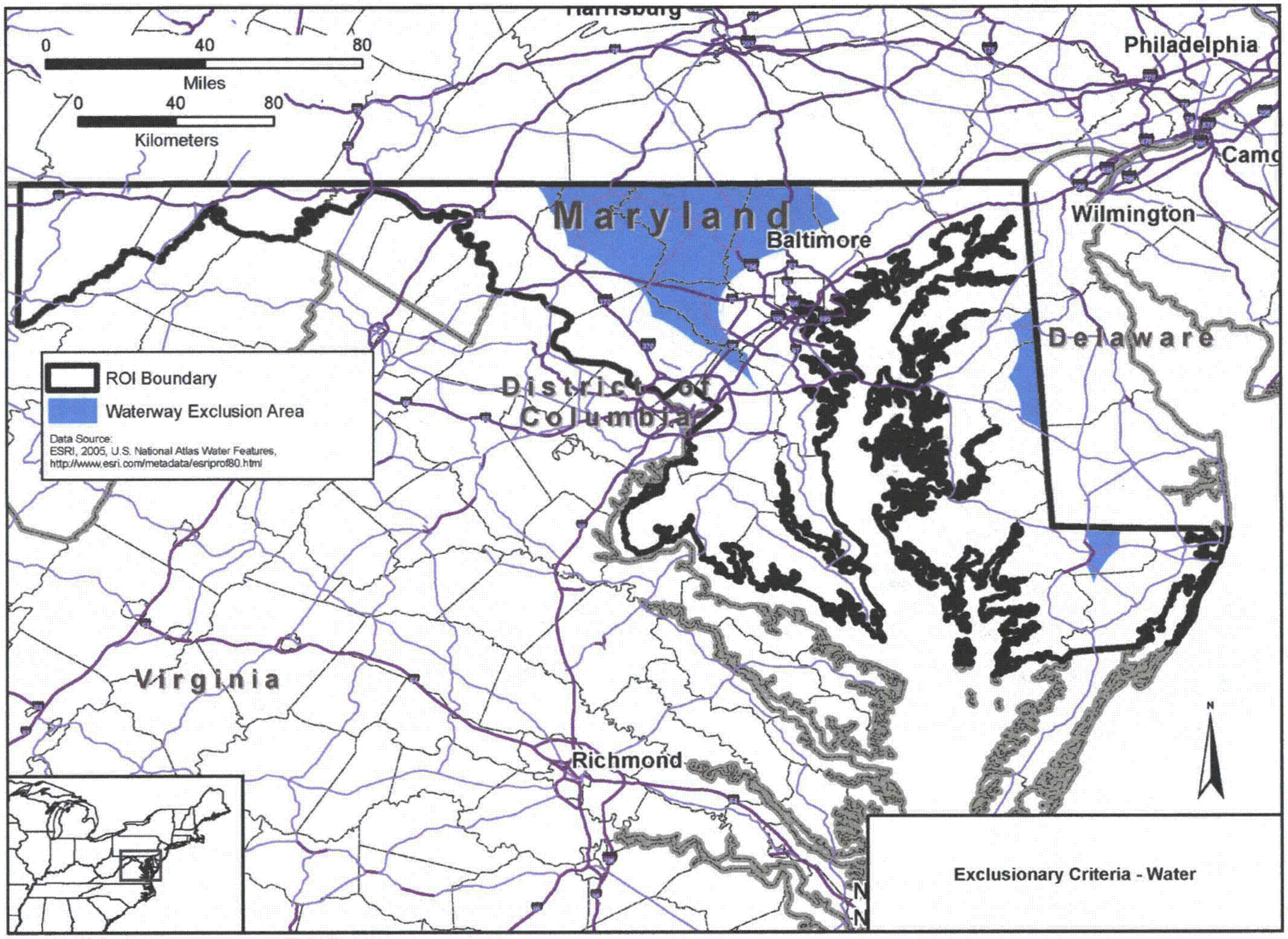


Figure 9.3-7— Candidate Area Exclusionary Criteria – All

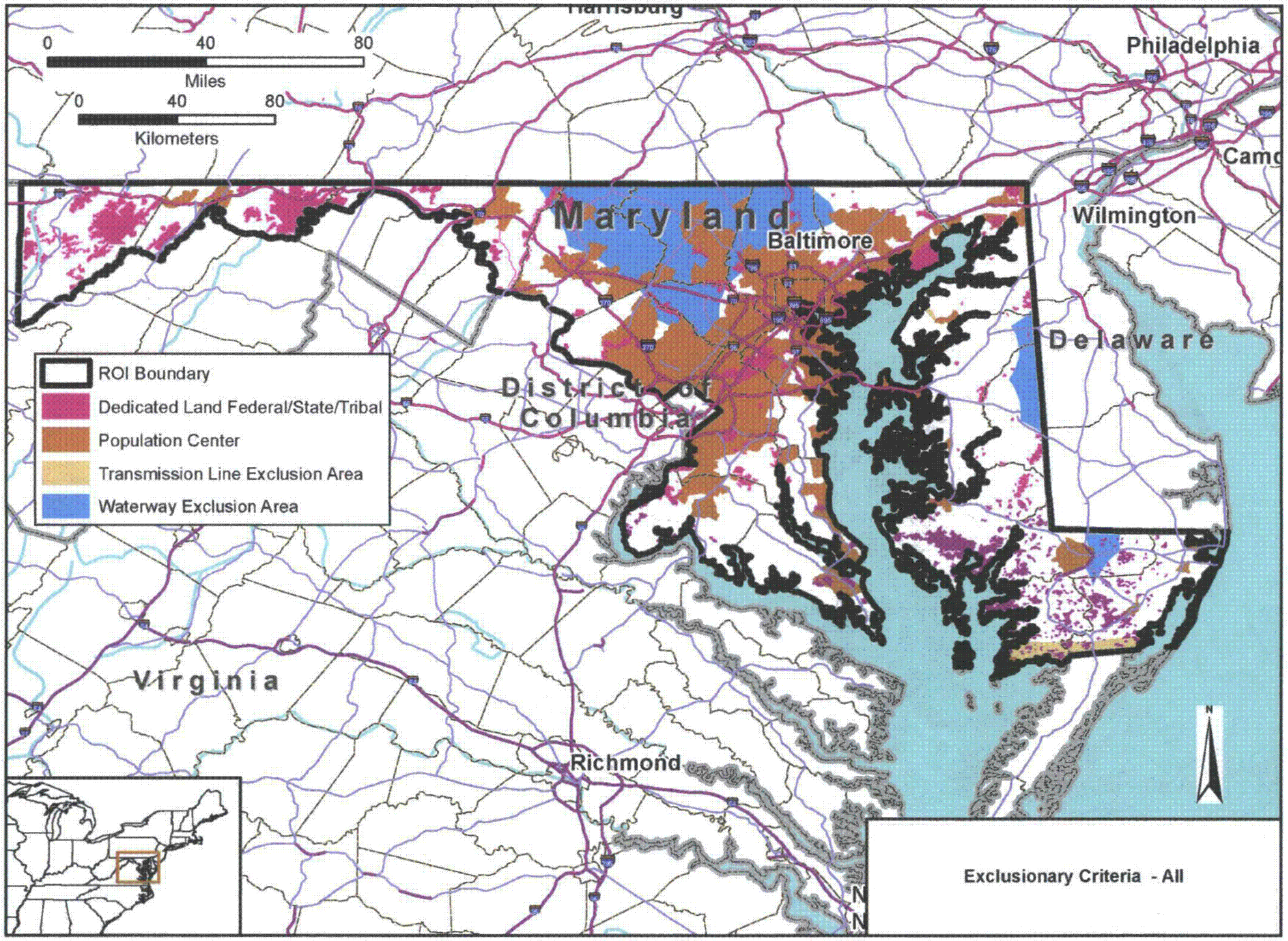


Figure 9.3-8— Candidate Areas

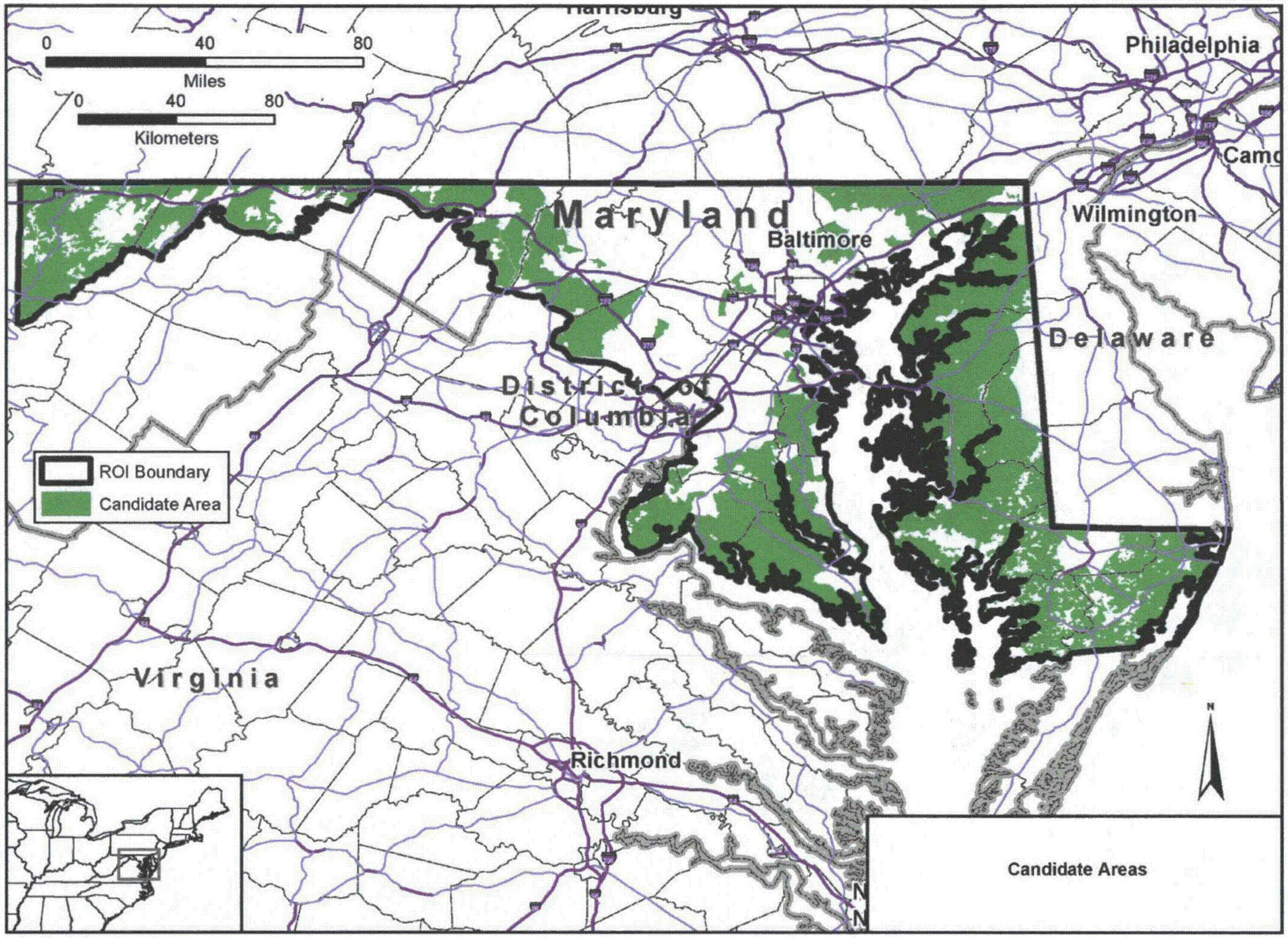


Figure 9.3-9— Locations of Sites within Candidate Areas

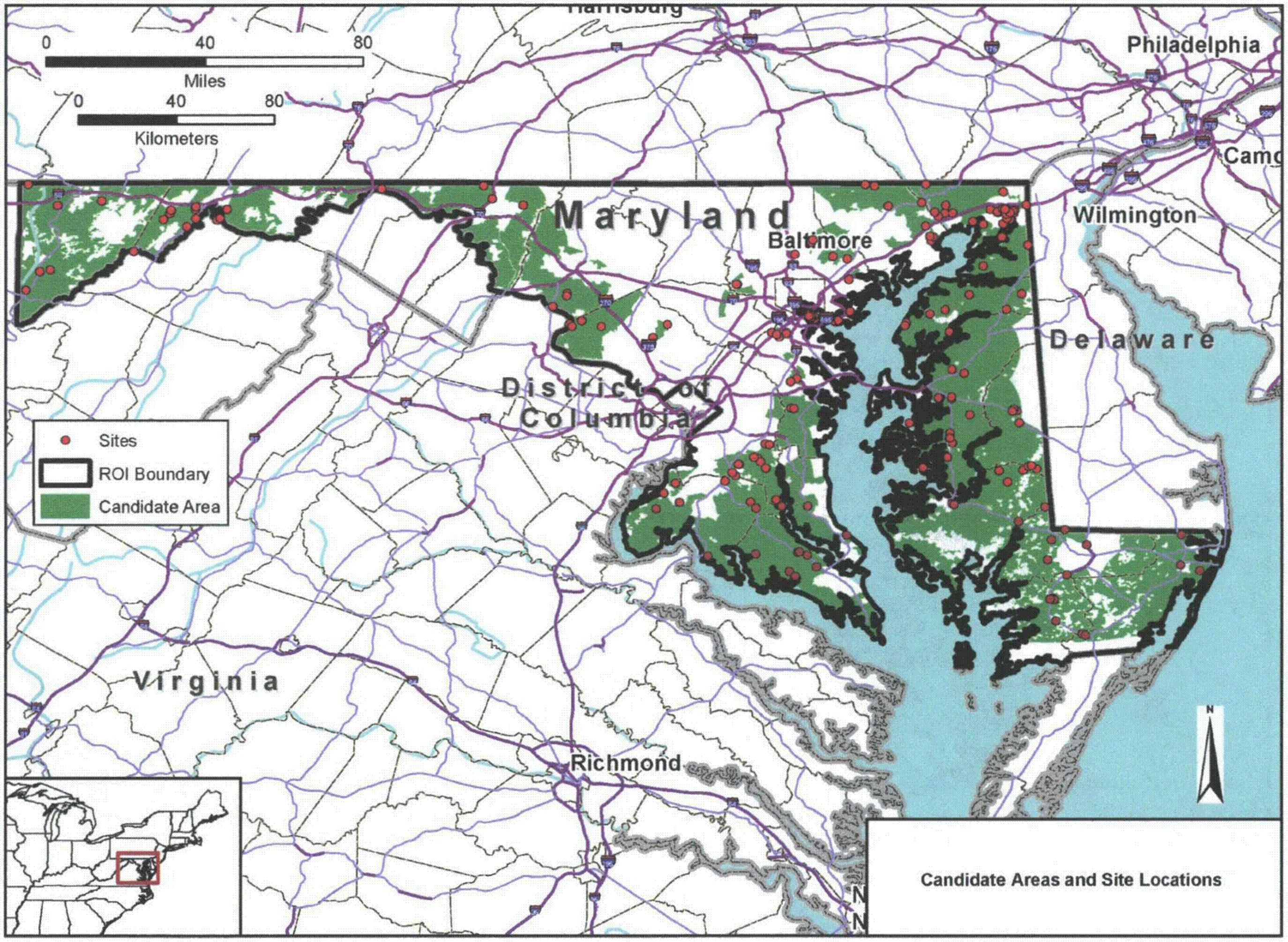


Figure 9.3-10— Candidate Sites

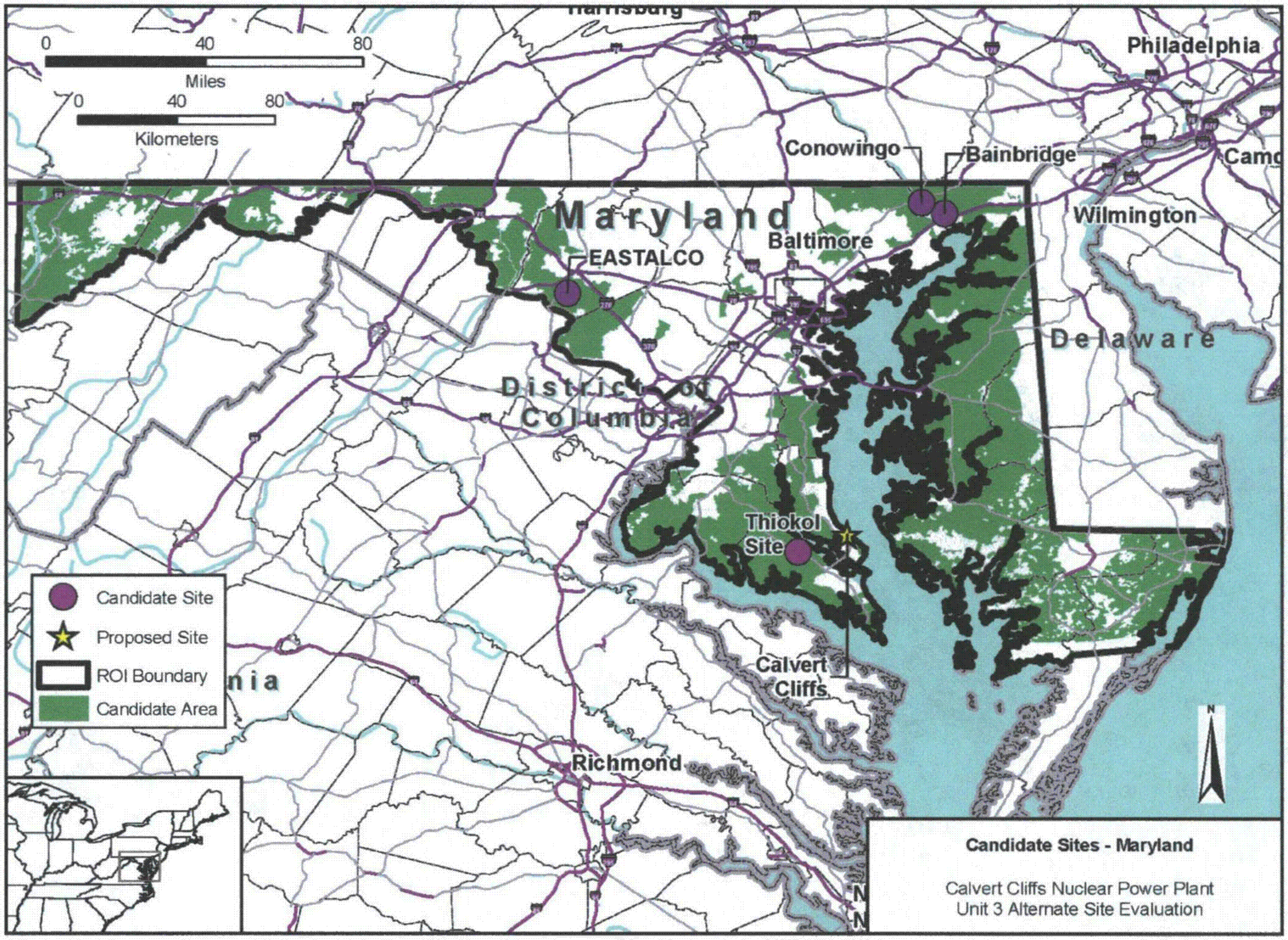


Figure 9.3-11— Alternative Sites and Proposed Site

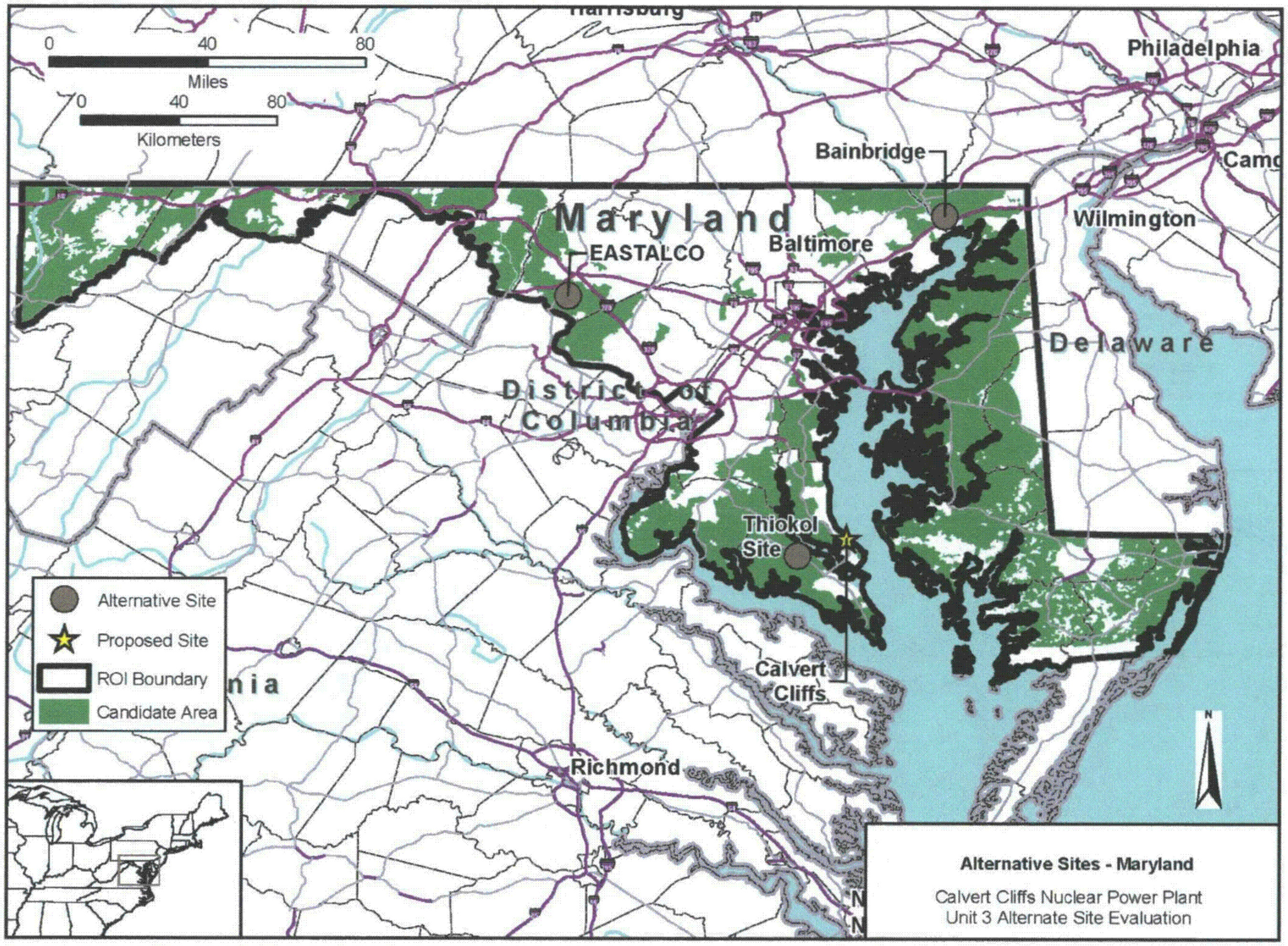


Figure 9.3-12— Bainbridge Naval Training Center Site Location

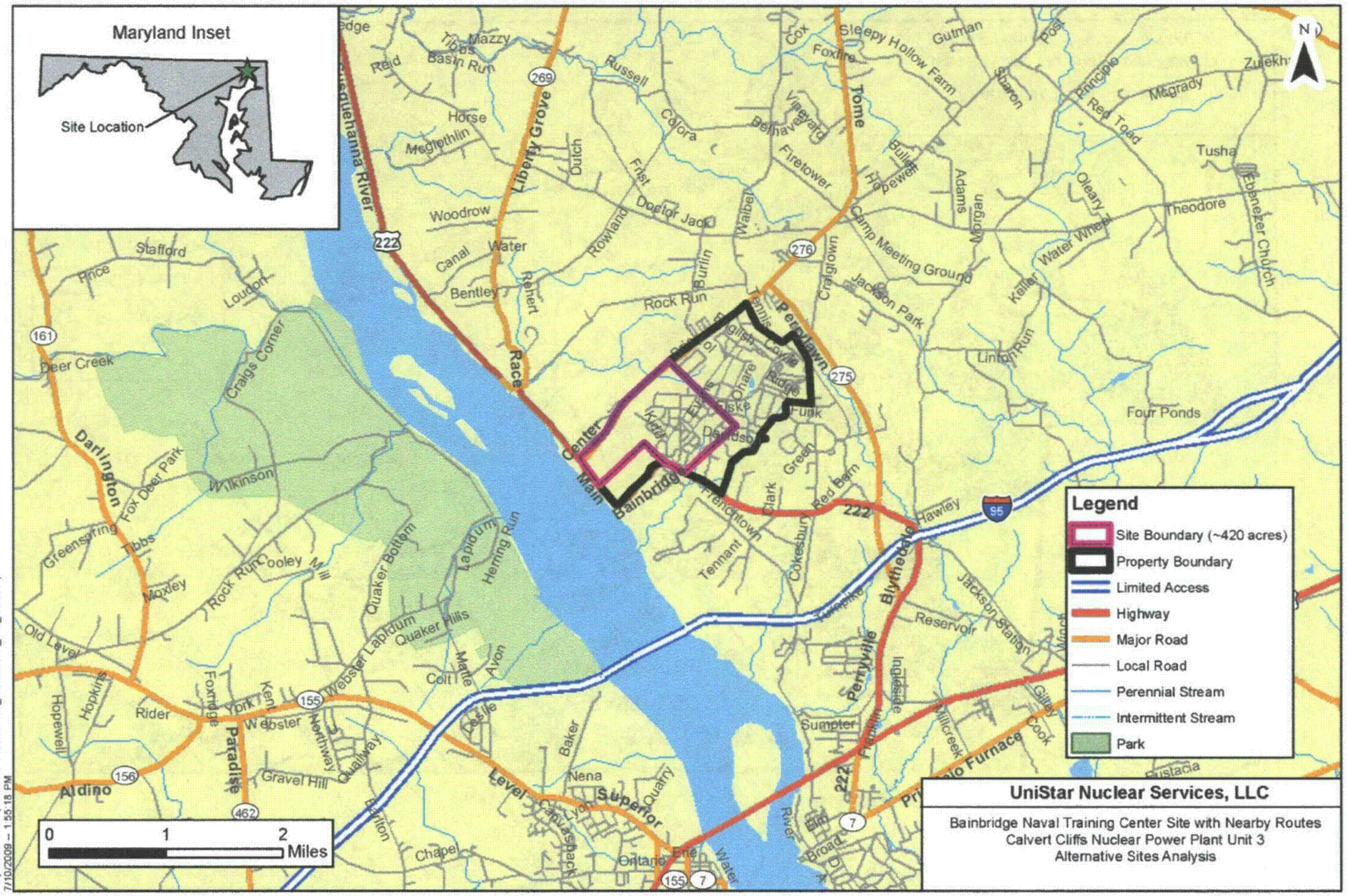


Figure 9.3-13— Bainbridge Naval Training Center Site Vicinity

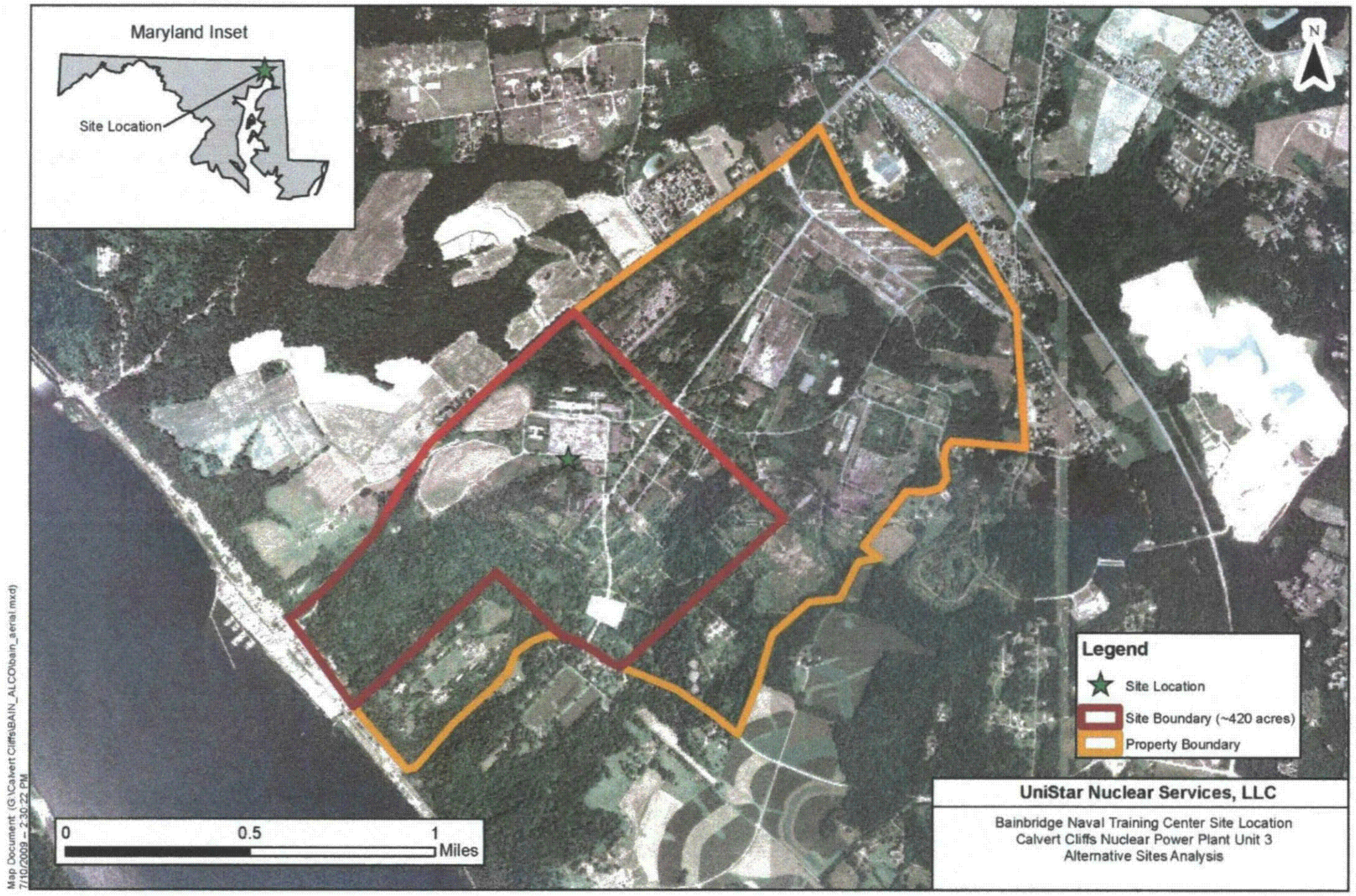


Figure 9.3-14— EASTALCO Aluminum Company Site Location

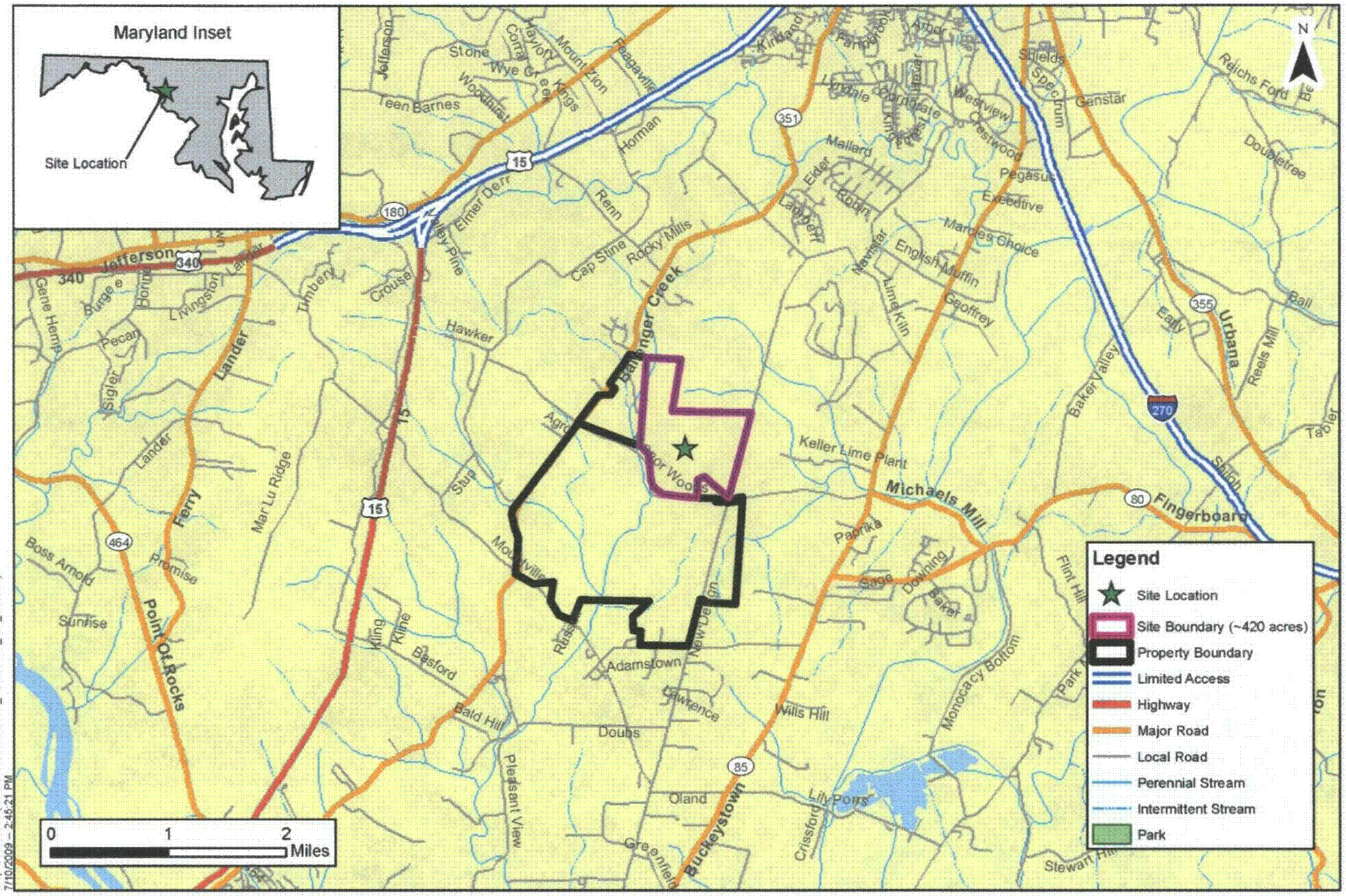
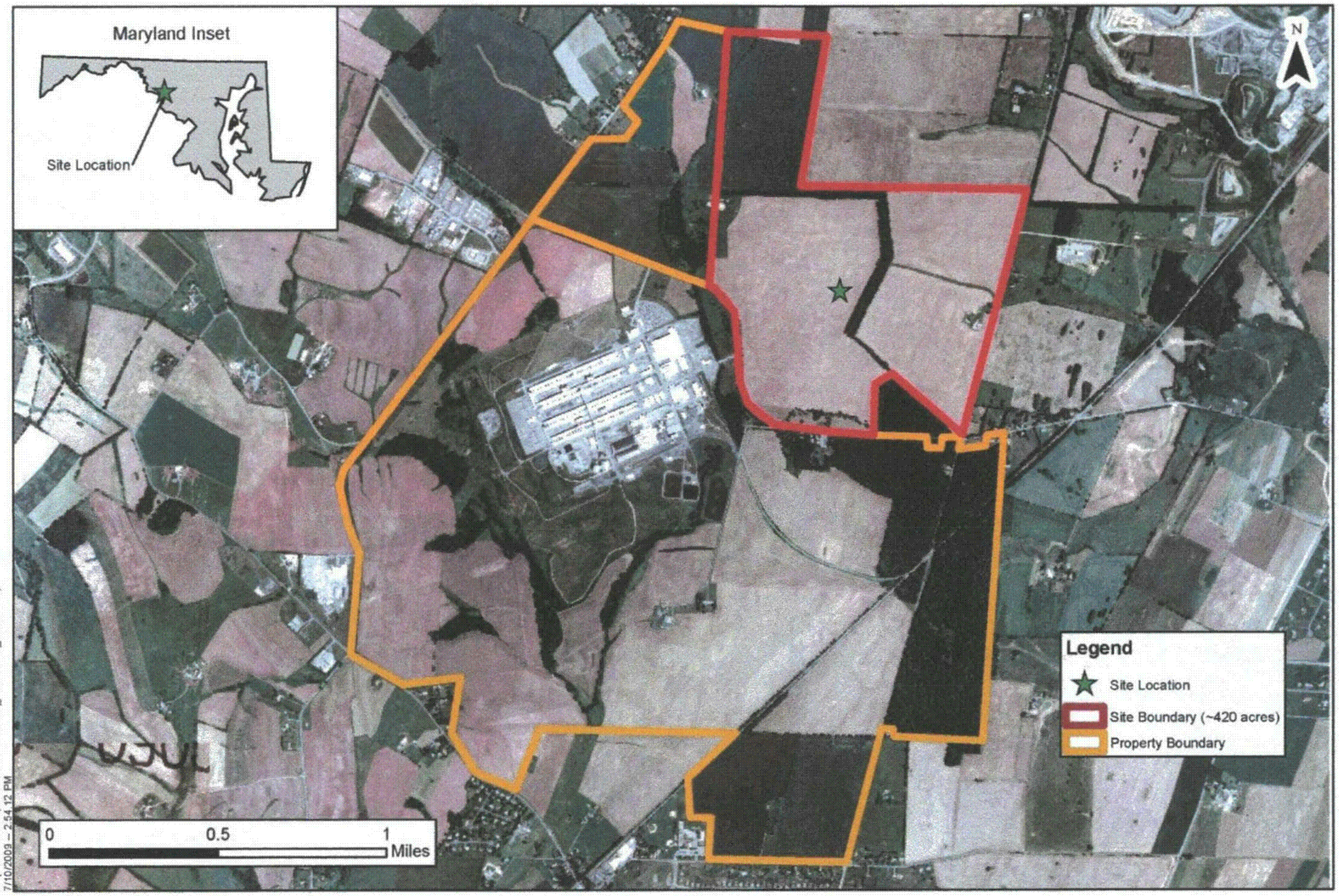


Figure 9.3-15— EASTALCO Aluminum Company Site Vicinity



Map Document: (G:\Calvert Cliffs\BAIN_ALCO\alco_aerial.mxd)
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Figure 9.3-16— Former Thiokol Site Location

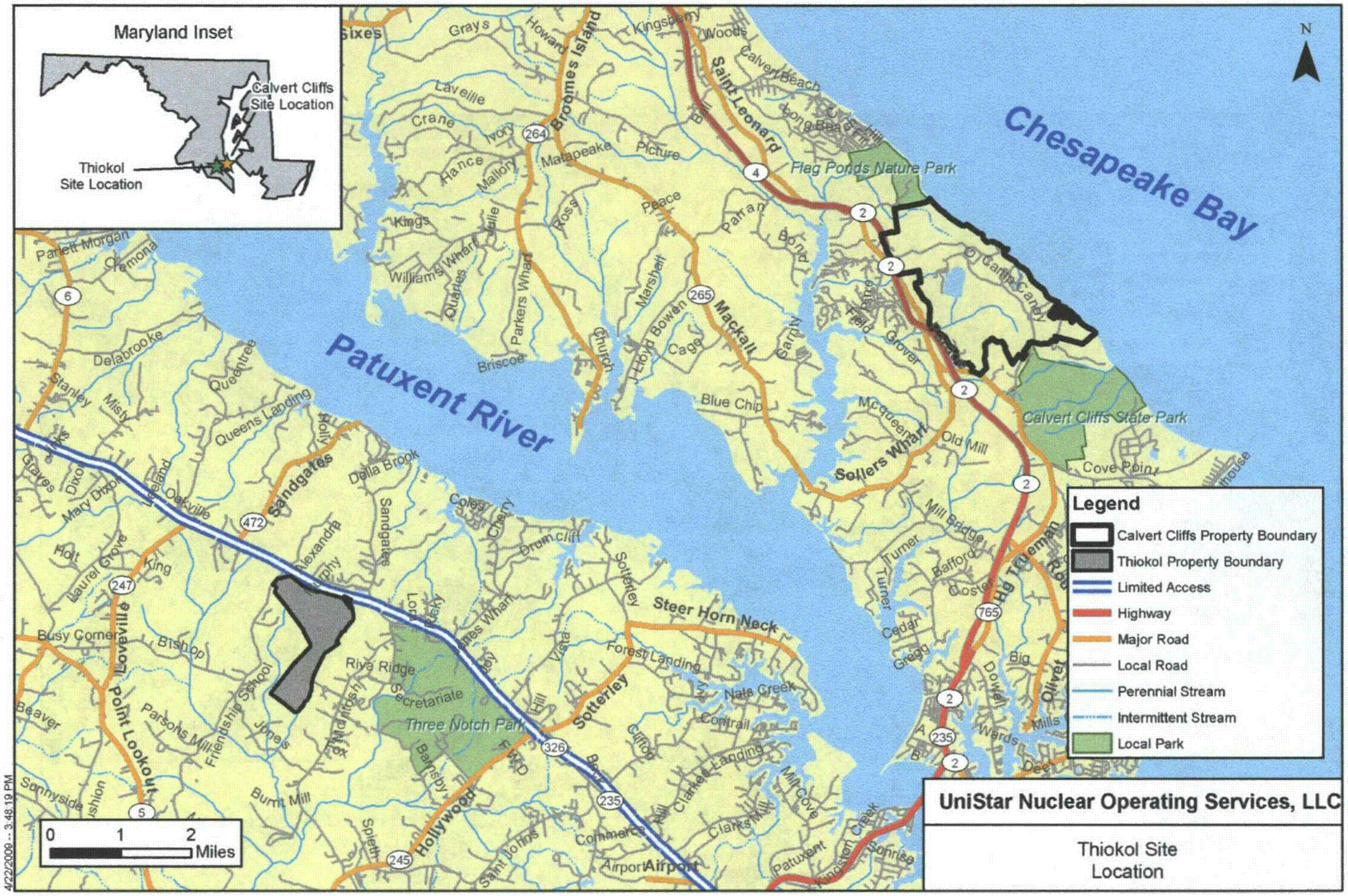
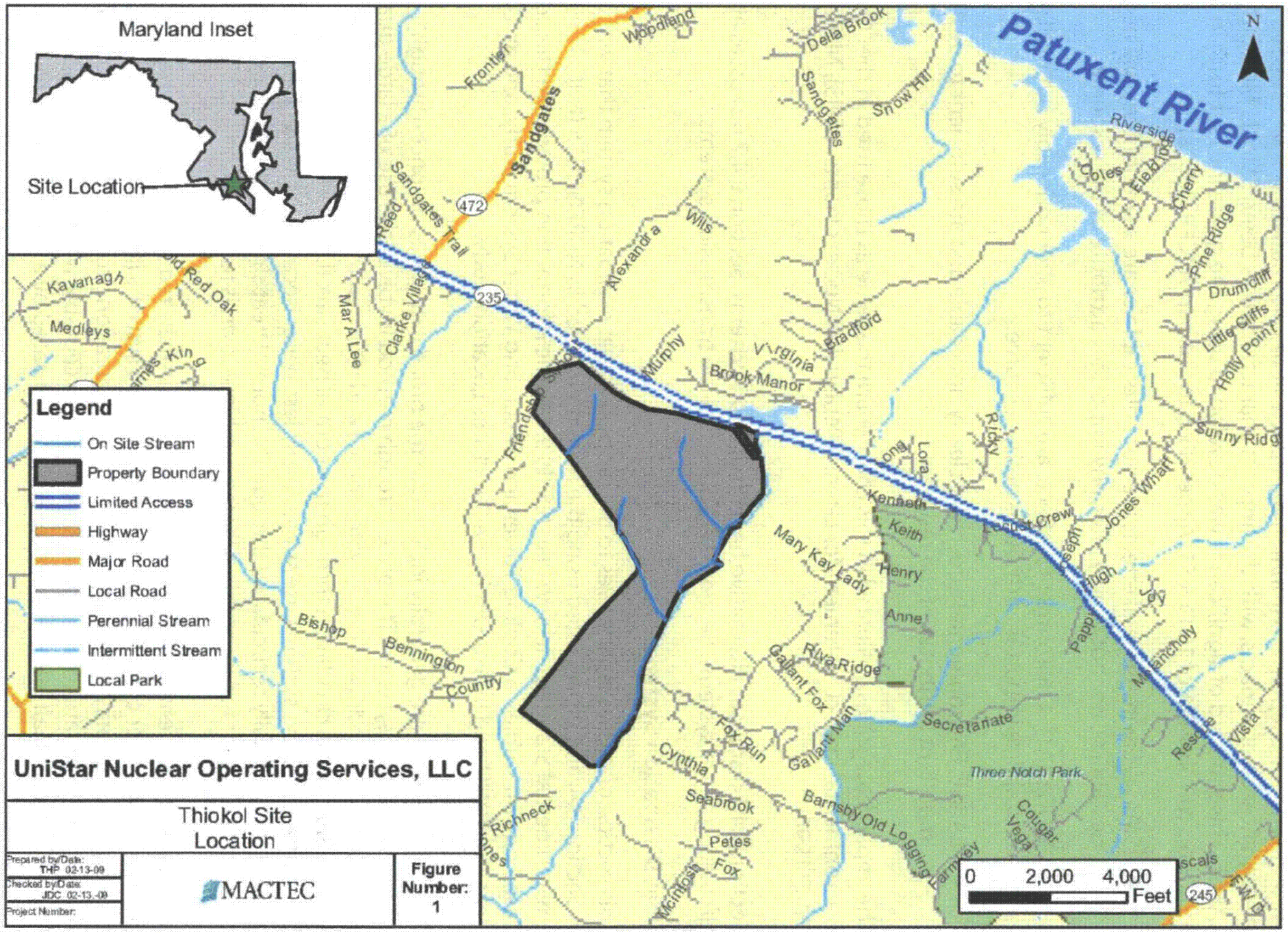


Figure 9.3-17— Former Thiokol Site Vicinity



9.4 ALTERNATIVE PLANT AND TRANSMISSION SYSTEMS

The information presented in this section describes the evaluation of the alternative plant and transmission systems for heat dissipation, circulating water, and power transmission associated with the 1,562 MWe CCNPP Unit 3 facility. The information provided in this section is consistent with the items identified NUREG-1555 (NRC, 1999).

Throughout this chapter, environmental impacts of the alternatives will be assessed based on the significance of impacts, with the impacts characterized as being SMALL, MODERATE, or LARGE. This standard of significance was developed using the guidelines set forth in the footnotes to Table B-1 of 10 CFR 51, Appendix B to Subpart A (CFR, 2007a):

- SMALL. Environmental effects are not detectable or are so minor they will neither destabilize, nor noticeably alter, any important attribute of the resource.
- MODERATE. Environmental effects are sufficient to alter noticeably but not to destabilize important attributes of the resource.
- LARGE. Environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

The impact categories evaluated in this chapter are the same as those used in the "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (GEIS), NUREG-1437, (NRC, 1996).

Section 9.4.1 discusses alternative heat dissipation systems. Section 9.4.2 discusses alternative circulating water systems. Section 9.4.3 discusses the transmission systems.

9.4.1 Heat Dissipation Systems

This section discusses alternatives to the proposed heat dissipation system that was described in Section 3.4, and is presented using the format provided in NUREG-1555 (NRC, 1999), i.e., Environmental Standard Review Plan (ESRP) 9.4.1. The information provided in this section is based on two studies: a Cooling Tower and Circulating Water System study, and an Ultimate Heat Sink (UHS) and Intake/Discharge Structures Location study.

These alternatives are generally included in the broad categories of "once-through" and "closed-loop" systems. The once-through method involves the use of a large quantity of cooling water, withdrawn from a water source and returned to that source (receiving water body) following its circulation through the normal heat sink (i.e., main condenser). Closed-loop cooling systems use substantially less water because the water performing the cooling is continually recirculated through the normal heat sink (i.e., the main condenser), and only makeup water for evaporative losses and blowdown is required.

In closed-loop systems, two pumping stations are usually required—a makeup water system and a cooling water circulation system. Closed-loop systems include cooling towers, and a cooling pond or spray pond. As a result of the evaporation process, the concentration of chemicals in the water will increase. To maintain acceptable water chemistry, water must be discharged at a small rate (blowdown) and compensated by a makeup water source.

Heat dissipation systems are also categorized as wet or dry, and the use of either system depends on the site characteristics. Both wet and dry cooling systems use water as the heat exchange medium. Wet heat dissipation systems cool water by circulating it through a cooling tower. Heat from the water is dissipated by direct contact with air circulating through the tower. The heat transfer takes place primarily by evaporation of some of the water into the air stream (latent heat transfer).

Generally, a relatively minor amount of sensible heat transfer (heating of the air and cooling of the water) also occurs. During very cold weather, the amount of sensible heat transfer can be fairly substantial. On the other hand, during a warm, dry summer day, the amount of sensible heat transfer may be nil or even negative (when negative, the air discharged from the tower is cooler than the ambient dry bulb). This does not adversely affect the cold water performance of mechanical draft towers, but does affect evaporation rate. The wet cooling tower is used widely in the industry and is considered a mature technology.

Because wet cooling towers provide direct contact between the cooling water and the air passing through the tower some of the liquid water may be entrained in the air stream and be carried out of the tower as "drift" droplets. The magnitude of drift loss is influenced by the number and size of the droplets produced within the cooling tower, which in turn are influenced by the fill design, the air and water patterns, and other interrelated factors. Tower maintenance and operation levels can influence the formation of drift droplets. For example, excessive water flow, excessive air flow, and water bypassing the tower drift eliminators can promote and/or increase drift emission.

To reduce the drift from cooling towers, drift eliminators are usually incorporated into the tower design to remove as many droplets as practical from the air stream before exiting the tower. The drift eliminators rely on inertial separation of the droplets, caused by direction changes, while passing through the eliminators. Types of drift eliminator configurations include herringbone, wave form, and cellular (or honeycomb) designs. The cellular units are generally the most efficient. Drift eliminators may include various materials, such as ceramics, fiber-reinforced cement, fiberglass, metal, plastic, and wood installed or formed into closely spaced slats, sheets, honeycomb assemblies, or tiles. The materials may include other features, such as corrugations and water removal channels, to enhance the drift removal further (USEPA, 1995).

Dry cooling systems transfer heat to the atmosphere without the evaporative loss of water. There are two types of dry cooling systems: direct dry cooling and indirect dry cooling. Direct dry cooling systems use air to directly condense steam, while indirect dry cooling systems use a closed-loop water cooling system to condense steam and air to cool the heated water.

The most common type of direct dry cooling system is a recirculated cooling system with mechanical draft towers. For dry cooling towers, the turbine exhaust steam exits directly to an air-cooled, finned-tube condenser. Because dry cooling systems do not evaporate water for heat transfer, dry cooling towers are quite large in comparison to similarly sized wet cooling towers. Also, because dry cooling towers rely on sensible heat transfer, a large quantity of air must be forced across the finned tubes by fans to improve heat rejection. This results in a larger number of fans being required for a mechanical draft dry cooling tower than would be needed for a mechanical draft wet cooling tower.

The key feature of dry cooling systems is that no evaporative cooling or release of heat to the surface water occurs. As a result, water consumption rates are very low compared to wet cooling. Because the unit does not rely in principle on evaporative cooling like the wet cooling tower, large volumes of air must be passed through the system compared to the volume of air used in wet cooling towers. As a result, dry cooling towers need larger heat transfer surfaces and therefore tend to be larger than comparable wet cooling towers.

Dry cooling towers require high capital and operating and maintenance costs that are sufficient to pose a barrier to entry to the marketplace for some facilities (USEPA, 2001b). Dry cooling technology has a detrimental effect on electricity production by reducing the energy efficiency of steam turbines. Dry cooling requires the facility to use more energy than would be required with wet cooling towers to produce the same electricity. This energy penalty is most significant in warmer southern regions during summer months, when the demand for electricity is at its peak. The energy penalty would result in an increase in environmental impacts because replacement generating capacity would be needed to offset the loss in efficiency from dry cooling.

9.4.1.1 Evaluation of Alternative Heat Dissipation Systems

Heat dissipation system alternatives were identified and evaluated. The alternatives considered were those generally included in the broad categories of "once- through" and "closed-loop" systems. The evaluation includes the following types of heat dissipation systems:

- Other heat dissipation systems
  - Cooling Ponds
  - Spray Ponds
- Once-through cooling
- Natural draft cooling tower
- Mechanical draft cooling tower
- Hybrid (plume abated) cooling towers
- Dry cooling systems (closed-loop cooling system)

An initial evaluation of the once-through cooling alternative and the closed-loop alternative designs was performed to eliminate systems that are unsuitable for use at CCNPP Unit 3. The evaluation criteria included aesthetics, public perception, space requirements, environmental effects, noise impacts, fog and drift, water requirements, capital and operating costs, and legislative restrictions that might preclude the use of any of the alternatives.

The evaluation identified the mechanical forced draft cooling tower, with plume abatement, as the preferred closed-loop heat dissipation system for CCNPP Unit 3. Under the restrictions imposed by Section 316 of the Federal Clean Water Act, closed-cycle cooling is the only practical alternative for CCNPP Unit 3 that would meet both the Section 316(b) intake requirements at new facilities, as well as the Section 316(c) thermal requirements at this multi-facility site. The analysis of this alternative is discussed in Section 9.4.1.2. The discussion of non-preferred alternatives that were considered is provided below. Selection of the preferred heat dissipation alternative was supported by detailed net present value (NPV) analysis.

Table 9.4-1 provides a summary of the screening of Circulating Water Supply (CWS) System heat dissipation system alternatives, and Table 9.4-2 provides a summary of the environmental impacts of the heat dissipation system alternatives. Cooling ponds and spray ponds were not included in the alternatives study since neither alternative is reasonable given the plant location and existing infrastructure at the CCNPP site. However, a discussion of cooling ponds and spray ponds as a non-preferred alternative is provided below.

Cooling Ponds and Spray Ponds

Cooling ponds are usually man-made water bodies that are used by power plants and large industrial facilities for heat dissipation. In a conventional static-type cooling pond, warmed cooling water exiting the main condenser and other plant heat loads would be routed to the cooling pond where some of the water would evaporate, and the remaining water would be cooled and recirculated to the plant. The primary heat transfer mechanism in a cooling pond is evaporation. If there is no vertical mixing in the pond, layers (or thermoclines) of warm and cold water can form causing horizontal flows which in turn, can restrict the movement of warmer water to the surface for evaporation and cooling. This can result in only portions of the pond cooling capacity being used.

Although the conventional static-type cooling pond is probably the oldest form of water cooling it is not preferred for several reasons. The modern spray pond offers the following advantages over a conventional cooling pond: (1) a spray pond requires less than 10% of the land area required for a conventional pond, and (2) they provide over 30 times the cooling capacity of a conventional pond on a BTU/ft^2 basis.

A spray pond is typically a bentonite-lined structure in the ground, and is typically long and narrow to improve efficiency. The spray pond structure contains a volume of water and consists of an intake structure that houses pumps to transfer the water from the pond through their respective loops and back to the pond through a network of sprays located in the pond. The spray pond size depends on the number of nozzles required. It is important that the long, narrow spray pond have its long side perpendicular to the prevailing summer wind direction in order to benefit from a better spray droplet surface area and air contact interface. Generally, a spray pond long side dimension would be in the range of two to four times that of the narrow side dimension.

The area of the pond is determined by the quantity of water which it can treat per hour per unit area of the pond. Accepted industry practice for sizing spray ponds is based on values that are typically between 120 lb/ft^2/hr (585 kg/m^2/hr) and 150 lb/ft^2/hr (732 kg/m^2/hr). In actual practice, a spray pond will only cool the water to a point approximately midway between the hot water and wet bulb temperatures. Because of the various factors in spray pond applications, it is virtually impossible to accurately calculate the expected cooled water temperature. The 50% design efficiency factor (cooling to halfway point between hot water and wet bulb temperature) is considered to be a reasonable value for a well designed and located, long and narrow, spray pond.

Due to loss of water from the pond, a fresh water make up system operating on pond level is required. The water levels in cooling and spray ponds are usually maintained by rainfall or augmented by a makeup water system using fresh, salt, or reclaimed water.

Given the relatively large amount of land that would be required for a cooling pond or spray pond option, and expected thermal performance, neither the spray pond, nor the cooling pond alternative is reasonable for CCNPP Unit 3. Cooling ponds and spray ponds were not considered in the alternatives study.

Once-through Cooling System Using Chesapeake Bay Water

In a once-through cooling system, water is withdrawn from a water body, passes through the heat exchanger, and is discharged back to the same water body. The discharged water temperature is higher than the intake by the temperature gained when passing through the heat exchanger. A once-through cooling water system for a single unit plant would require either an onshore intake design or an offshore design.

If an onshore intake is proposed, the onshore structure would need to accommodate upwards of 2.5 million gpm (9.5 million Lpm) considering a 10°F (5.6°C) temperature rise across the condenser.

For CCNPP Unit 3, it is estimated that an onshore intake structure/pump house would need to be approximately 1,200 ft (365.8 m) long, by 170 ft (51.8 m) wide, and 66 ft (20.1 m) deep below the site grade. The pump house would need to have 6, 417,000 gpm (1.6 million Lpm) volute type pumps. The intake screens would include 24 to 60 ft (7.3 to 18.3 m) diameter drum screens (two per pump) with the width of the screen panel would need to be about 15 ft (4.6 m). Additionally, 72 bar screens (trash racks) that are 12 ft (3.7 m) wide would be required, with four rakes to clean the screens.

An offshore structure would require twelve, 12 ft (3.7m) diameter concrete pipes routed at least 3,000 ft (914.4 m) into the Chesapeake Bay, at a depth 35 ft (10.7 m). At the offshore end of each pipe there would need to be one bank of wedge wire screens arranged with interconnecting manifolds to supply about 420,000 gpm (1.6 million Lpm). It is expected that twelve, 8 ft (2.4 m) diameter T-type wedge wire screens would be needed for each bank because the wire mesh slot would be very small (1.75 mm or smaller). Wire mesh material would need to be copper-nickel for bio-fouling protection.

At the outlet for each screen, biocide agent supply piping would be necessary to protect intake pipes from bio-fouling. It is expected that a total of 144, 8 ft (2.4 m) diameter T-screens could be required. The onshore pump house structure for this would be approximately 800 ft (243.8 m) long, 120 ft (36.6 m) wide, and 66 ft (20.1 m) deep. The total offshore intake area covered by the wedge wire screens would be approximately 10 acres (4.0 hectares). The long trench to place the intake pipes would cover approximately 20 acres (8.1 hectares) of the bottom of the Chesapeake Bay.

The discharge structure would consist of a common onshore seal well structure. This structure would need to be approximately 250 ft (76.2 m) long, 80 ft (24.4 m) wide, and 50 ft (15.2 m) deep. The discharge piping would consist of 12 ft (3.7 m) diameter concrete pipes. It is expected that the discharge pipe length would be about 2,000 ft (610 m). The pipes could be placed in a large trench in a cut-and-fill operation, backfilled, and covered with riprap. At the end of each discharge pipe would be a multiple port diffuser. The diffuser main body would also be 12 ft (3.7 m) diameter pipe.

On top of the diffuser pipe would be six, 54 in (1.4 m) risers that discharge heated effluent to the ambient water. The large discharge flow would necessitate large separation distance between offshore intakes and offshore distances to prevent thermal recirculation from reaching an unacceptable level. The estimated separation distance would be 4,000 ft (1,219 m). The offshore diffuser area would be approximately 10 acres (4.0 hectares) at the bottom of Chesapeake Bay, approximately 2,000 ft (609.6 m) offshore. The long trench to place the discharge pipes would cover approximately 12 acres (4.9 hectares) of the bottom of the Chesapeake Bay.

Once-through cooling systems are required to comply with Federal and State regulations for thermal discharges into the Chesapeake Bay. Additionally, U.S. Environmental Protection Agency (EPA) regulations governing cooling water intake structures under Section 316(b) of the (USC, 2007) make it difficult for steam electric generating plants to use once-through cooling systems (FR, 2004).

Based on the large size of the intake and discharge structures and offshore pipes and potential permitting issues under U.S. EPA Section 316(b) Phase I or Phase II Rules, the once-through cooling system would be cost-prohibitive, and is therefore is not considered feasible for the use at CCNPP Unit 3. Additional discussion of Federal and State regulations under Section 316(b) governing cooling water intake structures for existing power plants is found in Section 9.4.2.1.

Natural Draft Cooling Tower

Wet cooling towers predominantly rely on the latent heat of water evaporation to exchange heat between the water and the air passing through the tower. In a natural draft cooling tower, warm water is brought into direct contact with cooler air. When the air enters the cooling tower, its moisture content is generally less than saturation. When the air exits, it emerges at a higher temperature and with moisture content at or near saturation.

Even at saturation, cooling can take place because a temperature increase results in an increase in heat capacity, which allows more sensible heat to be absorbed. A natural draft cooling tower receives its air supply from natural wind currents that result in a convective flow up the tower. This air convection cools the water on contact.

Because of the significant size of natural draft cooling towers (typically 500 ft (152.4 m) high, 400 ft (121.9 m) in diameter at the base), their use is generally reserved for use at flow rates above 200,000 gpm (757,000 Lpm) (Young, 2000). They are typically sized to be loaded at about 2 to 4 gpm/ft^2 (1.4 to 2.7 Lps/m^2). The size of and cost of the natural draft towers preclude them from further consideration for the CCNPP site.

Mechanical Draft Cooling Tower

A wet mechanical draft cooling tower system, operated completely as a wet-type cooling tower, would consist of multi-cell cooling tower banks, and associated intake/discharge, pumping, and piping systems. This closed-loop system would receive makeup water from the Chesapeake Bay and transfer heat to the environment via evaporation and conduction. These towers would have a relatively low profile of approximately 80 ft (24.4 m). Mechanical draft towers use fans to produce air movement.

A mechanical draft cooling tower would typically consist of a continuous row of rectangular cells in a side-by-side arrangement sharing a common cold water basin. Water to be cooled is pumped to a hot water distribution system above the fill, and then falls over the fill to the cold water basin. Air is drawn through the falling water by fans, which results in the transfer of heat from the water to the air, and the evaporation of some of the water. The fill serves to increase the air-water contact surface and contact time, thereby promoting heat transfer.

A mechanical draft cooling tower employs large fans to either force or induce a draft that increases the contact time between the water and the air maximizing the heat transfer. A forced draft tower has the fan mounted at the base, forcing air in at the bottom and discharging air at low velocity through the top. An induced draft tower uses fans to create a draft that pulls air through the cooling tower fill.

Hybrid Plume Abatement Cooling Tower

A cooling tower plume occurs when the heated and saturated air leaving a wet cooling tower mixes with the relatively cooler ambient air under atmospheric conditions, and a supersaturated condition occurs during the process of mixing and dispersion. The excess vapor condenses (the amount in excess of saturation vapor) and becomes a visible plume.

A cooling tower plume may be visually objectionable or may result in problems of fogging or icing. A plume abatement hybrid cooling tower (i.e., combination wet-dry tower) combines dry cooling and wet cooling to reduce the cooling tower plume. The dry cooling section adds heat to the discharge air without adding moisture (sensible heat transfer). This results in a subsaturated air stream leaving the tower (less than 100% relative humidity) and therefore reduced plume potential.

Although the hybrid plume abatement cooling tower results in reduced water consumption and no visible plume, construction costs, operating and maintenance costs, and land use requirements are significantly higher. Nevertheless, the hybrid plume abatement cooling tower was the preferred alternative for CCNPP Unit 3 in order to have the least impact on the environment.

Dry Cooling System

A dry-type helper tower system could be utilized to assist a once-through cooling system by reducing circulating water discharge temperature before it re-enters the Chesapeake Bay. Use of a helper tower would be most beneficial when ambient air temperatures are low enough for a dry tower system to be functional.

A dry tower helper system would have the benefit of reduced environmental impact due to the fact that it would not experience cooling tower drift or evaporative losses. The water savings, however, are outweighed by the additional cost to construct and operate the air cooled condenser. Additionally, during periods of high ambient air temperature, the only way to reduce water temperature to within 7°F (13.9°C) of ambient dry bulb temperature would be to use evaporative cooling. The thermal performance limitations under high ambient air temperature conditions would result in either a very large dry tower array, or plant efficiency would have to be significantly reduced during high ambient air conditions due to high condenser water temperature and the consequential increase in steam turbine backpressure.

Use of a dry system would require a significant increase in dry tower land use. It is estimated that a dry (fin-fan) tower array would consist of 550 bays with a moderate profile (150 ft (45.7 m) high). Total land use for a dry cooling tower system is approximately 39.1 acres (15.8 hectares). An air-cooled condenser, where steam turbine exhaust is transported directly to a steam-to-air heat exchanger, was not considered because of the limitations of its use. The distances from the main steam turbine condensers to the air-cooled condensers and the size of the steam ducting required for this application (at approximately 26 ft (7.9 m) in diameter) would render the design not feasible. The steam duct would need to be uncommonly large and would far exceed the largest steam duct ever attempted.

There are, however, specific environmental advantages that would be realized with an air-cooled condenser (dry tower) scenario. These advantages include:

- Makeup water use limited to that necessary to compensate for system leakage,

- No environmental impacts to terrestrial or estuarine habitat due to presence of intake and discharge structure and flows, and
- No environmental impacts to terrestrial or estuarine habitat due to cooling tower drift.
- Specifically, there would be no impact to the Chesapeake Bay due to effluent discharges from CCNPP Unit 3 in a 100% dry cooling tower option.

For a completely dry tower system, the material cost ($269.9 million) and the operation and maintenance costs ($5.4 million) are significantly greater than a wet type or wet/dry type of cooling tower, land use would be significant, and the system would require periods of significant unit power output reduction during periods of high ambient air temperatures.

Therefore, for the reasons stated above, the use of a dry tower is not a feasible alternative for CCNPP Unit 3.

9.4.1.2 Analysis of the Hybrid Cooling Tower With Plume Abatement Alternative

A hybrid cooling tower system with plume abatement was identified as the preferred option for use at CCNPP Unit 3 to transfer heat loads from the CWS to the environment. The cooling tower design will consist of a hybrid cooling tower shelland installed plume abatement equipment. The cooling tower will operate as a combination wet-dry type mechanical draft cooling tower, and will have drift eliminators installed.

The hybrid cooling tower system for CCNPP Unit 3 would be wholly situated on the CCNPP site. The cooling tower will be constructed of concrete. It will have a round hybrid shell, and drift eliminators will be installed. The base of the concrete hybrid cooling tower structure will have an overall diameter of 528 ft (161 m) and the tower will have an approximate height of 164 ft (50 m). Internal construction materials will include fiberglass-reinforced plastic (FRP) or polyvinyl chloride (PVC) for piping laterals, polypropylene for spray nozzles, and PVC for fill material.

The hybrid tower with plume abatement is the preferred alternative to transfer heat loads from the circulating water system to the environment. This type of cooling tower provides the greatest degree of operational flexibility while reducing or eliminating the visible plume.

9.4.1.3 Summary of Alternative Heat Dissipation Evaluation

As discussed earlier in this section, a hybrid cooling tower system with plume abatement provides the greatest degree of operational flexibility, quiet performance under a wide range of environmental conditions, and little or no plume. It is therefore the preferred alternative to transfer heat loads from the CWS to the environment.

Although the dry cooling tower system and the hybrid plume abated cooling tower system may be considered an environmentally equivalent alternative as stated earlier, the construction costs and operation and maintenance costs for these options are significantly greater than for the hybrid cooling tower system with plume abatement. Additionally, the dry cooling system would require periods of significant unit power output reduction during periods of high ambient air temperatures.

9.4.2 Circulating Water Systems

In accordance with NUREG-1555 (NRC, 1999), ESRP 9.4.2, this section discusses alternatives to the following components of the CWS for CCNPP Unit 3. These components include the intake systems, discharge systems, water supply, and water treatment processes. The information provided in this section is based on two studies: a Cooling Tower and Circulating Water System study, and an Ultimate Heat Sink (UHS) and Intake/Discharge structures location study. A summary of the environmental impacts of the circulating water intake and discharge system alternatives for CCNPP Unit 3 are provided in Table 9.4-3 and Table 9.4-4.

The CWS is an integral part of the heat dissipation system. It provides the interface between (1) the normal heat sink (i.e., main steam turbine condenser) where waste heat is discharged from the steam cycle and is removed by the circulating water, and (2) the heat dissipation system where the heat energy is then dissipated or transferred to the environment.

Essentially, two types of CWSs are available for removing this waste heat: once-through (open-loop) and recycle (closed-loop) systems. In once-through cooling systems, water is withdrawn from a cooling source, passed through the condenser, and then returned to the source (receiving water body). In the recycle (closed-loop) cooling system, heat picked up from the condenser by the circulating water is dissipated through auxiliary cooling facilities, after which the cooled water is recirculated to the condenser.

As discussed in Section 9.4.1, the CWS for CCNPP Unit 3 will be a closed-loop system, with volute pumps and piping, a water retention basin, and a round mechanical draft hybrid cooling tower with drift eliminators that will be operated as a wet cooling tower (i.e., without plume abatement) year-round.

The cooling water withdrawal rate for the CWS will normally be approximately 34,800 gpm (131,500 lpm), and maximum makeup will be approximately 47,383 gpm (179,365 lpm). These numbers include the desalination plant. These withdrawals include consideration of losses due to evaporation, drift and blowdown. A fraction of the intake water will be used to clean debris from the traveling screens.

Blowdown from the CWS cooling tower will be routed to a retention basin prior to being returned to the Chesapeake Bay. The blowdown water will enter the retention basin at the cold water temperature for the cooling tower basin (approximately 90°F (32.2°C)). The water will then give up additional heat to the atmosphere before entering the discharge pipe, and will transfer additional heat to the discharge piping during its passage to the outfall. The normal circulating water system blowdown discharge is estimated to be 17,400 gpm (65,700 lpm). The discharge is not likely to produce tangible aesthetic or recreational impacts. No effect on fisheries, navigation, or recreational use of Chesapeake Bay is expected.

CCNPP Unit 3 will utilize methods similar to those employed at CCNPP Units 1 and 2 to minimize fish impingement and entrainment at the intake structure (e.g., low-velocity approach and screens). It is expected that addition of a new nuclear unit using closed-loop cooling systems will increase fish impingement and entrainment by less than 3.5% over the existing condition. The flow velocity into the intake channel from the Chesapeake Bay will be less than 0.5 fps (0.2 m/s). Therefore, it is anticipated that use of closed-loop cooling systems at CCNPP Unit 3 will have minimal impact on fish impingement and entrainment.

9.4.2.1 Intake and Discharge Systems

For both once-through and closed-loop cooling systems, the water intake and discharge structures can be of various configurations to accommodate the source water body and to minimize impact to the aquatic ecosystem. The intake structures are generally located along the shoreline of the body of water and are equipped with fish protection devices. The discharge structures are generally of the jet or diffuser outfall type and are designed to promote rapid mixing of the effluent stream with the receiving body of water. Biocides and other chemicals used for corrosion control and for other water treatment purposes may be mixed with the condenser cooling water and discharged from the system.

Cooling water intake structures (CWIS) are typically regulated under Section 316(b) of the Federal CWA and its implementing regulations (FR, 2004), and under the Code of Maryland Regulation 26.08.03.05 (COMAR, 2007). A federal court decision in January 2007 changed that regulatory process. The regulations that implement Section 316(b) were effectively suspended, and U.S. EPA recommended that all permits for Phase II facilities should include conditions under Section 316(b) developed on a best professional judgment basis (USEPA, 2007).

The Maryland CWIS regulation implements Section 316(b) at the state level and defines acceptable levels of impingement and entrainment (COMAR, 2007). The Maryland regulation requires the facility to mitigate impingement loss to the extent that the costs for the mitigation are not greater than the benefits. Specifically, the location, design, construction and capacity of cooling water intake structures must reflect the best technology available for minimizing adverse environmental impact. For entrainment, Maryland requires that the facility must determine whether the entrainment loss causes an adverse environmental impact and must mitigate the entrainment loss if the facility does cause an adverse environmental impact.

Intake and discharge structures will be required for operation of CCNPP Unit 3. Three alternative locations for the intake and discharge structures were considered:

- Alternative 1a and 1b - New intake and discharge structures near CCNPP Units 1 and 2. The intake structure would be located between the existing CCNPP Units 1 and 2 intake structure and the barge slip, near the existing intake structures for CCNPP Units 1 and 2. This location would provide not only physical protection but also facilitate the intake of cooler water afforded by the existing curtain wall. This location would also be likely to incur lower construction costs because dredging a new or expanded approach channel may not be required.

  For Alternative 1a, a new discharge structure would be built near the existing CCNPP Unit 1 and 2 intake structure to provide a flow path for discharge from the CCNPP Unit 3 retention basin, into the Chesapeake Bay.

  Alternative 1b would be very similar to 1a, with the exception of the intake piping. The Alternative 1b intake piping would extend approximately 3,500 ft (1,067 m) offshore. The suction end of the offshore intake piping would be fitted with velocity caps.

- Alternative 2 - New intake structure near CCNPP Units 1 and 2 intake structure and new discharge structure north of existing barge slip. The intake structure would be located close to CCNPP Units 1 and 2 intake structure (same as Option 1).

- Alternative 3 - New intake and discharge structures at Camp Conoy (south of the existing intake and discharge structures). The new intake and discharge structures would be located at Camp Conroy to provide a flow path for the intake and discharge loads.

For additional details, see Table 9.4-3 to Table 9.4-4.

Alternative 2 is the environmentally preferable alternative for locating the new intake and discharge systems. As stated above, the new outfall structure would be just north of the existing barge slip. In addition, the discharge concept will be a shoreline type discharge (unless there is restriction for a shoreline structure). This concept is based on the assumption that the blowdown discharge will meet the Water Quality Standard of the State of Maryland for discharge to Chesapeake Bay at end of pipe.

Discharge into the Chesapeake Bay at this location would have no/insignificant impact on plant operation caused by recirculation back to the existing intake channel. It also requires the fewest additional environmental permits because the intake and the discharge structures would be located in the existing IDA and would require shorter runs of piping. In addition, access and security constraints during construction would be avoided because construction would occur on the site of operating CCNPP Units 1 and 2.

Intake System

The Chesapeake Bay intake system would consists of the CCNPP Units 1 and 2 intake channel; the CCNPP Unit 3 intake piping, the CCNPP Unit 3 non-safety-related CWS makeup water intake structure and associated equipment, including the non-safety-related CWS makeup pump; the safety-related UHS makeup water intake structure and associated equipment, including the safety-related UHS makeup water pumps; and the makeup water chemical treatment system.

The CCNPP Unit 3 intake piping consists of two runs of 60-inch diameter safety related concrete pipes approximately 490 ft (149.4 m) long. These pipes convey water from the CCNPP Units 1 and 2 intake channel to a common forebay approximately 100 ft (30.48 m) long, 80 ft (24.38 m) wide structure with an earthen bottom at Elevation -22 ft 6 in (-6.86 m) NGVD 29 and vertical sheet pile sides extending to Elevation 11.5 ft (3.5 m) NGVD 29. The nonsafety-related CWS intake structure and the safety-related UHS makeup water intake structure are situated at opposite ends of the common forebay.

The new CCNPP Unit 3 intake piping draws water from the existing intake channel for CCNPP Units 1 and 2. The piping is oriented perpendicular to the tidal flow of the bay. This orientation minimizes the component of the tidal flow parallel to the channel flow and reduces the potential of fish entering the piping and common forebay as shown on Figure 3.4-3. The flow velocities at the circulating water makeup structure and the UHS makeup structure would be less than 0.3 feet per second (fps) (0.1 mps) and less than 0.1 fps (0.03 mps), respectively.

The new CCNPP Unit 3 CWS makeup water intake structure will be an approximately 120 ft (36.6 m long, 60 ft (18.3 m) wide concrete structure with individual pump bays. Three 50 percent capacity, vertical, wet pit CWS makeup pumps provide makeup water.

The new UHS makeup water intake will be approximately 90 ft (27.4 m) long, 60 ft (18.3 m) wide concrete structure with individual pump bays. Four 100 percent capacity vertical wet pit UHS makeup pumps will be available to provide saltwater makeup water.

In both the CWS and UHS makeup intake structures, one makeup pump is located in each pump bay, along with one dedicated traveling band screen and trash rack. Debris collected by the trash racks and the traveling water screens will be collected in a debris basin for cleanout and disposal as solid waste. The through-trash rack and through-screen mesh flow velocities will be less than 0.5 fps (0.15 m/s). Table 9.4-3 summarizes the environmental impacts of the circulating water intake alternatives for CCNPP Unit 3. In both intake structures, there is no need for a fish return system since the flow velocities through the screens are less than 0.5 fps (0.15 mps) in the worst case scenario (minimum bay level with highest makeup demand flow). Nevertheless, a fish return system will be provided as part of the combined makeup water intake structure design to reduce mortality of aquatic species.

The fish return system will be located on the east side (bay side) of the Unit 3 intake forebay. Screen wash water and fish collected from the traveling screens of Unit 3 makeup water structure will be diverted to the new fish return facility and returned to the Chesapeake Bay via a buried pipe to a new shoreline outfall. The outfall will be submerged below low tide to minimize impacts to fish into the Chesapeake Bay from any drop at the pipe exit.

Section 316(b) of the federal CWA requires the U.S. EPA to ensure that the location, design, construction, and capacity of CWIS reflect the best technology available (BTA) for minimizing adverse environmental impact. The objective of any CWIS design is to have adequate sweeping flow past the screens to meet entrainment and impingement reduction goals established under Section 316(b) requirements. In addition to the impingement and entrainment losses associated with CWIS, there are the cumulative effects of multiple intakes, re-siting or modification of CWIS contributing to environmental impacts at the ecosystem level. These impacts include disturbances to threatened and endangered species, keystone species, the thermal stratification of water bodies, and the overall structure of the aquatic system food web.

Consequently, in addition to evaluating alternative screen operations and screening technologies, such as fine mesh traveling water screens or wedge wire screens, additional means of reducing impingement, such as curtain walls, fish return systems, or other physical barriers, must also be assessed. There are a number of different alternatives for reducing impingement and entrainment impacts, including changes in intake structure operation, fish handling, external structure design; however no single operational or technological change will have the same effects or benefits at all facilities so therefore site specific studies and evaluations are critical to successful, cost-effective reductions of CWIS impacts.

The new intake piping will be located off the existing intake channel for CCNPP Units 1 and 2, which is perpendicular to the tidal flow of the Chesapeake Bay to minimize the component of the tidal flow parallel to the channel flow and the potential for fish to enter the channel and intake structure. Flow velocities at the intake structure will depend on the Chesapeake Bay water level. At the minimum Chesapeake Bay water level of -4.0 ft (-1.2 m) msl the flow velocity along the new intake channel will be less than 0.5 fps (0.15 m/s).

It is expected that addition of the CCNPP Unit 3 using closed cycle cooling will increase fish impingement and entrainment by less than 3.5% (based on preliminary cooling tower performance) over the existing condition. CCNPP Unit 3 will utilize methods similar to those employed at CCNPP Units 1 and 2 to minimize fish impingement and entrainment at the intake structure (e.g., low-velocity approach and screens). Therefore, it is anticipated that use of closed-loop cooling systems at CCNPP Unit 3 will have minimal impact on fish impingement and entrainment. However, to minimize the effects of entrainment a fish return system is used.

The fish return outfall, an 18-inch diameter HDPE pipe is located in a mechanically excavated trench. The pipe is installed 4 feet below the bay bottom and emerges from the bay bottom 40 feet channelward. The outfall location is protected with a 10-foot by 10 foot riprap apron extending approximately 48 feet channelward. To install the pipe, approximately 40 linear feet of the existing shoreline revetment was removed, and approximately 500 cubic yards of material will be dredged within the work area. The dredged material will be returned to the trench after the pipe is placed, and the existing shoreline revetment restored to its original design after pipe installation.

CCNPP Unit 3 relies on makeup water from the Chesapeake Bay for safe shutdown, and is designed for a minimum low water level of -4.0 ft (-1.2 m) msl and can continue to operate at an extreme low water elevation of -6.0 ft (-1.8 m) msl. The Essential Service Water System (ESWS) cooling towers will typically be supplied with fresh water makeup from storage tanks that are supplied from the desalinization plant.

Flow velocities at the CWS makeup water intake structure and the UHS makeup water intake structure will be sufficiently low that the intake channel may also act as a siltation basin. As a result, dredging may be required to maintain the channel depth. However, operating experience at CCNPP Units 1 and 2 has not indicated that siltation will be a problem, or that dredging will be required.

Discharge System

The final plant discharge consists of cooling tower blowdown from both the CWS and ESWS cooling towers and site wastewater streams, including the domestic water treatment and circulation water treatment systems. Only biocides or chemical additives approved by the U.S. EPA and the State of Maryland as safe for humans and the constituent discharged to the environment will meet requirements established in the NPDES permit.

An NPDES permit will be obtained for CCNPP Unit 3 prior to startup. This permit will specify threshold concentrations of "free available chlorine" (when chlorine is used) and "free available oxidants" (when bromine or a combination of bromine and chlorine is used) in cooling tower blowdown when the dechlorination system is not in use. Lower discharge limits will apply to effluent from the dechlorination system (which will be released into the Chesapeake Bay) when it is in use. The CCNPP Unit 3 NPDES permit will contain discharge limits for discharges from the cooling towers for two priority pollutants, chromium and zinc, which are widely used in the U.S. as corrosion inhibitors in cooling towers.

During operation, discharge flow to the Chesapeake Bay will be from the retention basin, which collects all site treated wastewater and tower blowdown. Discharge from the retention basin would be through an a 30 in (76.2 cm) diameter discharge pipe. Before the discharge point, the pipe will branch into three nozzles. The normal discharge flow will be up to 21,019 gpm (79,172 lpm) and the maximum discharge flow will be approximately 24,363 gpm (91,364 lpm).

The proposed discharge structure will be designed to meet all applicable navigation and maintenance criteria and to provide an acceptable mixing zone for the thermal plume per state regulations for thermal discharges. Figure 3.4-7 shows details of the discharge system. The proposed discharge point will be near the southwest bank of Chesapeake Bay, approximately 400 ft (122 m) north of the barge slip and extending about 550 ft (167.6 m) into the Chesapeake Bay.

The preliminary centerline elevation of the discharge pipe will be 3 ft (0.9 m) above the bottom of the Chesapeake Bay. Riprap will be placed around the discharge point to resist potential erosion as a result of the discharge jet from the pipe. A summary of the environmental impacts of the circulating water discharge system alternatives for CCNPP Unit 3 are provided in Table 9.4-4.

9.4.2.2 Water Supply (Makeup Water System Alternatives)

CCNPP Unit 3 will require makeup water to the CWS and ESWS cooling towers to replace water inventory lost to evaporation, drift, and blowdown. As described in Section 9.4.2, during normal operations fresh water makeup to the ESWS cooling towers and UHS will be provided either directly from the non-safety related desalination plant, or from storage tanks that are supplied from desalination plant. Makeup water for the desalination plant will be extracted from the CWS cooling tower makeup line, which draws water from the Chesapeake Bay. Brackish water from the Chesapeake Bay will provide an backup source of makeup water to the ESWS and UHS when the fresh water supply is unavailable.

The following makeup water system alternatives were analyzed:

- Potential Groundwater Sources
- Recycled plant water
- Desalination plant

As noted in Chapters 4 and 5, the preferred water supply alternative (desalination) would have SMALL construction and operational impacts. As a result, mitigation alternatives are not discussed in this section.

<u>Groundwater Sources</u>

There are five aquifers in the vicinity of the CCNPP site: Surficial, Chesapeake, Castle-Hayne – Aquia, Severn-Magothy, and Potomac (includes the Patapsco Aquifer and Potomac Confining Unit). The characteristics of these aquifers are described within Section 2.3.

Groundwater is the primary water supply in most areas of Maryland within the Atlantic Coastal Plain. The aquifers in this region are the primary water supply for southern Maryland (which includes Calvert County) and the Eastern Shore. Withdrawals from Coastal Plain aquifers have caused groundwater levels in confined aquifers to decline by tens to hundreds of feet from their original levels.

The current rate of decline in many of the confined aquifers has been estimated at about 2 ft (0.6 m) per year. Declines have been especially large in southern Maryland and parts of the Eastern Shore, where groundwater pumping is projected to increase by more than 20% between 2000 and 2030. Some regions are expected to experience significantly greater increases. Continued water level declines at current rates could affect the long-term sustainability of the region's groundwater resources and introduce saltwater intrusion concerns.

Groundwater withdrawals will not be used to support CCNPP Unit 3 operations; however, construction water needs may be met through a combination of limited groundwater withdrawals and haulage. These limited groundwater withdrawals would be performed within the limits of the existing groundwater permit for CCNPP Units 1 and 2, and will require prior discussions with the MDE. Groundwater withdrawals made to support construction of CCNPP Unit 3 will use existing wells.

<u>Recycled Plant Water</u>

CCNPP Unit 3 waste water treatment plant effluent could be used to reduce groundwater demand or desalinization plant output to provide fresh water for the proposed CCNPP Unit 3.

This source would only provide 20 gpm (75.7 lpm) and fresh water from the desalinization plant will still be required for the plant potable/sanitary water system and demineralized water system. As a result, recycled plant water cannot, on its own, provide the makeup water need to support construction and operation of the proposed unit.

Desalinization Plant

A desalinization plant is also a viable option for fresh water. The desalinization plant will use Chesapeake Bay water as its raw water input and will therefore not affect existing groundwater resources. Placing a desalinization plant at plant grade instead of near the intake structures at the shoreline significantly reduces the head requirement for the effluent transfer pump(s) used to send the desalination plant fresh water output to the proposed storage tanks.

About half of all of the desalinated water produced is produced through thermal processes, in which salt water is heated to produce vapor that is then condensed into fresh water. The main objective of any thermal process is to minimize the amount of heat required to produce a gallon of fresh water. Two principal competitive types of thermal processes produce desalinated water, multi-stage flash evaporation (MSF) and multiple effect distillation (MED). An alternative, non-thermal process used to produce desalinated water is reverse osmosis (RO).

Although the MED and MSF desalination processes are more often employed on larger desalinization plants, and thus are more mature technologies, they were not considered to be viable options for the relatively small water output requirement at CCNPP. As a result of advancements in technology, seawater desalination using RO membranes has become more attractive for this type of application and will be used for CCNPP Unit 3. The desalinization plant considered will be required to provide 3,063 gpm (11,595 lpm) of product flow using stage media filtration, a one-pass sea water reverse osmosis (SWRO).

The desalinization system will also provide the initial fill for the 72 hour inventory of the ESWS cooling tower basins system. The system will include seawater feed pumps, multimedia filters, chemical injection system, and an RO permeate tank. The RO reject stream will be diluted using a holding pond or by mixing with the CCNPP Units 1 and 2 cooling water discharge. A 500 gpm (31.6 l/s) desalinization plant will require a building with an approximate size of 65 ft (19.8 m) by 165 ft (50.3 m). This building will be located adjacent to the circulating water cooling towers, on the southwest end of the CCNPP site (approximate Elevation 100 ft (30.5 m)) as shown in Figure 3.1-1.

Summary of Makeup Water Alternatives

The operation of CCNPP Unit 3 will require a consistent source of fresh makeup water for cooling purposes. It has been determined that CCNPP Unit 3 will not withdraw any groundwater for use at the site during operations, but will make limited groundwater withdrawals to support construction within the limitations of the existing groundwater permit for CCNPP Units 1 and 2. The SWRO desalinization plant will provide fresh water for the plant demineralized water system, potable and sanitary water systems, and normal makeup for the ESWS cooling towers. The Chesapeake Bay is the source of water for the desalination plant. The desalinization plant will withdraw an estimated 3,063 gpm (11,595 Lpm) from the Chesapeake Bay via a connection to the CWS makeup line.

9.4.2.3 Water Treatment

Evaporation of water from cooling towers leads to an increase in chemical and solids concentrations in the circulating water, which in turn increases scaling tendencies of the cooling water. A water treatment system is required at CCNPP Unit 3 to minimize bio-fouling, prevent or minimize growth of bacteria (especially *Legionella* in the case of cooling towers), and inhibit scale on system heat transfer surfaces. Water treatment will be required for both influent and effluent water streams. Considering that water sources for CCNPP Unit 3 are the same as those for CCNPP Units 1 and 2, treatment methodologies will be similar.

The circulating water treatment system provides treated water for the CWS and consists of three phases: makeup treatment, internal circulating water treatment, and blowdown treatment. Makeup treatment will consist of a biocide injected into Chesapeake Bay water influent during spring, summer, and fall months to minimize marine growth and control fouling on heat exchanger surfaces. Treatment also improves makeup water quality.

Similar to CCNPP Units 1 and 2, an environmental permit to operate this treatment system will be obtained from the State. For prevention of *Legionella*, treatment for internal circulating water components (i.e., piping between the new intake structure and condensers) will include existing power industry control techniques consisting of hyperchlorination (chlorine shock) in combination with intermittent chlorination at lower levels, biocide and scale inhibitor addition. Blowdown treatment will depend on water chemistry, but is anticipated to include application of biocide dechlorinator, and scale inhibitor to control biogrowth, reduce residual chlorine and protect against and scaling, respectively. Since seawater has a tendency to foam due to the presence of organics, a small amount of antifoam may also be added to blowdown.

ESWS cooling tower water chemistry will be maintained by the SW water treatment system, which is designed to treat desalinated water from the SWRO desalinization plant for normal operating and shutdown conditions. This treatment system will also be capable of treating Chesapeake Bay water for design basis accident conditions. Treatment of system blowdown will also control the concentration of various chemicals in the ESWS cooling towers.

Desalinated water from the SWRO desalinization plant will be treated by the demineralized water treatment system, which provides demineralized water to the demineralized water distribution system. During normal operation, demineralized water is delivered to power plant users. Treatment techniques will meet makeup water treatment requirements set by the Electric Power Research Institute and include the addition of a corrosion inhibitor, similar to the service water system for the existing plant that uses demineralized water.

The drinking water treatment system, which supplies water for the potable and sanitary distribution system, will treat desalinated water so that it meets the State of Maryland potable (drinking) water program and U.S. EPA standards for drinking water quality under the National Primary Drinking Water Regulation and National Secondary Drinking Water Regulation. The system will be designed to function during normal operation and outages (i.e., shutdown).

Liquid wastes generated by the plant during all modes of operation will be managed by the liquid waste storage and processing systems. The liquid waste storage system collects and segregates incoming waste streams, provides initial chemical treatment of those wastes, and delivers them to one or another of the processing systems. The liquid waste processing system separates waste waters from radioactive and chemical contaminants. The treated water is returned to the liquid waste storage system for monitoring and eventual release. Chemicals used to treat wastewater for both systems include sulfuric acid for reducing pH, sodium hydroxide for raising pH, and an anti-foaming agent for promoting settling of precipitates.

CCNPP Unit 3 will use a Waste Water Treatment System for the treatment of sewage similar to that of CCNPP Units 1 and 2. This treatment system removes and processes raw sewage so that discharged effluent conforms to applicable Local and State health and safety codes, and environmental regulations. Sodium hypochlorite (chlorination) is used to disinfect the effluent by destroying bacteria and viruses, and sodium thiosulfate (dechlorination) reduces chlorine concentration to a specified level before final discharge. Soda ash (sodium bicarbonate) is used for pH control. Alum and polymer are used to precipitate and settle phosphorus and suspended solids in the alum clarifier; polymer is also used to aid flocculation.

9.4.3 Transmission Systems

Section 9.4.3 of NUREG-1555 (NRC, 1999) provides guidelines for the preparation of summary discussion that identifies the feasible and legislatively compliant alternative transmission systems . As discussed in Section 3.7, the existing CCNPP Units 1 and 2 power transmission system consists of two circuits, which connects CCNPP to the Waugh Chapel Substation in Anne Arundel County and to the Potomac Electric Power Company Chalk Point generating station in Prince Georges County. The northern CCNPP to Waugh Chapel circuit is composed of two separate three-phase 500 kV transmission lines on a single right-of-way from CCNPP, while the southern CCNPP to Chalk Point circuit is a single 500, three-phase 500-kV line.

The north and south circuits of the CCNPP power transmission system are located in corridors totaling approximately 65 mi (105 km) of 350 to 400 ft (100 to 125 m) right-of-way that is owned by Baltimore Gas and Electric Company. Land use within these corridors is well established, stable, does not interfere with Federal, State, Regional, or Local land use plans, and is without Native American tribal communities. The lines cross mostly secondary-growth hardwood and pine forests, pasture, and farmland.

The transmission lines to support CCNPP Unit 3 will be constructed within the CCNPP site. Thus, environmental impacts are limited to CCNPP Unit 3 construction area on the CCNPP site.

No new corridors, widening of existing corridors, or crossings over main highways, primary and secondary roads, waterways, or railroad lines will be required. Therefore, there would be no impacts from land use changes. The impact to humans and animals resulting from increased transmission-line induced currents is minimized due to conformance with the consensus electrical code, and is SMALL. Access to the existing corridors would be through existing access roads in compliance with existing negotiated easement agreements.

The transmission line work to support CCNPP Unit 3 will, however, require new towers and transmission lines to connect the CCNPP Unit 3 switchyard to the CCNPP Units 1 and 2 switchyard. Line routing would be conducted to avoid or minimize impacts to the existing Independent Spent Fuel Storage Installation, wetlands, and protected species (bald eagle nest) identified in the local area. Based on the results of a feasibility study, numerous breaker upgrades and associated modifications will also be required at Waugh Chapel, Chalk Point, and other substations, but all of these changes would be implemented within the existing substations.

The power transmission needs of CCNPP Unit 3 can be satisfied with relatively minimal changes to the existing transmission corridor and power transmission system for CCNPP Units 1 and 2. Based on this conclusion, and the small expected impact to the environment from utilizing the existing transmission corridor and equipment, no other alternatives were considered since all other alternatives were obviously less preferable.

9.4.4 References

CFR, 2007a. Title 10, Code of Federal Regulations, Part 51, Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions, Appendix B to Subpart A, Table B-1, 2007.

CFR, 2007b. Title 40, Code of Federal Regulations, Part 125, Criteria and Standards for the National Pollutant Discharge Elimination System, 2007.

COMAR, 2007. Code of Maryland Regulations, COMAR 26.08.0.3.03, Discharge Limitations, 2007.

FR, 2004. National Pollutant Discharge Elimination System - Final Regulations to Establish Requirements for Cooling Water Intake Structures at Phase II Existing Facilities, Federal Register: July 9, 2004 (Volume 69, Number 131), Pages 41575-41624, U.S. Environmental Protection Agency, Website: http://a257.g.akamaitech.net/7/257/2422/06jun20041800/edocket.access.gpo.gov/2004/pdf/04-4130.pdf, Date accessed: May 21, 2007.

NRC, 1996. Generic Environmental Impact Statement for License Renewal of Nuclear Plants (GEIS), NUREG-1437, Nuclear Regulatory Commission, 1996.

NRC, 1999. Standard Review Plans for Environmental Reviews of Nuclear Power Plants, NUREG-1555, Nuclear Regulatory Commission, October 1999.

USC, 2007. Title 33, United States Codes, Part 1326, Federal Water Pollution Control Act, Thermal Discharges, 2007.

USEPA, 1995. Technology Transfer Network, Clearinghouse for Inventories and Emissions Factors (CHIEF), Document AP-42, Fifth Edition, Chapter 13, January 1995, U.S. Environmental Protection Agency, Website: http://www.epa.gov/ttn/chief/ap42/ch13/final/c13s04.pdf, Date accessed: May 21, 2007.

USEPA, 2007. Implementation of the Decision in Riverkeeper, Inc. v. EPA, Remanding the Cooling Water Intake Structures Phase II Regulation Memorandum, U.S. Environmental Protection Agency, March 20, 2007, Website: http://www.epa.gov/waterscience/316b/phase2/implementation-200703.pdf, Date accessed: May 21, 2007.

Young, 2000. Cooling Towers, Bay Area Air Quality Management District Air Permit Program Handbook, Source Specific Guidance, Miscellaneous Operations, B. Young and E. Ciammaichella, July 17, 2000.

Table 9.4-1— Comparison of Cooling Tower Evaluation Criteria

	Footprint per Plant Unit (1,562 MWe) [a]	Maximum Height	Materials of Construction	Plant Efficiency Impact	Auxiliary Load	Water Makeup (b)	Drift Rate	Pump Head	Visible Plume	Noise	O&M Cost (c)	Capital Cost
Type of Cooling	**Acres**	**Ft (m)**		**%**	**MW**	**gpm (Lpm)**	**% of Full Flow**	**Feet H_2O (kg/cm^2)**		**dBA @ 1m**	**USD**	**USD**
Natural Draft Wet Cooling Tower	10	439 (134)	Concrete	0.5	0	43,000 (162,800)	<0.005	38 (1.16)	Yes	82	1,320,000	66,000,000
Rectangular Mechanical Draft (Wet)	23	58 (17.7)	Fiberglass (FRP)	0.5	8.3	43,000 (162,800)	0.005	31 (0.94)	Yes	85	760,000	38,000,000
Round Mechanical Draft (Wet)	11	65 (19.8)	Concrete	0.5	7.2	43,000 (162,800)	0.005	32 (0.97)	Yes	85	1,080,000	54,000,000
Rectangular Plume Abated (Hybrid)	28	67 (20.4)	FRP Structure Titanium Coils	0.5	15.5	38,700 (146,500)	0.005	32 (0.97)	No	88	1,000,000	100,000,000
Round Plume Abated (Hybrid)	8.	164 (50)	Concrete Structure Titanium Coils	0.5	17.9	38,700 (146,500)	0.005	44 (1.34)	No	88	900,000	90,000,000
Round Plume Abated (Hybrid) Without Plume Abatement Option	5	164 (50)	Concrete Structure	0.5	11.6	38,700 (146,500)	0.005	44 (1.34)	Yes	85	200,000	60,000,000
Dry Tower (Air Cooled)	39	122 (37.2)	Hot Dipped Galvanized Steel, Titanium Tubes	25	78.7	None	None	0 (0)	No	88	5,398,000	269,900,000

Notes:
Footprint includes the required separation between towers, if applicable.
Water total makeup includes drift, evaporation, and blowdown (at 2 cycles of concentration).
O&M costs are calculated at 1% or 2% of the capital cost, based on vendor input.

Table 9.4-2— Environmental Impacts of Alternative Cooling Tower Systems

(Page 1 of 4)

Factors Affecting System Selection	Once-Through Cooling System	Dry Tower (Air-Cooled Condenser)	Natural Draft Wet Cooling Tower (NDWCT)	Mechanical Draft Wet Cooling Tower (MDWCT)	Hybrid (plume-abated) Cooling Tower (HCT)	Hybrid Cooling Tower (HCT) without Plume Abatement Option
Land Use: Onsite Land Requirements	N/A Rejected from range of alternatives before land use evaluated Impacts would be small.	39.1 acres (15.8 hectares) Impacts would be small.	10.0 acres (4 hectares) Impacts would be small.	23 acres (10.1 hectares) for rectangular MDWCT and 11 acres for a round MDWCT. Impacts would be small.	8 acres (3.2 hectares) for a round HCT and 27.5 acres (11.1hectares) for a rectangular HCT. Impacts would be small.	5.0 acres (2.0 hectares) for a round HCT without plume abatement option. Impacts would be small.
Land Use: Terrain Considerations	N/A Rejected from range of alternatives before land use evaluated Impacts would be small.	Terrain features of the CCNPP site are suitable for a dry tower air-cooled system. Impacts would be small.	Terrain features of the CCNPP site are suitable for an NDWCT system. Impacts would be small.	Terrain features of the CCNPP site are suitable for a MDWCT system. Impacts would be small.	Terrain features of the CCNPP site are suitable for an HCT. Impacts would be small.	Terrain features of the CCNPP site are suitable for an HCT without plume abatement option. Impacts would be small.
Water Use	2,500,000 gpm (9.5 million Lpm) for an on-shore intake. 420,000 gpm (1.6 million Lpm) for an off-shore intake. Potential for large impacts to aquatic biota. Impacts would be large.	No makeup water needed for use of a dry tower air-cooled system. No significant impacts to aquatic biota. Impacts would be small.	43,000 gpm (163,000 Lpm) for water makeup. Total water makeup includes drift, evaporation, and blowdown (@ 2 cycles of concentration). Potential for small to moderate impacts to aquatic biota. Impacts would be small to moderate.	43,000 gpm (163,000 Lpm) for water makeup for both a rectangular and round MDWCT. Total water makeup includes drift, evaporation, and blowdown (@ 2 cycles of concentration). Potential for small to moderate impacts to aquatic biota. Impacts would be small to moderate.	38,700 gpm (146,500 Lpm) for water makeup for both a rectangular and round HCT. Total water makeup includes drift, evaporation, and blowdown (@ 2 cycles of concentration). Potential for small to moderate impacts to aquatic biota. Impacts would be small to moderate.	38,700 gpm (146,500 Lpm) for water makeup for a round concrete HCT without plume abatement option. Total water makeup includes drift, evaporation, and blowdown (@ 2 cycles of concentration). Potential for small to moderate impacts to aquatic biota. Impacts would be small to moderate.
Atmospheric Effects	Some plume associated with discharge canal. Impacts would be small.	No visible plume associated with a dry tower air-cooled system. Impacts would be small.	Visible plume. NDWCT presents greater potential for fogging and salt deposition. Impacts would be small	Short average and median visible plume. Drift eliminators minimize salt deposition. Impacts would be small.	Reduced plume potential with an HCT. Impacts would be small	Short average and median visible plume. Drift eliminators minimize salt deposition. Impacts would be small

Table 9.4-2— Environmental Impacts of Alternative Cooling Tower Systems
(Page 2 of 4)

Factors Affecting System Selection	Once-Through Cooling System	Dry Tower (Air-Cooled Condenser)	Natural Draft Wet Cooling Tower (NDWCT)	Mechanical Draft Wet Cooling Tower (MDWCT)	Hybrid (plume-abated) Cooling Tower (HCT)	Hybrid Cooling Tower (HCT) without Plume Abatement Option
Thermal and Physical Effects	Enormous size of the intake and discharge structures and offshore pipes are needed. Thermal Discharges associated with the once-through cooling system would need to meet applicable water quality standards and be in compliance with applicable thermal discharge regulations. Thermal discharge study needed to identify environmental impacts on Chesapeake Bay. Impacts would be large.	Discharges associated with a dry tower air-cooled system would need to meet applicable water quality standards and be in compliance with applicable thermal discharge regulations. The discharge is not likely to produce tangible aesthetic or recreational impacts. No effect on fisheries, navigation, or recreational use of Chesapeake Bay is expected. Impacts would be small.	Discharges associated with the NDWCT would need to meet applicable water quality standards and be in compliance with applicable thermal discharge regulations. The discharge is not likely to produce tangible aesthetic or recreational impacts. No effect on fisheries, navigation, or recreational use of Chesapeake Bay is expected. Impacts would be small to moderate.	Discharges associated with the MDWCT would need to meet applicable water quality standards and be in compliance with applicable thermal discharge regulations. Cooling water will be sent to a retention basin, thus reducing thermal impacts to receiving waters. The discharge is not likely to produce tangible aesthetic or recreational impacts. No effect on fisheries, navigation, or recreational use of Chesapeake Bay is expected. Impacts would be small.	Discharges associated with the HCT would need to meet applicable water quality standards and be in compliance with applicable thermal discharge regulations. Therefore, the discharge is not likely to produce tangible aesthetic or recreational impacts. No effect on fisheries, navigation, or recreational use of Chesapeake Bay is expected. Impacts would be small.	Discharges associated with the HCT without the plume abatement option would need to meet applicable water quality standards and be in compliance with applicable thermal discharge regulations. Therefore, the discharge is not likely to produce tangible aesthetic or recreational impacts. No effect on fisheries, navigation, or recreational use of Chesapeake Bay is expected. Impacts would be small.
Noise Levels	N/A Rejected from range of alternatives before noise evaluated	A dry tower air-cooled system would emit broadband noise that is largely indistinguishable from background levels and would be considered unobtrusive Impacts would be small.	NDWCT would emit broadband noise that is largely indistinguishable from background levels and would be considered unobtrusive Impacts would be small.	MDWCT would emit broadband noise that is largely indistinguishable from background levels and would be considered unobtrusive Impacts would be small.	HCT would emit broadband noise that is largely indistinguishable from background levels and would be considered unobtrusive. Impacts would be small.	HCT without plume abatement would emit broadband noise that is largely indistinguishable from background levels and would be considered unobtrusive Impacts would be small.

Table 9.4-2— Environmental Impacts of Alternative Cooling Tower Systems

(Page 3 of 4)

Factors Affecting System Selection	Once-Through Cooling System	Dry Tower (Air-Cooled Condenser)	Natural Draft Wet Cooling Tower (NDWCT)	Mechanical Draft Wet Cooling Tower (MDWCT)	Hybrid (plume-abated) Cooling Tower (HCT)	Hybrid Cooling Tower (HCT) without Plume Abatement Option
Aesthetic and Recreational Benefits	No likely tangible aesthetic or recreational impacts; no effect on navigation or recreational use of Chesapeake Bay is expected. Impacts would be small.	No visible plume with the use of a dry tower air-cooled system. The heavily forested onsite areas, onsite elevation changes and topographical features (i.e., hills and valleys), and the new plant's location approximately 3,000 to 4,000 ft (914.4 to 1,219.2 m) from the nearest residential properties will help to shield the new plant from view.	NDWCT plumes resemble clouds and would not disrupt the viewscape. The heavily forested onsite areas, onsite elevation changes and topographical features (i.e., hills and valleys), and the new plant's location approximately 3,000 to 4,000 ft (914.4 to 1,219.2 m) from the nearest residential properties will help to shield the new plant from view.	MDWCT plumes resemble clouds and would not disrupt the viewscape. The heavily forested onsite areas, onsite elevation changes and topographical features (i.e., hills and valleys), and the new plant's location approximately 3,000 to 4,000 ft (914.4 to 1,219.2 m) from the nearest residential properties will help to shield the new plant from view.	No visible plume with the use of an HCT. The heavily forested onsite areas, onsite elevation changes and topographical features (i.e., hills and valleys), and the new plant's location approximately 3,000 to 4,000 ft (914.4 to 1,219.2 m) from the nearest residential properties will help to shield the new plant from view.	Visible plume. The heavily forested onsite areas, onsite elevation changes and topographical features (i.e., hills and valleys), and the new plant's location approximately 3,000 to 4,000 ft (914.4 to 1,219.2 m) from the nearest residential properties will help to shield the new plant from view. The cooling tower discharge is not likely to produce tangible aesthetic or recreational impacts. Impacts would be small.
		The discharge is not likely to produce tangible aesthetic or recreational impacts No effect on fisheries, navigation, or recreational use of Chesapeake Bay is expected. Impacts would be small.	The cooling tower discharge is not likely to produce tangible aesthetic or recreational impacts; no effect on fisheries, navigation, or recreational use of Chesapeake Bay is expected. Impacts would be small.	The cooling tower discharge is not likely to produce tangible aesthetic or recreational impacts; no effect on fisheries, navigation, or recreational use of Chesapeake Bay is expected. Impacts would be small.	The cooling tower discharge is not likely to produce tangible aesthetic or recreational impacts; no effect on fisheries, navigation, or recreational use of Chesapeake Bay is expected. Impacts would be small.	No effect on fisheries, navigation, or recreational use of Chesapeake Bay is expected. Impacts would be small.

Table 9.4-2— Environmental Impacts of Alternative Cooling Tower Systems

(Page 4 of 4)

Factors Affecting System Selection	Once-Through Cooling System	Dry Tower (Air-Cooled Condenser)	Natural Draft Wet Cooling Tower (NDWCT)	Mechanical Draft Wet Cooling Tower (MDWCT)	Hybrid (plume-abated) Cooling Tower (HCT)	Hybrid Cooling Tower (HCT) without Plume Abatement Option
Legislative Restrictions	Potential compliance issues with Section 316(b) of the CWA. Also, potential significant NPDES thermal discharge issues surrounding discharges back into Chesapeake Bay. Impacts would be large.	Potential compliance issues with the requirements for emissions under the federal Clean Air Act. These regulatory restrictions would not negatively affect implementation of this heat dissipation system, but they may impact overall operational cost.	Intake structure would meet Section 316(b) of the CWA and implementing regulations, as applicable. NPDES discharge permit thermal discharge limitation would address thermal load from blowdown to Chesapeake Bay. These restrictions would not negatively affect implementation of this heat dissipation system. Impacts would be small to moderate.	Intake structure would meet Section 316(b) of the CWA and implementing regulations, as applicable. NPDES discharge permit thermal discharge limitation would address thermal load from blowdown to Chesapeake Bay. These restrictions would not negatively affect implementation of this heat dissipation system. Impacts would be small.	Intake structure would meet Section 316(b) of the CWA and implementing regulations, as applicable. NPDES discharge permit thermal discharge limitation would address thermal load from blowdown to Chesapeake Bay. These restrictions would not negatively affect implementation of this heat dissipation system. Impacts would be small.	Intake structure would meet Section 316(b) of the CWA and the implementing regulations, as applicable. NPDES discharge permit thermal discharge limitation would address thermal load from HCT blowdown to Chesapeake Bay. These restrictions would not negatively affect implementation of this heat dissipation system. Impacts would be small.
Environmental impacts	Large	Small	Small to Moderate	Small to moderate	Small	Small
Is this an environmentally suitable alternative heat dissipation system?	No	No	No	No	Yes	Yes

Table 9.4-3— Alternate Intake Systems

(Page 1 of 2)

	Proposed System (closed loop)	Alternative Systems (open loop)	Intake location (Alternative 1a – Nearshore)	Intake location (Alternative 1b – Offshore)	Intake Location (Alternative 2)	Intake Location (Alternative 3)
Construction Impacts	Some adverse impacts as discussed in Section 4.1, but mitigated as noted in Section 4.6. Small	Adverse impacts due to large intake structure required. Large	Impacts minimal: use existing structures – avoid new channel dredging. But construction could interfere with operations at CCNPP Units 1 and 2. Small	Impacts moderate: use existing structures – new offshore channel dredging for pipeline needed. But construction could interfere with operations at CCNPP Units 1 and 2. Moderate	Impacts minimal; for minor dredging, similar to Alternative 1; Better flow for construction traffic, less impact on operations at CCNPP Units 1 and 2. Small	New intake structures would require new trenching for intake – higher costs due to longer pipe runs. Moderate
Aquatic Impacts	No expected long-term impacts; entrainment and impingement expected to be minimal. Small	Adverse impacts from entrainment of resident species. Large	Short term adverse impact from dredging and sediment. Mitigation plans (barriers and coffer dams) would limit impact. Small	Short to moderate term adverse impact from dredging and sediment. Mitigation plans (barriers and coffer dams) would limit impact. Moderate	Short term aquatic impacts associated with dredging and sediment. Mitigation plans (barriers and coffer dams) would limit impact. Small	Short term aquatic impacts from sedimentation; sedimentation would be greater with construction of new trench and structure. Small
Water Use Impacts	No expected long term impacts; water consumption minimal. Small	High water use would require large intake structure from Chesapeake Bay Large	Impact on surface and groundwater expected to be minimal. Small	Impact on surface and groundwater expected to be minimal. Small	Impact on surface and groundwater expected to be minimal. Small	Surface and groundwater impact. Moderate
Compliance with Regulations	Satisfies regulatory performance standards for CWA and Maryland regulations.	Does not meet current CWA and Maryland criteria for entrainment	Would comply with current CWA and Maryland regulations with additional permits.	Would comply with current CWA and Maryland regulations with additional permits.	Compliance with CWA and Maryland regulations. Similar permitting structure as Alternative 1, intake and discharge in intensely disturbed areas.	Compliance with CWA and Maryland regulations; extensive new permitting may be required.

Table 9.4-3— Alternate Intake Systems
(Page 2 of 2)

	Proposed System (closed loop)	Alternative Systems (open loop)	Intake location (Alternative 1a – Nearshore)	Intake location (Alternative 1b – Offshore)	Intake Location (Alternative 2)	Intake Location (Alternative 3)
Environmental Preferability	Environmentally preferable: limits entrainment and lower water use.	Cost prohibitive not compliant with regulations.	No; construction may interfere with operation at CCNPP Units 1 and 2.	No; construction may interfere with operations at CCNPP Units 1 and 2.	Yes; minimal impacts to current operation, better flow for construction traffic and laydown.	No, would require significant construction activities in previously undisturbed areas.

Table 9.4-4— Alternate Discharge Systems

	Proposed System (closed loop)	Alternative Systems (open loop)	Discharge Location south of intake structure (nearshore - closed loop)	Deep Water Discharge Location (offshore - open loop)
Construction Impacts	Some sedimentation for construction of subsurface diffuser	Adverse impacts due to large discharge structure required.	Impacts minimal: use existing structures – dredging into the Chesapeake Bay would result in some sedimentation that would be mitigated per Section 4.6.	Offshore diffuser area would be approximately 10 acres at the bottom of Chesapeake Bay. Discharge pipe trench to disturb approximately 12 acres of Chesapeake Bay bottom. Large intake and discharge structures necessary for large volume of water.
Aquatic Impacts	No expected long-term impacts; thermal diffusion is expected to reduce impacts from thermal discharge and mixing zones.	Adverse impacts from entrainment – best fish return technology not feasible.	Short term disturbance to benthic organisms; short term effect on fin-fish from sediment and other construction – mitigation per Section 4.2 and Section 4.6.	Greater impact to fish and shellfish from potential impingement and entrainment. Potential for long-term thermal impacts to local ecology.
Water-Use Impacts	No expected long term impacts; water consumption minimal.	Large discharge flow – impact on water quality and aquatic biota from discharge.	Impact on surface and groundwater expected to be minimal.	Large intake/discharge flow from/into Chesapeake Bay for system cooling. Potential for greater impacts from large volume of heated thermal discharge.
Compliance with Regulations	Meets regulatory temperature limit standards for CWA and Maryland regulations – Discharge of chemicals or other constituents limited by Maryland NPDES permit.	Does not meet current CWA and Maryland criteria for thermal discharge or best technology.	Location would limit mixing and impact to intake system. Meets current CWA and Maryland criteria for thermal discharge or best technology.	Necessary location for compliance with mixing zone standards Potential issues with compliance under Section 316 (a) and (b) of Maryland NPDES permit.
Environmental Preferability	Environmentally preferable: limits thermal impacts.	Cost prohibitive not compliant with regulations.	Yes. Greater diffusion and less mixing issues.	No. Regulatory compliance issues, aquatic biota impacts, and potential for public perception controversy.

ENVIRONMENTAL REPORT

CHAPTER 10

ENVIRONMENTAL CONSEQUENCES OF THE PROPOSED ACTION

10.0 ENVIRONMENTAL CONSEQUENCES OF THE PROPOSED ACTION

This chapter presents the potential environmental consequences of constructing and operating a new U.S. EPR at the Calvert Cliffs Nuclear Power Plant (CCNPP) site. The environmental consequences are evaluated in five sections:

- Unavoidable adverse impacts of construction and operations
- Irreversible and irretrievable commitments of resources
- Relationship between short-term uses and long-term productivity of the human environment
- Benefit-Cost balance
- Cumulative impacts

10.1 UNAVOIDABLE ADVERSE ENVIRONMENTAL IMPACTS

This section summarizes adverse impacts of CCNPP Unit 3 construction and operation that cannot otherwise be avoided, and for which there may be no practical means of mitigation. Chapter 4 and Chapter 5 provide supporting details.

10.1.1 Unavoidable Adverse Environmental Impacts of Construction

Most construction related environmental impacts can be avoided or minimized through the application of best management construction plans and conformance with applicable Federal, State and Local regulations that protect the environment. CCNPP Unit 3 requires use of a site footprint where permanent structures and roads are located. Construction activities, on the other hand, can be managed in ways that limit long-term loss of habitat and impacts to workers and the public.

Construction impacts and potential mitigation measures are discussed in Section 4.6, and summarized here in Table 10.1-1 summarizes the potential environmental impacts of construction and their mitigation. Considering the planned mitigation measures, the level of unavoidable adverse impacts from construction is expected to be SMALL.

10.1.2 Unavoidable Adverse Environmental Impacts of Operations

Operational impacts of CCNPP Unit 3 are discussed in Chapter 5. Expected impacts and their mitigation are summarized in Table 10.1-2. Unavoidable impacts are limited to operation of the cooling water systems and the generation of additional non-radioactive and radioactive waste. Actions to minimize these impacts include use of closed-cycle cooling and waste minimization. As a result, the unavoidable adverse impacts of operation are also expected to be SMALL.

10.1.3 Summary of Unavoidable Adverse Environmental Impacts from Construction and Operations

Construction and operation will require the disturbance of approximately 460 acres (186 hectares) of land for construction, of which 320 acres (129 hectares) will be permanently committed to power plant structures and roads for CCNPP Unit 3. Temporary storage and lay-down areas will be restored following construction to reduce the size of the footprint affected during operations. The infrastructure required for CCNPP Unit 3 will be consistent with existing site use, with exception of the cooling tower that is being installed to limit water consumption and related ecological impacts. The use of existing offsite transmission right-of-ways for CCNPP Unit 3 will eliminate the need for construction of new corridors further limiting the plant's utilization of available land.

Protection of surface and subsurface water resources during construction will require limitations on the amount of groundwater withdrawn and the discharge of construction waste waters from dewatering activities. Best Management Practices will be implemented to limit construction related erosion and sedimentation of surface waters. Water quality monitoring will be conducted to verify that control measures are adequate. Use of groundwater during construction will be within existing appropriations and, to further limit long-term groundwater use, CCNPP Unit 3 will employ desalination technology to produce freshwater for use in the essential service water system during operations. Long-term protection of surface waters will be managed through an onsite Storm Water Pollution Prevention Plan required under current regulations.

Certain natural resources on site will be affected including unavoidable encroachment on non-tidal wetlands and surface waters. Activities within these areas will conform to applicable state and federal regulations to ensure that impacts are limited and controlled. Impacts to aquatic resources are expected to be minimal given the limited area to be committed to permanent use and the absence of threatened and/or endangered species in these freshwaters.

Construction of permanent CCNPP Unit 3 structures such as the reactor and turbine buildings and the cooling towers will require the removal of mixed deciduous forest occupying this portion of the site. Available old field will allow for reforestation efforts following construction.

There are sensitive archaeological and architectural sites located in the construction area and their protection and/or mitigation of impacts will be administered through cooperative efforts with the Maryland State Historic Preservation Officer (SHPO).

Measures to promote public health and safety will be implemented during construction and operation. The temporary increase in workforce during construction will require actions to minimize traffic congestion. A new access road and interconnection with Maryland State Highway 2/4 will facilitate traffic flow during shift change over. Noise levels at the site boundary are predicted to conform to applicable state and federal environmental standards. Non-routine noise, such as blasting, will be limited to day time. Measures to control fugitive dust and emissions from equipment will be implemented along with a general Safety and Health Plan. Emissions from the testing of diesel generators will conform to applicable Maryland state permit requirements and related federal emission standards.

Radiological dose to workers on site and to the general public have been calculated and are estimated to be well within applicable regulatory limits. Continuing monitoring of radioactivity in the environment surrounding the CCNPP site will ensure that radiological consequences of station operation are maintained within applicable environmental and health based standards. While some radioactive solid wastes will be created, efforts to control and limit their production will be implemented.

Impacts associated with the CCNPP Unit 3 cooling water systems include construction and operation of the intake and discharge structures, as well as evaporative losses from the operating cooling towers. Construction of the CCNPP Unit 3 circulating water supply system (CWS) makeup water intake structure and the ultimate heat sink (UHS) makeup intake structure will take place along the shoreline terrace approximately 500 ft (152.4 m) south of the southern edge of the Units 1 and 2 intake channel curtain wall. Two intake pipes that originate at the southeastern edge of the existing Unit 1 and 2 intake channel will deliver cooling water to a common Unit 3 UHS intake and CWS intake forebay. As a result, sedimentation potentially released into the CCNPP Units 1, 2 and 3 intakes, or into the Chesapeake Bay, will be limited. Periodic maintenance dredging of the intake areas will be required for the continued operation of all three CCNPP units. These activities will conform to applicable State and U.S. Army Corps of Engineers regulations, including proper disposal of dredge spoils.

Since CCNPP Unit 3 will employ a closed-cycle cooling water system that conforms to the U.S. Environmental Protection Agency (EPA) Phase I Clean Water Act 316(b) regulations, the withdrawal of cooling water from the Chesapeake Bay will be small. The effect will be to limit impact on near shore hydrology and the potential effects of impingement and entrainment. Measures to further reduce impingement will include intake approach velocities less than 0.5 ft/sec (0.15 m/sec) and a CWS makeup water intake fish return system. Details of the fish return system are described in Section 3.4.

Evaporative loss from the cooling tower will not create a visible plume. Salt deposition is likely to occur but will be below NUREG-1555 (NRC, 1999) significance levels at which visible vegetation damage may occur. Offsite noise from tower operations is predicted to be within applicable state regulatory requirements.

A portion of the CWS and ESWS cooling towers water will be discharge back into the Chesapeake Bay as blowdown to maintain water quality of the cooling water as it is recirculated. The maximum blowdown water temperature rise will be approximately 12°F (6.7°C). The resulting thermal plume is predicted to be small and should not pose a threat to marine biota. The thermal discharge will contain small amounts of chemicals used in plant systems and small quantities of radioactive liquids. Concentrations of these waste water constituents will be limited by NPDES permit requirements and applicable NRC radiological release limitations.

Socioeconomic impacts of CCNPP Unit 3 construction and operation are expected to be SMALL. It is estimated that many of the skilled construction laborers will commute to the site from outside the immediate geographic area and temporary housing and other related public services appear to be adequate to absorb both the temporary increase in workers during construction and the long-term, but smaller, increase in operational staff. Beneficial increases to the local economy from taxes and spending are likely to occur but are estimated to be a small percentage of the existing economy. There are no unique minority or low-income populations within the comparative environmental impact areas surrounding the CCNPP site. Therefore, it is not likely that these groups would be disproportionately affected by construction or operation.

10.1.4 References

NRC, 1999. Environmental Standard Review Plan, NUREG-1555, Nuclear Regulatory Commission, October 1999.

Table 10.1-1— Construction-Related Unavoidable Adverse Environmental Impacts
(Page 1 of 5)

Impact Category	Adverse Impact	Mitigation Measures	Unavoidable Adverse Environmental Impacts
Land Use	Approximately 460 acres (186 hectares) of land will be disturbed of which 320 acres (129 hectares) will be permanently committed to power plant structures and roads for CCNPP Unit 3	Comply with applicable federal, state and local construction permits/ approvals including Coastal Zone Management guidelines. Clear only areas necessary for installation of power plant infrastructure and implement construction Best Management and Storm Water Protection Plans.	281 acres (114 hectares) of land will be permanently occupied by nuclear plant infrastructure.
		Limit activities in the 500 year flood plain to those associated with the intake structures.	
		Implement a Site Resource Management Plan. Acreage will be restored/revegetated following construction to the maximum extent possible.	
		Use of existing transmission corridor right-of-ways. Implement Storm Water Pollution Prevention Plan (SWPPP), including sediment and erosion control.	
		Implement Spill Prevention Control and Countermeasures (SPCC) Plan.	
		Use site Resource Management Plan and Best Management Practices (BMP) to protect resources such as wetlands and streams in vicinity; also, onsite land is not used for farmland nor is it considered prime or unique.	
		Obtain individual U.S. Army Corps of Engineers 404 Permit; comply with BMP requirements. Obtain Maryland Non-Tidal Wetlands Protection Act permit; comply with BMP requirements.	
	Potential to disturb archaeological and architectural sites during construction	Undertake extensive archaeological survey of site prior to construction.	Small potential for destruction of unanticipated historic and/or cultural resources.
		Review significance of sites with the Maryland State Historic Preservation Officer (SHPO) and develop plans to avoid and/or minimize impacts to these sites.	
		Develop procedures compliant with Federal and State laws to protect cultural, historical or paleontological resources or human remains in the event of discovery during construction.	

Table 10.1-1— Construction-Related Unavoidable Adverse Environmental Impacts

(Page 2 of 5)

Impact Category	Adverse Impact	Mitigation Measures	Unavoidable Adverse Environmental Impacts
Hydrologic and Water Use	Construction has the potential to change drainage characteristics, flood handling, and erosion and sediment transport.	Implement BMP and Storm Water Pollution Prevention (SWPPP) Plans according to applicable Local and State regulations to limit erosion and contamination of surface waters. Comply with the U.S. Army Corps of Engineers 404 Permit.	Potential erosion of sediments into surface waters and local, temporary depression in the water table due to dewatering activities.
	Construction will require approximately 250 gpm of groundwater withdrawal.	Water use controlled within the existing CCNPP Units 1 and 2 allowable withdrawal appropriations. Monitor perched and groundwater water levels. Use offsite water supply, as needed. Following construction, use of groundwater will be replaced with water provided by a desalinization unit. Dewatering ponds will assist with groundwater recharge and sediment control.	Temporary drawdown of the aquifer and redirection of recharge source water during construction.
	Surface and subsurface water quality could be affected by construction activities.	Implement BMP and SWPPP. Monitor water quality in construction impoundments and compare to applicable criteria and historic data. Comply with the U.S. Army Corps of Engineers 404 Permit requirements. Use site Resource Management Plan to protect resources such as wetlands and streams in vicinity. Implement Spill Prevention, Control, and Countermeasures (SPCC) Plan.	Potential for contamination of subsurface groundwater.
Aquatic Ecology	Two onsite ponds and a small stream will be permanently affected; others will experience temporary impairment resulting in elimination and/or displacement of aquatic species	Implement BMP and SWPPP to limit erosion and sedimentation. Review CCNPP historic survey database to identify important aquatic species; conduct new surveys, as needed. Use site Resource Management Plan and BMP to protect resources.	Aquatic resources in the ponds and stream will be permanently lost.
	Chesapeake Bay marine life may be affected due to increased suspended sediment, dredging for the intake, and removal of substrate for the discharge structure.	Activities at the intake will occur within a sheet pile barrier. Dredging for the discharge will be confined to a small area and will quickly recolonize based on prior experience.	Benthic organisms in the dredged areas will be temporarily removed.

Table 10.1-1— Construction-Related Unavoidable Adverse Environmental Impacts

(Page 3 of 5)

Impact Category	Adverse Impact	Mitigation Measures	Unavoidable Adverse Environmental Impacts
		Implement SWPPP, including sediment and erosion control and the construction of new impoundments, as appropriate. Comply with the U.S. Army Corps of Engineers 404 Permit requirements. Implement SPCC Plan. No marine or aquatic endangered species are expected to be impacted.	
Terrestrial Ecology	Vegetation loss will occur in certain construction areas, including mixed forest, old field, and wetlands habitats.	Restore available old field not impacted by CCNPP with mixed deciduous forest to provide an overall net gain. Perform activities in wetlands in accordance with permit requirements of Section 404 of the Clean Water Act and the Maryland Non-tidal Wetlands Protection Act including setbacks and erosion controls. Facilities will be sited to limit wetland encroachment. Review CCNPP historic survey database to identify important terrestrial species; conduct new surveys, as needed. Use site Resource Management Plan and BMP to protect resources. Preserve aesthetically outstanding tree clusters, as practical; harvest merchantable timber; use or recycle other woody material, as appropriate; develop reforestation plan. Obtain individual U.S. Army Corps of Engineers 404 Permit; comply with BMP requirements. Obtain Maryland Non-Tidal Wetlands Protection Act Permit; comply with BMP requirements. Acreage will be restored following construction to the maximum extent possible.	A limited amount of mixed deciduous forest will be lost. A portion of onsite wetlands will be lost.
Terrestrial Ecology	Designated bird species may be displaced or disturbed.	Manage forest habitat specific to key bird species to limit habitat fragmentation. Reclamation of old fields will contribute to added forest habitat. Consult with appropriate agencies regarding avoidance and appropriate mitigation measures, if necessary, for bald eagle nests. Design construction footprint to account for Chesapeake Bay Critical Area and other important habitat, including bald eagle nests. Minimize lighting, as practicable and allowed by regulation. No activities will take place in the most favorable habitat area for the two threatened beetles, thereby avoiding impact.	No unavoidable impacts.

Table 10.1-1— Construction-Related Unavoidable Adverse Environmental Impacts
(Page 4 of 5)

Impact Category	Adverse Impact	Mitigation Measures	Unavoidable Adverse Environmental Impacts
Socioeconomic	Construction workers, existing employees and local residents could be affected by increased dust, noise, emissions and traffic.	Onsite noise will be maintained within applicable Maryland limits and OSHA noise-exposure limits. Limit construction activities resulting in non-routine noise levels to day time. Train construction workers and employees in use of appropriate personal protective equipment Develop fugitive dust and vehicle emissions control strategies in conformance with air quality standards and best management practices. Ameliorated traffic congestion with improvements to site access road from Maryland State Route 2/4 and with onsite shift changes. Comply with applicable U.S. EPA and Maryland Department of the Environment (MDE) air quality regulations. Install new site perimeter and access road.	No unavoidable impacts.
	Public services supporting construction activities and expanded work force may be impacted. Influx of workers may impact housing availability.	Minor aggregate socioeconomic impacts anticipated; mitigation not required.	Small increase in emergency calls, number of new students, temporary housing.
		Town Comprehensive Plans address stressors associated with population growth.	No unavoidable adverse impacts.
		There are adequate numbers of vacant housing units to accomodate the influx of workers.	No unavoidable adverse impacts
Radiological	Construction workers will be exposed to small doses of radiation from existing units.	All doses will be within 10 CFR 20.1301 limits. Implement ALARA practices at construction site.	Small doses to construction workers.
Atmospheric and Meteorological	Construction will cause increased air emissions from traffic and construction equipment, and fugitive dust.	Train construction workers and employees on appropriate personal protective equipment. Develop fugitive dust and vehicle emissions control strategies in conformance with air quality standards and best management practices. Equipment maintenance plans. Comply with applicable U.S. EPA and MDE air quality regulations.	No unavoidable adverse impacts.

Table 10.1-1— Construction-Related Unavoidable Adverse Environmental Impacts
(Page 5 of 5)

Impact Category	Adverse Impact	Mitigation Measures	Unavoidable Adverse Environmental Impacts
Environmental Justice	No disproportionate impacts to low income or minority groups were identified.	None.	No unavoidable adverse impacts.
Non-radiological Health Impacts	Risk to workers from accidents and occupational illness.	Implement construction site-wide health and safety program.	Industrial worker accidents may occur.

Table 10.1-2— Operations-Related Unavoidable Adverse Environmental Impacts
(Page 1 of 3)

Impact Category	Adverse Impact	Mitigation Measures	Unavoidable Adverse Environmental Impacts
Land Use	The CCNPP Unit 3 footprint will permanently occupy a portion of the site.	Limit area required during design and construction.	Land use is consistent with current operations at the site.
	Some potential impact on land and water courses from spills and discharges.	Maintain Storm Water Pollution Prevention Plan (SWPPP), including sediment and erosion control.	No unavoidable impacts
		Maintain Spill Prevention Control and Countermeasures (SPCC) Plan.	
	Operation of the new unit will increase radioactive and non-radioactive waste disposal in landfills and onsite in long-term storage facilities.	Implement a waste minimization, pollution prevention program to limit waste generation.	Some land will be dedicated to offsite and onsite waste storage and will not be available for other uses.
	Transmission line maintenance may have some impact on vegetation and wildlife.	Best management practices will mitigate potential impacts from vegetation control and other ROW activities.	Unavoidable but small impacts may occur as a result of keeping the ROWs in a safe condition.
Hydrologic and Water Use	Circulating water supply system makeup water will be withdrawn from Chesapeake Bay potentially affecting near-shore hydrology.	Implement closed-cycle cooling and reduce water use.	No unavoidable impact.
	Evaporative loss of water from the cooling tower represents a consumptive use.	Use desalination to supply makeup water; minimize use of groundwater resources.	A limited amount of cooling water taken from Chesapeake Bay will be consumed through evaporative loss.
Aquatic Ecology	Cooling water withdrawal will result in impingement and entrainment.	Implement closed-cycle cooling. Limit intake velocity. Implement the use of a fish return system.	Some limited entrainment and impingement will occur.
	Thermal plume may impact aquatic species abundance and distribution.	Meet all applicable state and federal regulatory requirements regarding the discharge of heat.	A small thermal plume will be created.
		The diffuser is being designed to rapidly disperse the thermal discharge.	
	Biofouling and other process control chemicals will be discharged.	*Meet all applicable state and federal Clean Water Act and NPDES permit regulations and limitations.*	*Chemicals will be discharged in small quantities.*

Table 10.1-2— Operations-Related Unavoidable Adverse Environmental Impacts
(Page 2 of 3)

Impact Category	Adverse Impact	Mitigation Measures	Unavoidable Adverse Environmental Impacts
	Recreational and commercial fishing may be impacted by impingement and entrainment.	Implement closed-cycle cooling.	No unavoidable impacts.
Terrestrial Ecology	Operation of the cooling tower would result in a visible plume, fogging, icing and salt deposition.	Use of low-profile cooling tower with drift eliminators to limit evaporative loss and deposition.	The tower plumes will be visible from beyond the site boundary and from Chesapeake Bay
	Salt deposition from the cooling tower operations will have some impact on terrestrial vegetation.		No unavoidable adverse impacts.
	Bird collisions with the tower may occur.	Use of low-profile cooling tower and lower lighting	No unavoidable adverse impacts
Socioeconomic	Operating nuclear plants emit low noise.	Studies demonstrate noise levels on and offsite will meet applicable regulations.	No unavoidable adverse impacts.
	The additional transmission line has potential to cause electric shock onsite	Design to NESC code to minimize potential impacts.	No unavoidable adverse impacts.
	Cooling tower and plume may impact existing site aesthetics.	Site contours and the forest canopy limit landward visibility. The new facilities will be consistent with existing uses. The towers will have a low-profile.	The cooling tower plume will be visible from Chesapeake Bay, and inland offsite during winter.
	An additional 363 permanent staff will increase traffic during shift changes.	A new access road and interconnection with Maryland State Route 2/4 will limit traffic congestion. Heavy plant components will be barged in.	No unavoidable adverse impacts.
	Air quality could potentially be affected due to onsite diesel generators.	Conform to state and federal emission standards and permit requirements.	No unavoidable adverse impacts.
	Population increases due to added staff may affect public services.	Existing capacity exists to absorb the increased population related services.	No unavoidable adverse impacts.
	Public services supporting the increased operations work force may be impacted.	County Comprehensive Plans address population growth, housing, land use, recreation, and public services.	Small increase in emergency calls, students use of recreational facilities.
	Increased direct and indirect work force and increased population may impact housing availability.	The number of vacant housing units will be adequate to accomodate the increased work force.	

Table 10.1-2— Operations-Related Unavoidable Adverse Environmental Impacts
(Page 3 of 3)

Impact Category	Adverse Impact	Mitigation Measures	Unavoidable Adverse Environmental Impacts
Radiological	Potential doses to members of the public from releases to air and surface water.	All releases will be well below regulatory limits.	No unavoidable adverse impacts.
	General public and worker exposure to radiation during incident-free transport of fuel and wastes.	Detailed analysis performed in accordance with 10 CFR 51.52(b), yielding conservative results.	No unavoidable adverse impacts.
Atmospheric and Meteorological	The cooling tower plume will traverse the site.	Use of cooling tower drift eliminators to limit drift losses.	No unavoidable adverse impacts.
Environmental Justice	No disproportionately high or adverse impacts on minority or low income populations are predicted.	None required.	No unavoidable adverse impacts.
Non-radiological Health Impacts	Potential growth of infectious organisms within the Essential Service Water System coolong towers.	Apply best management biocide treatment to limit growth and dispersal of harmful organisms.	No unavoidable adverse impacts.
	Risk to workers from occupational related accidents and illnesses.	Implement site-wide Safety and Medical Program.	Some accidents are likely to occur.

10.2 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

This section describes the expected irreversible and irretrievable environmental resource commitments used in the construction and operation of Calvert Cliffs Nuclear power Plant (CCNPP) Unit 3. The information contained in this section satisfies the requirements of 10 CFR 51.45(b)(5) (CFR, 2007) and 10 CFR 51, Appendix A to Subpart A (CFR, 2007), with respect to consideration of irreversible and irretrievable commitment of resources (CFR, 2007).

Irreversible resource commitments are those that could not be restored at a later time to pre-existing conditions. Irretrievable resources are materials that will be used that could not, by practical means, be recycled or restored for other uses.

10.2.1 Irrevesible Environmental Committments

Irreversible environmental commitments resulting from installation of CCNPP Unit 3 in addition to materials used for nuclear fuel fabrication and onsite structural components include:

- Surface water
- Land
- Aquatic and terrestrial biota, and
- Releases to air and surface water

10.2.1.1 Surface Water

Surface waters will be withdrawn from the Chesapeake Bay to support the Circulating Water Supply System (CWS) and Essential Service Water Systems (ESWS). Some of this water will be consumed as a result of evaporative loss from the cooling towers. The remainder will be returned to the Chesapeake Bay. The amount of water potentially lost from the CWS cooling tower due to evaporation is expected to be approximately 19,016 gpm (71,984 lpm). Evaporative loss from the ESWS cooling tower will be approximately 566 gpm (2,142 Lpm) during operation. Because evaporative loss is consumptive, it will be unavailable for other uses.

The onsite water courses and non-tidal wetlands that will be filled or otherwise modified to accommodate the construction of CCNPP Unit 3 represent a small percent of the existing areas occupied by these natural resources. While the overall percent of area to be affected is small, those areas included within the CCNPP Unit 3 footprint will be permanently unavailable for reclamation in the future.

The groundwater limits currently permitted for CCNPP Units 1 and 2 will be adhered to in meeting water demands during construction of CCNPP Unit 3. Groundwater withdrawals will not be needed to support operation of CCNPP Unit 3. Groundwater that is removed from the aquifer to support construction will be consumed or managed as surface water run off. The impact to this resource will be temporary and SMALL. Because the resource use is consumptive, it will not be available for other uses.

10.2.1.2 Land Use

Land designated for the storage of radioactive and non-radioactive waste on and offsite is dedicated to that use and will be unavailable for other uses during the operational period.

Following decommissioning and the development of permanent offsite storage, the onsite waste storage areas could be reclaimed.

10.2.1.3 Aquatic and Terrestrial Biota

Construction of CCNPP Unit 3 will require the removal of a portion of the onsite mixed deciduous forest and will encroach on landward surface waters and wetlands. These areas will be permanently occupied by plant structures during operations and will be unavailable for reclamation. However, the construction areas represent a small percentage of the overall site acreage and do not contain any unique or otherwise protected aquatic or wetland species.

10.2.1.4 Releases to Air and Surface Water

Radioactivity, air pollutants and chemicals will be released to the environment during routine operations of CCNPP Unit 3. Since these releases will conform to applicable Nuclear Regulatory Commission, U.S. Environmental Protection Agency and the State of Maryland regulations, their impact to the public health and the environment would be limited. Routine long-term monitoring of radioactivity in the environment and the measurement of chemical concentrations discharged will be performed to verify regulatory compliance.

10.2.2 Irretrievable Commitments of Resources

Irretrievable commitments of resources during construction of CCNPP Unit 3 will be similar to that required for other major energy construction projects. Studies performed for the U.S. Department of Energy have summarized the amount of materials historically consumed for nuclear power plant construction (DOE, 2004a) (DOE, 2005).

For a typical new 1,300 MWe nuclear power plant, it can be estimated that reactor building steel-plate reinforced structures would require 12,239 yards of concrete and 3,107 tons of rebar. Approximately 2,500,000 linear feet of cable would be required for the reactor building, and 6,500,000 linear feet of cable and up to 275,000 feet of piping for the unit. Based on historical information from operating reactors (DOE, 2005), it is estimated that pressurized water reactors between 1,000 and 1,300 MWe require a total of approximately 182,900 cubic yards of concrete to construct the reactor building, major auxiliary buildings, turbine generator building and the turbine generator pedestal. A total of 20,512 tons of structural steel was typically required.

The rated electrical output for CCNPP Unit 3 is 1,710 MWe. This is approximately 30% higher than the largest plant referenced in the historical data. However, these historical estimates are representative of the quantities of materials that will be consumed during construction. Historical data for materials consumed for domestic nuclear power plant construction in the 1970's is summarized in Table 10.2-1 (DOE, 2005).

The inventories of construction materials tabulated by the US Census Bureau for 2002, 2005, and 2006 are shown in Table 10.2-2. In general, construction supplies increased from 2002 through 2006 suggesting that such commodities will continue to be available for the foreseeable future in response to demand (USCB, 2006a).

Similarly, inventories of minerals and related construction materials have remained relatively stable between 2000 and 2005 (Table 10.2-3) (USCB, 2008). Another important measure is industry capacity in those sectors that may affect nuclear power plant construction. In general, the data suggest that most industries have surplus capacity (Table 10.2-4). During the fourth quarter of 2007, U.S. domestic manufacturing plants collectively used only 70% of their full production capacity (USCB, 2006).

While these quantities are large, their use provides a cost-effective allocation of resources given that energy from nuclear power plants is now increasingly cost competitive (DOE, 2004a) (DOE, 2005). Furthermore, nuclear energy provides environmental benefits consistent with current concerns relative to overall life cycle environmental effects caused by fuel extraction, emission of air pollutants and solid waste disposal typically associated with fossil fuel (DOE, 2004b) (WNA, 2005).

Irretrievable resources include uranium and the energy used to fabricate fuel. However, available supplies of uranium suggest that there is a considerable degree of security of supply to ensure the continued operation and expansion of nuclear power for the foreseeable future (NEA, 2002) (WNA, 2006).

While a given quantity of material consumed during construction and operation of CCNPP Unit 3 will be irretrievable, except for materials recycled during decommissioning, the impact on their availability is expected to be SMALL.

10.2.3 References

CFR, 2007. Title 10, Code of Federal Regulations Part 51, Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions, 2007.

DOE, 2004a. Study of Construction Technologies and Schedules, O&M Staffing and Cost, Decommissioning Costs and Funding Requirements for Advanced Reactor Designs, Application of Advanced Construction Technologies to New Nuclear Power Plants, Volume 2, Paper NP2010, May 27, 2004, U.S. Department of Energy, Website: http://www.ne.doe.gov/np2010/reports/mpr2610Rev2Final924.pdf, Date accessed: June 1, 2007.

DOE, 2004b. Strategic Plan for Light Water Reactor Research and Development, U.S. Department of Energy, Office of Nuclear Energy, Science and Technology, February 1, 2004, Website: http://np2010.ne.doe.gov/reports/LWR_SP_Feb04.pdf, Date accessed: May 21, 2007.

DOE, 2005. Cost Estimating Guidelines for Generation IV Nuclear Energy Systems. Rev. 2.02 Final, U.S. Department of Energy, September 30, 2005, Website: http://nuclear.inl.gov/deliverables/docs/emwgguidelines_rev2.pdf, Date accessed: June 1, 2007.

NEA, 2002. Nuclear Fuel Resources: Enough to Last?, NEA News 2002, No. 20.2, Nuclear Energy Agency, R. Price and J. Blaise, Website: http://www.nea.fr/html/pub/newsletter/2002/20-2-Nuclear_fuel_resources.pdf, Date accessed: May 21, 2007.

USCB, 2006a. U.S. Census Bureau 2006 Annual Trade Wholesale Report, Table 1, Estimated Sales and Inventories of U.S. Merchant Wholesalers 2002 through 2006.

USCB, 2006b. US Census Bureau Survey of Plant Capacity: 2006. U.S. Department of Commerce, Economics and Statistics Administration.

USCB, 2008. US Census Bureau. Statistical Abstract of the United States: 2008, Table 868, Natural Resources. April, 2008.

WNA, 2005. The New Economics of Nuclear Power, World Nuclear Association, December 2005, Website: http://www.uic.com.au/neweconomics.pdf, Date accessed: May 21, 2007.

WNA, 2006. Ensuring Security of Supply in the International Nuclear Fuel Cycle, World Nuclear Association, May 2006, Website: http://www.world-nuclear.org/reference/pdf/security.pdf, Date accessed: April 26, 2007.

Table 10.2-1— Summary of Historical Data - Materials Consumed by Nuclear Power Plant Construction in the United States During the 1970's

	BWR 1074-1308 MWE	PWR 1116-1311 MWE	LWR 1074-1311 MWE
	Building Volume		
Building Volume 1,000,000 cubic ft (1,000,000 cubic m)	14.6 (0.41)	15.9 (0.45)	15.3 (0.43)
Concrete (Reactor Building, Major Auxiliary Buildings, Turbine Generator Building, Turbine Generator Pedestal, Other)			
Concrete 1,000 cubic yds (1,000 cubic m)	195.7 (149.6)	182.9 (139.8)	188.7 (144.3)
Concrete cubic yds/net KW (cubic m/net KW)	173.2 (132.4)	152.8 (116.8)	162.1 (123.9)
Concrete cubic yds/building 1,000 ft (cubic m/building cubic 1,000 m)	12.5 (338)	11.3 (305)	11.8 (319)
Structural Steel (supports, shield plate, miscellaneous steel)			
Structural Steel Tons (MT)	13,642 (12,376)	20,512 (18,608)	17,389 (15,775)
Structural Steel lb/net KW (kg/net KW)	23.9 (10.8)	34.1 (15.5)	29.5 (13.4)
Structural Steel TN/building 1,000 cubic ft (MT/building 1,000 cubic m	0.94 (30.32)	1.30 (41.93)	1.13 (36.45)

BWR – Boiling water reactor

PWR – Pressurized water reactor

LWR – Light water reactor

Table 10.2-2— Estimated Inventories of Construction Supplies Based on U.S. Merchant Wholesalers Data in 2002, 2005 and 2006 (USCB, 2006a)

Category	Inventories ($\$x10^6$)		
	2002	2005	2006
Metals and Minerals	14,750	23,782	29,567
Electrical Goods	28,188	32,098	35,747
Hardware, Plumbing, Heating equipment and supplies	12,855	15,385	16635
Machinery, Equipment, and Supplies	53,495	65,237	70,866
Lumber & Other Construction Materials	10,300	16,524	17,080

Reference: USCB, 2006a

Table 10.2-3— U.S. Mineral Production in 2000, 2005 and Estimated for 2006 (USCS 2008)

Category	Inventory		
	2002	**2005**	**2006 est**
Inventories Per 1000 metric tons			
Aluminum (Per 1000 metric tons)	3,688	2,481	2,280
Copper (Per 1000 metric tons)	1,450	1,140	1,200
Iron ore (mil. metric tons)	61	53	53
Lead (Per 1000 metric tons)	449	426	430
Titanium (Per 1000 metric tons)	300	300	300
Zinc (Per 1000 metric tons)	805	748	725
Portland Cement (mil. metric tons)	84	94	94
Masonry Cement (mil metric tons)	4	5	5
Construction Sand and Gravel (mil. metric tons)	1,120	1,270	1,280

Reference: USCB, 2008

Table 10.2-4— Percent Capacity Utilization Rates by Industry (USCB 2006b)

Industry	2002	2003	2004	2005	2006
Primary Metal Manufacturing	71	72	74	79	73
Ferrous Metal Foundries	62	63	68	72	72
Nonferrous Metal Foundries	65	63	60	66	64
Fabricated Metal Products	59	61	66	68	70
Electrical Equipment	60	64	69	68	69

Reference USCB, 2006b

10.3 RELATIONSHIP BETWEEN SHORT-TERM USES AND LONG-TERM PRODUCTIVITY OF THE HUMAN ENVIRONMENT

The CCNPP Unit 3 environmental report provides information associated with the environmental and socioeconomic impacts of activities that occur during construction and operation. These activities are considered short-term for purposes of this section and include that period through prompt decommissioning. Long-term is considered to be that period from construction to end of plant life and beyond that required for delayed decommissioning. This section reviews the extent to which the proposed project use of the environment precludes any future, long-term use of the site.

The information contained in this Section satisfies the requirements of 10 CFR 51.45(b)(4) (CFR, 2007) and 10 CFR 51, Appendix A to Subpart A (CFR, 2007), with respect to consideration of irreversible and irretrievable commitment of resources.

10.3.1 Construction and Long-term Productivity

Section 10.1 summarizes the potential unavoidable adverse environmental impacts of CCNPP Unit 3 construction including measures being implemented to mitigate those impacts. While some impacts will remain following construction, none should preclude the future use of the site following decommissioning.

CCNPP Unit 3 is being constructed on the existing nuclear power plant site for CCNPP Units 1 and 2. As a result, construction related activities and permanent structures will be consistent with established site use. Construction activities will occupy a footprint larger than the permanent structures required for operations because of the need for additional temporary work force parking, equipment and material lay-down areas and construction buildings.

The acreage to be disturbed includes existing mixed deciduous forest and a small portion of the site's existing surface waters and non-tidal wetlands. Current plans call for reclaiming those areas affected by construction including use of old field onsite for supplemental forest plantings. These mitigation measures will limit terrestrial impacts and protect long-term productivity.

Groundwater and surface waters will be temporarily disturbed during construction due to water withdrawal and creation of dewatering basins. Following completion of construction these impacts will cease and groundwater should recharge to pre-construction levels with no long-term loss of surface or subsurface water resources.

Potential archaeological and architectural sites located in the construction area will be managed in cooperation with the Maryland State Office of Historic Preservation so that appropriate mitigative actions are implemented.

Construction of the CCNPP Unit 3 intake and discharge structures will require some disturbance of sediments within the intake embayment and in the area of the proposed discharge multi-port diffuser. Existing ecological studies performed for CCNPP Units 1 and 2 show that these impacts are temporary and will not affect long-term ecological productivity of the Chesapeake Bay in the Calvert Cliffs area.

Noise above ambient levels will occur onsite due to some construction activities. However, at the site boundary, construction related noise is expected to conform to applicable state and federal environmental standards. Non-routine noise, such as blasting, will be limited to day time. Since construction noise is temporary, there would be not long-term impacts.

Temporary traffic increases will occur due to the numbers of additional workers required to support construction. A new site access road is proposed to alleviate onsite and offsite traffic during this period and through operations and decommissioning with no long-term impact.

Economic benefits during construction accrue from the need for temporary housing and local spending. It is predicted that while this benefit is substantial, it will represent a small increment to the total economic base of the CCNPP site two-county area.

10.3.2 Operation and Long-term Productivity

The potential unavoidable adverse environmental impacts of CCNPP Unit 3 operation are also summarized in Section 10.1 along with proposed mitigation measures. Some impacts will occur during CCNPP Unit 3 operations but will largely terminate upon plant shut down and any residual environmental issues resolved during decommissioning such that long-term uses of the site are not precluded.

Environmental impacts during operations are largely related to operation of the CWS system and ESWS and the generation of radioactive wastes. Impacts of the cooling water systems stem from withdrawal of water from the Chesapeake Bay via the intake structures, evaporative loss from the systems' cooling towers and the return of cooling water back to the Chesapeake Bay.

The use of closed-cycle cooling systems will substantially reduce these potential impacts such that during and following operations there would be no long-term loss of ecological productivity of marine resources in the Chesapeake Bay. The long-term reproductive viability of marine species potentially affected by entrainment or impingement is expected to be unaffected, resulting in no long-term power plant related loss in biomass.

Discharge of the thermal plume and associated power plant chemical additives will meet applicable permit regulatory requirements during operations and are not expected to have any long-term consequences for water quality in the Chesapeake Bay. Due to the use of closed-cycle cooling, the thermal plume is predicted to occupy a comparatively small area. Similarly the concentrations of chemicals released will be limited and will quickly dissociate in marine waters with little or no long-term accumulation.

Evaporative loss of water from the cooling towers represents a consumptive use during operations but will cease following plant shutdown. Salt deposition during cooling tower operations is not predicted to cause visible vegetative impacts, yet this potential impact will also cease following shutdown as well. It is expected that terrestrial plants and/or soil will quickly recover should impacts be observed.

Emission of fossil fuel combustion byproducts will increase during the periodic testing of the CCNPP Unit 3 engines . The amount of emissions will be governed by applicable state permits and federal standards for air pollutants. Since the emissions are periodic and transient, and will cease following CCNPP Unit 3 shutdown, long term impacts to air quality are not expected.

Radiological releases will be controlled according to applicable state and federal standards to ensure protection of terrestrial and marine biota, and protection of workers and the general public. Onsite storage of radioactive wastes will be temporary and ultimately removed from site. Reclamation of the site including removal of any radioactive contamination will occur such that future long-term uses of the site are not precluded.

Socioeconomic benefits to the counties surrounding the CCNPP site will result from increased taxes, additional spending and housing. While the relative impact to the economic base is small, some benefit will continue up to and through decommissioning, particularly where increased tax revenues have been used to enhance public infrastructure and services.

10.3.3 Summary of Relationship between Short-term Uses and Long-term Productivity

The construction and operation of CCNPP Unit 3 will result in some limited short-term and unavoidable impacts to the environment. Mitigation measures have been proposed to limit both the short-term impacts of construction and those that may occur during the operational life of Unit 3. Benefits accrue from the production of electricity and increases in the tax base that could support public infrastructure and services. Following site decommissioning, it is expected there will be no long-term impacts on productivity or the human environment that would preclude alternative uses of the site.

10.3.4 References

CFR, 2007. Title 10, Code of Federal Regulations, Part 51, Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions, 2007.

10.4 BENEFIT-COST BALANCE

This section describes the benefit-cost balance resulting from the proposed construction and operation of Calvert Cliffs Nuclear Power Plant (CCNPP) Unit 3. It was prepared in accordance with the guidance provided in NUREG-1555 (NRC, 1999) i.e., "Environmental Standard Review Plan" (ESRP). Section 10.4.1 describes the benefits of the proposed project; Section 10.4.2 discusses the costs associated with the proposed project; and Section 10.4.3 provides a benefit-cost balance summary.

The information contained in this Section satisfies the requirements of 10 CFR 51.45(d) (NRC, 2007) and 10 CFR 51, Appendix A to Subpart A (CFR, 2007), with respect to consideration of irreversible and irretrievable commitment of resources.

10.4.1 Benefits

This section discusses the benefits resulting from the proposed construction and operation of CCNPP Unit 3. The information provided in this section was prepared in accordance with the guidance provided in NUREG-1555, ESRP 10.4.1 (NRC, 1999). Information provided in this section includes a summary of the following information:

- The evaluation that was performed to determine if there is sufficient demand for new electric power in Maryland;
- The evaluation that was performed to determine an electric power generation source (i.e., coal, gas, nuclear, solar, wind);
- The evaluation that was performed to choose a location for the selected electric power generation source; and
- Benefits that the new electric power generation facility will provide.

Table 10.4-1 summarizes the benefits and costs of the proposed action. Section 10.5 summarizes the potential cumulative adverse environmental impacts at the site. These benefits and costs include:

- Identification of appropriate plant production benefits;
- Calculation of the plant average annual electrical-energy generation in kilowatt-hours (kWh);
- Evaluation of the reliability of the electrical distribution system;
- Identification of other project benefits, including state and local tax revenues, regional productivity, enhancement of recreational and aesthetic values, environmental enhancement, creation and improvement of local roads or other facilities, and intangible benefits (e.g., reduced dependence on scarce fossil fuels);
- Quantification of benefits in monetary or other appropriate terms;
- Evaluation of the significance of the benefits on a political boundary or regional basis; and
- Assessment of any potential social or economic impacts as a result of the proposed project construction and operation

The potential cumulative adverse impacts at the site resulting from construction of a new power plant are summarized in Section 10.5

10.4.1.1 Need for Power

As discussed in Section 8.4, the Maryland Public Service Commission (PSC) noted in its adequacy supply report that the need for in-state generating capacity is increasing rapidly. The PSC assessed the following factors for its growing concern about reliability and power supply: Maryland's growing reliance on imported electricity and the need for infrastructure additions and new transmission.

Maryland's dependence on out-of-state generation resources will likely increase over the next 5 to 10 years because of both growth in electricity demand, and the possible de-rating or retirement of existing generating units. Further contributors to the uncertain outlook for supply adequacy is that over the next 10 years only a small amount of new electricity generation will likely be built in Maryland. The conclusion that there is a need for new baseload generating capacity in Maryland based on the following:

- Maryland has a well-defined, systematic, and comprehensive resource monitoring, assessment, and reporting process that adequately reviews the state's resources and growing demand for additional baseload, eliminating the need for additional Nuclear Regulatory Commission (NRC) review; and
- The PSC/ Power Plant Research Program (PPRP)/ Certificate of Public Convenience and Necessity (CPCN) process in Maryland assures the NRC that construction would not proceed without Maryland's due consideration of the projects impact on the adequacy, stability, and reliability of the electrical system in the state; and
- The PSC has concluded that there is a need for new baseload capacity, and this conclusion has been given "great weight" in this ER, as allowed by NUREG-1555 (NRC, 1999).

10.4.1.2 Energy Alternatives

The following paragraphs provide a summary of the evaluation that was conducted in Section 9.2, to determine a suitable electric generating power source to meet the demand for new power in Maryland. The evaluation identified alternatives that would require the construction of new generating capacity—such as wind, geothermal, oil, natural gas, hydropower, municipal solid wastes (MSW), coal, photovoltaic (PV) cells, solar power, wood waste/biomass, and energy crops, as well as any combination of these alternatives. In addition, alternatives that would not require new generating capacity were evaluated, including initiating energy conservation measures and Demand-Side Management (DSM), reactivating or extending the service life of existing plants within the power system, and purchasing electric power from other sources.

The evaluation indicated that neither a coal-fired nor a gas-fired facility would appreciably reduce overall environmental impacts relative to a new nuclear plant, with the exception of air-quality impacts. A coal-fired or gas-fired facility would entail a significantly greater environmental impact on air quality than would a new nuclear plant. The analysis indicated that wind and solar facilities in combination with fossil facilities could be used to generate baseload power. However, wind and solar facilities in combination with fossil facilities would have higher costs and larger land requirements than a new nuclear facility and therefore are not preferable to a new nuclear facility.

Based on environmental impacts, it has been concluded that neither a coal-fired, nor a gas-fired, nor a combination of alternatives, including wind and solar facilities, would appreciably reduce overall environmental impacts relative to a new nuclear plant; therefore making nuclear power a suitable electric power generation source.

10.4.1.3 Alternative Locations for the Proposed Facility

The following paragraphs provide a summary of the evaluation that was conducted in Section 9.3 to identify a preferred location for the new nuclear power facility. The objective of the evaluation was to verify that no obviously superior location for the siting of a new nuclear unit exists.

Three alternative sites were chosen for the analysis, all in Maryland: 1) Bainbridge Naval Training Center, Port Deposit, Cecil County; 2) EASTALCO, Buckeystown, Frederick County; and 3) Thiokol site, Mechanicsville, St. Mary's County. These sites were chosen as a result of the application of an extensive site selection process described in Section 9.3. In addition, a preliminary evaluation was done on a generic undeveloped greenfield site. The sites were evaluated based on potential impacts to land use, air quality water, terrestrial ecology and sensitive species, aquatic ecology and sensitive species, demographics, and historic, cultural, and archeological resources.

The evaluation concluded that the preferred location for the new nuclear facility is collocation with an existing nuclear facility. Siting a new reactor at an existing nuclear facility offers a number of benefits:

- By collocating nuclear reactors, the total number of generating sites is reduced.
- No additional land acquisitions are necessary, and the applicant can readily obtain control of the property. This reduces both initial costs to the applicant and the degree of impact to the surrounding anthropogenic and ecological communities.
- Site characteristics, including geologic/seismic suitability, are already known, and the site has already undergone substantial review through the National Environmental Policy Act (NEPA) process during the original selection procedure.
- The environmental impacts of both construction and operation of the existing unit are known. It can be expected that the impacts of a new unit should be comparable to those of the operating nuclear plant.
- Collocated sites can share existing infrastructure, reducing both development costs and environmental impacts associated with construction of new access roads, waste disposal areas, and other important supporting facilities and structures. Construction of new transmission corridors may be eliminated or reduced because of the potential use of existing corridors.
- Existing nuclear plants have nearby markets, the support of the local community, and the availability of experienced personnel.

The analysis concluded that the greenfield site could be dismissed from further evaluation because it is not environmentally preferable and entails high costs.. Development of any of the three alternative sites offers no environmental advantages over locating the new nuclear facility at the existing CCNPP site.

10.4.1.4 Benefits of the Proposed Facility

Locating the proposed new nuclear facility at the existing CCNPP property will afford benefits to the local economy. The CCNPP owners will pay property taxes on the proposed new unit for the duration of the operating licenses. CCNPP owners estimate that annual property tax payments could reach approximately [Proprietary Information - Withheld Under 10 CFR 2.390 - See Part 9 of the COL Application] million in 2016, the year of plant startup and a maximum of [Proprietary Information - Withheld Under 10 CFR 2.390 - See Part 9 of the COL Application] million as described in Section 4.4.2.6.2. Most people consider large tax payments a benefit to the taxing entity because they support the development of infrastructure that supports further economic development and growth.

Approximately 833 people are employed at the existing CCNPP facility (BGE, 1998). It is anticipated that construction and operation of the new facility would require a skilled workforce of 363 people. New jobs within approximately a 50 mi (80 km) radius of the plant would be created by the construction and operation of the new facility. Many of these jobs would be in the service sector and could be filled by unemployed local residents, lessening demands on social service agencies in addition to strengthening the economy. It is anticipated that the new jobs would be maintained throughout the life of the plant.

Construction and operation of the new nuclear facility at CCNPP would generate an economic multiplier effect in the area. The economic multiplier effect means that for every dollar spent an additional $0.69 of indirect economic revenue would be generated within the region of influence (BEA, 2007). 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 the direct and indirect labor force created as a result of the construction and operation of the new nuclear reactor unit would increase economic activity in the region, most noticeably in Calvert County.

Given concerns in the State of Maryland about climate change and carbon emissions, CCNPP Unit 3 serves an important environmental benefit need by reducing carbon emissions in the State. Upon operation, CCNPP Unit 3 would displace significant amounts of carbon compared to a coal-fired generating plant. The costs of climate change, which have been quantified, will have a significant impact on the global and national economies.

10.4.2 Costs

This section summarizes estimated costs for construction and operation of CCNPP Unit 3. The information provided in this section was prepared in accordance with the guidance provided in NUREG-1555 (NRC, 1999), ESRP 10.4.2). The discussion below provides sufficient economic information to assess and predict costs and benefits.

Table 10.4-1 summarizes the benefits and costs of the proposed action. Section 10.5 summarizes the potential cumulative adverse environmental impacts at the proposed project site.

10.4.2.1 Monetary - Construction

The phrase commonly used to describe the monetary cost of constructing a nuclear plant is "overnight capital cost." The capital costs are those incurred during construction, when the actual outlays for equipment and construction and engineering are expended, in other words, the cost resulting if one were to pay for 100% of the plant "overnight". Overnight costs are:

- expressed as a constant dollar amount versus actual nominal dollars,
- expressed in $/kW, and
- for the nuclear industry, the overnight capital cost does not include inflation, financing, extraordinary site costs, licensing, transmission or the initial fuel load.

The overnight capital cost for CCNPP Unit 3, excluding contingency costs, is estimated to be [Proprietary Information - Withheld Under 10 CFR 2.390 - See Part 9 of the COL Application]. This is the unlevelized capital cost for Unit 3. The levelized capital cost for the "nth" U.S. EPR will be lower than that for CCNPP Unit 3 as a result of cost savings such as document reuse, supply chain volume savings, labor and construction sequence learning curve, and reduced spare parts inventory, that can be realized by constructing multiple EPRs.

10.4.2.2 Monetary - Operation

Operation costs for CCNPP Unit 3 are in the process of being estimated. Operation costs are frequently expressed as the 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 a third of the levelized cost, and interest costs on the overnight costs account for another 25% (UC, 2004). At this time, levelized cost estimates ranging from $31 to $46 per MWh ($0.031 to $0.046 per kWh) has been selected. Factors affecting the range include choices for discount rate, construction duration, plant life span, 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, because of the effect of discounting a cost that would occur as much as 40 years in the future, decommissioning costs have relatively little effect on the levelized cost. In addition, the Energy Policy Act of 2005 instituted a production tax credit for the first advanced reactors brought on line in the U.S. (PL, 2005) would tend to lower this estimate.

10.4.3 Summary

Table 10.4-1 summarizes the benefits and costs associated with the proposed construction and operation of CCNPP Unit 3. Costs that are environmental impacts are those anticipated after proposed mitigation measures are implemented. Section 10.5 addresses the environmental costs and cumulative impacts.

10.4.4 References

BEA, 2007. Regional Input-Output Modeling System (RIMS II), Developed for Calvert County and St. Mary's County, Maryland for TetraTech NUS, General RIMS II, U.S. Department of Commerce, Bureau of Economic Analysis, Website: http://www.bea.gov/regional/gsp/action.cfm, Date accessed: May 17, 2007.

BGE, 1998. Calvert Cliffs Nuclear Plant, Units 1 and 2, Docket Numbers 50-317 and 50-318, Application for License Renewal, Letter from C. H. Cruse (Baltimore Gas and Electric) to Nuclear Regulatory Commission, April 8, 1998.

CFR, 2007. Title 10, Code of Federal Regulations, Part 51, Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions, 2007.

EIA, 2004. Annual Energy Outlook 2004, Energy Information Administration, DOE/ EIA-0383(2004), January, Website: http://www.eia.doe.gov/oiaf/archive/aeo04/index.html, Date accessed: May 16, 2007.

GPC, 2004. 2004 Integrated Resource Plan, Document 70086, Georgia Power Company, January 30, 2004, Website: http://www.psc.state.ga.us/facts/docftp.asp?txtdocname=70086, Date accessed: May 16, 2007.

IAEA, 2005. Projected Costs of Generating Electricity, 2005 Update, International Atomic Energy Agency, Organization for Economic Cooperation and Development, 2005.

MIT, 2003. The Future of Nuclear Power; An Interdisciplinary MIT Study, Massachusetts Institute of Technology, 2003, Website: http://web.mit.edu/nuclearpower/, Date accessed: May 16, 2007.

NRC, 1999. Standard Review Plans for Environmental Reviews of Nuclear Power Plants, NUREG-1555, Section 9.4, Alternative Plant and Transmission Systems, Nuclear Regulatory Commission, October 1999.

PL, 2005. Energy Policy Act of 2005, Public Law 109-58, 119 STAT. 596, August 2005, Website: http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=109_cong_public_laws&docid=f:publ058.109, Date accessed: May 19, 2007.

SEB, 2006. Southern Nuclear Energy: Cornerstone of Southern Living, Today and Tomorrow, Southern States Energy Board, July 2006, Website: http://www.sseb.org/publications/nucleardocument.pdf, Date accessed: May 16, 2007.

UC, 2004. The Economic Future of Nuclear Power, University of Chicago, August 2004. Website: http://www.anl.gov/Special_Reports/NuclEconSumAug04.pdf, Date accessed: May 16, 2007.

Table 10.4-1— Benefit and Costs of the Proposed Project Summarized

[Proprietary Information - Withheld Under 10 CFR 2.390 - See Part 9 of the COL Application]

(Page 1 of 9)

Cost Category	CCNPP Site	Thiokol Site	EASTALCO Site	Bainbridge Site
		INTERNAL COSTS		
Construction Cost	[ ] (It is anticipated that CCNPP Unit 3 will have a net electrical output of approximately 1,600 MWe. Using the value of [ ]per kW results in a CCNPP Unit 3 construction cost of approximately [ ].)	[ ] (It is anticipated that the installed reactor will be similar to CCNPP Unit 3 (net electrical output of approximately 1,600 MWe.) Using the value of [ ] per kW results in a construction cost of approximately [ ].)	[ ] (It is anticipated that the installed reactor will be similar to CCNPP Unit 3 (net electrical output of approximately 1,600 MWe. Using the value of [ ] per kW results in a construction cost of approximately [ ].)	[ ] (It is anticipated that the installed reactor will be similar to the CCNPP Unit 3 (net electrical output of approximately 1,600 MWe. Using the value of [ ] per kW results in a construction cost of approximately [ ].)
Operating Cost	$0.031 to $0.046 per kilowatt-hour	$0.031 to $0.046 per kilowatt-hour	$0.031 to $0.0 46 per kilowatt-hour	$0.031 to $0.046 per kilowatt-hour
Land	The CCNPP site is 2,070 acres (838 hectares). Co-located on the CCNPP site with CCNPP Units 1 and 2. Impact on land use is minimal compared to a new site. SMALL	620 acres (251 hectares) of space is available at the property for the new facility. Impact on land use is small to moderate compared to new site. Potential wetland issues. SMALL-MODERATE	2,200 acres (890 hectares) of space is available at the EASTALCO for the new facility. Impact on land use is small compared to new site. SMALL	1,185 acres (480 hectares) of space is available at the Bainbridge property for the new facility. Impact on land use is small to moderate compared to new site. SMALL-MODERATE
Labor	Add 363 direct new jobs, 661 indirect new jobs to the benefits. SMALL	It is assumed that similar size workforce to that which is anticipated for the proposed CCNPP facility. SMALL	It is assumed that similar size work force to that which is anticipated for the proposed CCNPP facility. LARGE	It is assumed that similar size workforce to that which is anticipated for the proposed CCNPP facility. LARGE
Materials	Construction materials include: concrete, aggregate, rebar, conduit, cable, piping, building supplies, and tools. Operating material includes uranium	Construction materials include: concrete, aggregate, rebar, conduit, cable, piping, building supplies, and tools. Operating material includes uranium	Construction materials include: concrete, aggregate, rebar, conduit, cable, piping, building supplies, and tools. Operating material includes uranium	Construction materials include: concrete, aggregate, rebar, conduit, cable, piping, building supplies, and tools. Operating material includes uranium
Equipment	Typical construction equipment will include cranes, cement trucks, excavation equipment, dump truck, and graders. Equipment for the new facility would include all of the necessary components for the facility such as the reactor, turbine, cooling system, water processing/ treatment system, cooling tower, etc.	Typical construction equipment will include cranes, cement trucks, excavation equipment, dump truck, and graders. Equipment for the new facility would include all of the necessary components for the facility such as the reactor, turbine, cooling system, water processing/treatment system, cooling tower, etc.	Typical construction equipment will include cranes, cement trucks, excavation equipment, dump truck, and graders. Equipment for the new facility would include all of the necessary components for the facility such as the reactor, turbine, cooling system, water processing/treatment system, cooling tower, etc.	Typical construction equipment will include cranes, cement trucks, excavation equipment, dump truck, and graders. Equipment for the new facility would include all of the necessary components for the facility such as the reactor, turbine, cooling system, water processing/treatment system, cooling tower, etc.

Table 10.4-1— Benefit and Costs of the Proposed Project Summarized

[Proprietary Information - Withheld Under 10 CFR 2.390 - See Part 9 of the COL Application]

(Page 2 of 9)

Cost Category	CCNPP Site	Thiokol Site	EASTALCO Site	Bainbridge Site
Services	Support services and supplies would be needed during construction. Security, maintenance, trash removal, and/or landscaping services may be needed during operation of the facility.	Support services and supplies would be needed during construction. Security, maintenance, trash removal, and/or landscaping services may be needed during operation of the facility.	Support services and supplies would be needed during construction. Security, maintenance, trash removal, and/or landscaping services may be needed during operation of the facility.	Support services and supplies would be needed during construction. Security, maintenance, trash removal, and/or landscaping services may be needed during operation of the facility.
Water Use	Maximum Chesapeake Bay water demand equals an estimated total 47,383 gpm (179,365 lpm). Surface and groundwater use will be mitigated by construction of desalinization plant for cooling water systems. SMALL	Water availability is limited . SMALL	Water availability is less than optimal. MODERATE	Water availability is less than optimal. MODERATE
EXTERNAL COSTS				
Land Use	Existing CCNPP site is 2,070 acres (838 hectares) Co-located on the CCNPP site with CCNPP Units 1 and 2. Impact on land use is minimal compared to new site. SMALL	A new right-of-way would need to be constructed to accommodate new transmission lines. There are more than 30 acres of wetlands on the site that would be impacted by use of the site. The site area is adequate to support the EPR footprint, but is zoned for other uses than industrial. The site topography is generally flat and cut-and-fill requirements would be small. Neither rail nor barge access are available close to the site. SMALL-MODERATE	A new right-of-way and/or expansion of an existing right-of-way would need to be constructed to accommodate new transmission lines. There are no wetlands on the site that would be impacted by use of the site. The site area is adequate to support the EPR footprint and is zoned for industrial use and part zoned for other uses than industrial. The site topography is generally flat and cut-and-fill requirements would be small. There is existing rail access, but only distant barge access, to the site. SMALL	A new right-of-way and/or expansion of an existing right-of-way would need to be constructed to accommodate new transmission lines. There are no wetlands on the site that would be impacted by use of the site. The site area is adequate to support the EPR footprint, but is zoned for other uses than industrial. The site topography is relatively flat over a large portion of the site but a limited area has significant topographic relief and would necessitate moderate cut-and-fill requirements. There is existing barge and rail access at the site. SMALL-MODERATE

Table 10.4-1— Benefit and Costs of the Proposed Project Summarized
[Proprietary Information - Withheld Under 10 CFR 2.390 - See Part 9 of the COL Application]
(Page 3 of 9)

Cost Category	CCNPP Site	Thiokol Site	EASTALCO Site	Bainbridge Site
Air Quality	The CCNPP site lies in a non-attainment area for 8 hour ozone. Calvert County is in attainment with all National Ambient Air Quality Standards except for ozone. Based on the design of the new reactor, siting the unit at this location would have a SMALL impact on air quality. MODERATE	The Thiokol site lies in an attainment area for all pollutants. The Thiokol site is at least 80 mi (129 km) from the closest Class 1 PSD area. Based on the design of the new reactor, siting the unit at this location would have a SMALL impact on air quality. SMALL	The EASTALCO site lies in a non-attainment area for 8 hour ozone and Particulate Matter 2.5. The EASTALCO site is 45 mi (72 km) from the closest Class 1 PSD area. Based on the design of the new reactor, siting the unit at this location would have a SMALL impact on air quality. SMALL	The Bainbridge site lies in a non-attainment area for 8 hour ozone and is at least 80 mi (129 km) from the closest Class 1 PSD area. Based on the design of the new reactor, siting the unit at this location would have a SMALL impact on air quality. SMALL-MODERATE
Terrestrial Biology	The CCNPP site is largely forested and situated among other large forested tracts. Together these tracts form one contiguous and predominantly undeveloped forested area. The Wildlife Habitat Council has certified and registered the CCNPP site as a valuable corporate wildlife habitat MODERATE (construction) SMALL (operation)	The site falls within a known location of a federally-listed species and there are wetlands at the site. Mitigation/ monitoring with applicable federal, state, and local permitting regulatory entities will occur during construction and operation. SMALL (operation) MODERATE (construction)	The predominant land cover at the EASTALCO site is agricultural land. There are no State or Federally regulated wetlands at the site. There is one known location of state-listed species within a mile of the site. SMALL	The Bainbridge site is surrounded by a variety of habitat types, such as woodlands, grasslands, and scrub. There are no State or Federally regulated wetlands at the site. There is one known location of a federally-listed species and one location of a state-listed species in Cecil County. SMALL-MODERATE
Aquatic Biology	The area of the Chesapeake Bay where CCNPP is located is in the mesohaline zone, which is characterized by moderate salinity. Mitigation/monitoring with applicable federal, state, and local permitting regulatory entities will occur during construction and operation. SMALL	There are numerous Federal and State threatened and endangered species in the county. One known location of a state-listed species was identified a mile from the site. Impacts to the environment are predominantly temporary. SMALL (operation) SMALL to MODERATE	There are no known State or Federally listed threatened or endangered species in the area of the cooling water intake system, and construction related impacts will be temporary and controlled using BMPs. Impacts are expected to be SMALL.SMALL	There are numerous Federal and State threatened and endangered species in the county; however, construction related impacts will be temporary. SMALLto MODERATE
Socioeconomic	87,500 Calvert Countypopulation $88,900 median household income in Calvert County SMALL	100,200 St. Mary's County population $71,500 median household income in St. Mary's County SMALL	222,000 Frederick County population $77,000 median household income in Frederick County SMALL	98,300 Cecil County population $63,000 median household income in Cecil County SMALL

Table 10.4-1— Benefit and Costs of the Proposed Project Summarized

[Proprietary Information - Withheld Under 10 CFR 2.390 - See Part 9 of the COL Application]
(Page 4 of 9)

Cost Category	CCNPP Site	Thiokol Site	EASTALCO Site	Bainbridge Site
Housing	No short term negative impact on availability of housing units in the area during construction SMALL	No short term negative impact on availability of housing units in the area during construction SMALL	No short term negative impact on availability of housing units in the area during construction. SMALL	No short term negative impact on availability of housing units in the area during construction SMALL
Local Infrastructure	Increased traffic at beginning and end of shifts may increase traffic on highways to and from plant. Little impact on availability of services; CCNPP Unit 3 will be built and operated in a large urbanized area. SMALL	Increased traffic at beginning and end of shifts may increase traffic on highways to and from plant. Little impact on availability of services. SMALL	Increased traffic at beginning and end of shifts may increase traffic on highways to and from plant. Little impact on availability of services. SMALL	Increased traffic at beginning and end of shifts may increase traffic on highways to and from plant. Little impact on availability of services. SMALL
Radiological Heath	Radiological exposure below limits to workers and public SMALL	Radiological exposure below limits to workers and public SMALL	Radiological exposure below limits to workers and public SMALL	Radiological exposure below limits to workers and public SMALL
Loss of resources	Loss of resources is discussed in Sections 10.1 through 10.3. It is expected that losses will be mitigated to minimize the impact of the loss. SMALL	Loss of resources is discussed in Sections 10.1 through 10.3. It is expected that losses will be mitigated to minimize the impact of the loss. SMALL	Loss of resources is discussed in Sections 10.1 through 10.3. It is expected that losses will be mitigated to minimize the impact of the loss. SMALL	Loss of resources is discussed in Sections 10.1 through 10.3. It is expected that losses will be mitigated to minimize the impact of the loss. SMALL
Measures and Controls to reduce environmental impact	Costs associated with mitigation will be small, since this unit will be built on an existing nuclear site. Existing mitigation and environmental monitoring programs will be expanded to account for the new unit. Construction and operational impacts are expected to be small. SMALL	Costs associated with mitigation will be moderate, since this unit will be built on a site that has substantial wetlands. Construction and operational impacts are expected to be small. MODERATE	Costs associated with mitigation will be small, since this unit will be built on a site that has little or no wetlands. Construction and operational impacts are expected to be small. SMALL	Costs associated with mitigation will be small, since this unit will be built on a site that has little or no wetlands. Construction and operational impacts are expected to be small. SMALL
Electricity Generated and Generating Capacity	The EPR nuclear power generating station reactor for the CCNPP has a rated core thermal power of 4,590 MWt electrical output of approximately 1,600 MWe.	It is assumed that the electricity generated and generating capacity would be similar to that of the CCNPP.	It is assumed that the electricity generated and generating capacity would be similar to that of the CCNPP.	It is assumed that the electricity generated and generating capacity would be similar to that of the CCNPP.

Table 10.4-1— Benefit and Costs of the Proposed Project Summarized
[Proprietary Information - Withheld Under 10 CFR 2.390 - See Part 9 of the COL Application]
(Page 5 of 9)

Cost Category	CCNPP Site	Thiokol Site	EASTALCO Site	Bainbridge Site
Fuel Diversity	Nuclear provides option to natural gas. Does not have price volatility of natural gas, fuel availability issues limited.	Nuclear provides option to natural gas. Does not have price volatility of natural gas, fuel availability issues limited.	Nuclear provides option to natural gas. Does not have price volatility of natural gas, fuel availability issues limited.	Nuclear provides option to natural gas. Does not have price volatility of natural gas, fuel availability issues limited.
Licensing Certainty	Resolution of design criteria through certification; resolution of site, construction and operational issues in Combined License Application (COLA); reliance on nuclear as generation.	Resolution of design criteria through certification; resolution of site, construction and operational issues in COLA; reliance on nuclear as generation.	Resolution of design criteria through certification; resolution of site, construction and operational issues in COLA; reliance on nuclear as generation.	Resolution of design criteria through certification; resolution of site, construction and operational issues in COLA; reliance on nuclear as generation.
Carbon Emissions (reduction)	Coal: (1,908,000 carbon dioxide equivalents [CO_2eq]) Natural Gas: (623,000 CO_2e) Nuclear: No carbon emissions.	It is assumed that carbon emissions reduction would be similar to the CCNPP. Nuclear: No carbon emissions.	It is assumed that carbon emissions reduction would be similar to the CCNPP. Nuclear: No carbon emissions.	It is assumed that carbon emissions reduction would be similar to the CCNPP. Nuclear: No carbon emissions.
Increased Customer Choice	Retail choice of "clean" energy source, in addition to menu of renewable sources.	Retail choice of "clean" energy source, in addition to menu of renewable sources.	Retail choice of "clean" energy source, in addition to menu of renewable sources.	Retail choice of "clean" energy source, in addition to menu of renewable sources.
Local Economy	Add a maximum of 3,950 new employees to the workforce for construction of the new facility. It is anticipated that a direct workforce of approximately 363 employees would be needed for operation. An additional 661 indirect jobs would be created during operation. Construction and operation workforce provide an economic benefit to the community.	It is assumed that a similar size work force to that which is anticipated for the CCNPP would be needed.	It is assumed that a similar size work force to that which is anticipated for the CCNPP would be needed.	It is assumed that a similar size work force to that which is anticipated for the CCNPP would be needed.
Aesthetic Values	Selection of design and cooling tower technology allows for minimal aesthetic impacts. Site contains existing nuclear power facility structures.	Selection of design and cooling tower technology allows for minimal aesthetic impacts.	Selection of design and cooling tower technology allows for minimal aesthetic impacts.	Selection of design and cooling tower technology allows for minimal aesthetic impacts.
Air Quality	Major beneficial impact in terms of avoidance of power plant emissions.	Major beneficial impact in terms of avoidance of power plant emissions.	Major beneficial impact in terms of avoidance of power plant emissions.	Major beneficial impact in terms of avoidance of power plant emissions.

Table 10.4-1— Benefit and Costs of the Proposed Project Summarized
[Proprietary Information - Withheld Under 10 CFR 2.390 - See Part 9 of the COL Application]
(Page 6 of 9)

Cost Category	CCNPP Site	Thiokol Site	EASTALCO Site	Bainbridge Site
Land Use	Land to be used for new unit is owned by Constellation. The land is adjacent to an existing operating nuclear power plant.	Land will need to be acquired for the proposed Thiokol site. The required land will need to be re-zoned for development of the nuclear facility.	Land to be used for new unit is owned by Constellation. Land will need to be acquired for the new unit. The required land will need to be re-zoned for development of the nuclear facility.	Land to be used for new unit is owned by Constellation. Land will need to be acquired for the new unit. The required land will need to be re-zoned for development of the nuclear facility.
State/Local Tax Payments during Construction and Operations	Construction will generate tax revenues from sources including income tax, retail sales tax on materials, supplies, and selected construction services; retail sales tax on expenditures by workers; and corporate income taxes paid by contractors. Tax revenue will be generated on an estimated [ ] in direct and indirect wages on an annual basis. During operation of the facility, local government tax revenues will accrue from property taxes and permitting and impact fees. Tax payments would occur annually over the life of the new reactor units [ ] per year.	Construction will generate tax revenues from sources including income tax, retail sales tax on materials, supplies, and selected construction services; retail sales tax on expenditures by workers; and corporate income taxes paid by contractors. Revenue on wages will be similar to that noted for CCNPP. During operation of the facility, local government tax revenues will accrue from property taxes and permitting and impact fees. Tax payments would occur annually over the life of the new reactor units. Annual expenditures during operation on material, equipment and outside services are assumed to be similar to that noted for CCNPP.	Construction will generate tax revenues from sources including income tax, retail sales tax on materials, supplies, and selected construction services; retail sales tax on expenditures by workers; and corporate income taxes paid by contractors. Revenue on wages will be similar to that noted for CCNPP. During operation of the facility, local government tax revenues will accrue from property taxes and permitting and impact fees. Tax payments would occur annually over the life of the new reactor units. Annual expenditures during operation on material, equipment and outside services are assumed to be similar to that noted for CCNPP.	Construction will generate tax revenues from sources including income tax, retail sales tax on materials, supplies, and selected construction services; retail sales tax on expenditures by workers; and corporate income taxes paid by contractors. Revenue on wages will be similar to that noted for CCNPP. During operation of the facility, local government tax revenues will accrue from property taxes and permitting and impact fees. Tax payments would occur annually over the life of the new reactor units. Annual expenditures during operation on material, equipment and outside services are assumed to be similar to that noted for CCNPP.
State/Local Tax Payments during Construction and Operations (Cont'd)	Beneficial economic impacts associated with station operation. Operations will result in annual expenditures in approximately $9 million on materials, equipment and outside services.			

Table 10.4-1— Benefit and Costs of the Proposed Project Summarized
[Proprietary Information - Withheld Under 10 CFR 2.390 - See Part 9 of the COL Application]
(Page 7 of 9)

Cost Category	CCNPP Site	Thiokol Site	EASTALCO Site	Bainbridge Site
Effects on Regional Productivity	Anticipate an increase in regional productivity through the influx of construction and station operation workers. Workers will create additional new indirect (service related) jobs in the region through the multiplier effect of direct employment. Construction workforce and their families will increase the population in the area. The expenditures of construction and facility operation workers for food, shelter, and services will create jobs, which will have a SMALL to LARGE positive impact on the region's economy. Job creation will inject millions of dollars in the region's economy, reducing unemployment and creating business opportunities.	Anticipate an increase in regional productivity through the influx of construction and station operation workers. Workers will create additional new indirect (service related) jobs in the region through the multiplier effect of direct employment. Construction workforce and their families will increase the population in the area. The expenditures of construction and facility operation workers for food, shelter, and services will create jobs, which will have a SMALL to LARGE positive impact on the region's economy. Job creation will inject millions of dollars in the region's economy, reducing unemployment and creating business opportunities.	Anticipate an increase in regional productivity through the influx of construction and station operation workers. Workers will create additional new indirect (service related) jobs in the region through the multiplier effect of direct employment. Construction workforce and their families will increase the population in the area. The expenditures of construction and facility operation workers for food, shelter, and services will create jobs, which will have a SMALL to LARGE positive impact on the region's economy. Job creation will inject millions of dollars in the region's economy, reducing unemployment and creating business opportunities.	Anticipate an increase in regional productivity through the influx of construction and station operation workers. Workers will create additional new indirect (service related) jobs in the region through the multiplier effect of direct employment. Construction workforce and their families will increase the population in the area. The expenditures of construction and facility operation workers for food, shelter, and services will create jobs, which will have a SMALL to LARGE positive impact on the region's economy. Job creation will inject millions of dollars in the region's economy, reducing unemployment and creating business opportunities.

Table 10.4-1— Benefit and Costs of the Proposed Project Summarized
[Proprietary Information - Withheld Under 10 CFR 2.390 - See Part 9 of the COL Application]
(Page 8 of 9)

Cost Category	CCNPP Site	Thiokol Site	EASTALCO Site	Bainbridge Site
Technical and Other Non Monetary Improvements (for example, New Recreational Facilities and Improvements to Local Facilities)	Co-located with an existing nuclear facility (CCNPP). Anticipate that existing local and county police, fire, and medical facilities and/or personnel would be able to accommodate the influx of construction and facility operation workers. Anticipate that the existing water supply and the township wastewater treatment facilities can accommodate the added increase in population. Anticipate that the existing education and social services facilities can accommodate the increase in population. Construction and operation activities should not have long-term, adverse impacts to recreational use of the surrounding area. Neither technical developments nor recreational enhancements are anticipated at this time from the construction and operation of the proposed nuclear facility. In addition, minor road improvements would occur near the proposed nuclear facility, on an as-needed basis, to support construction and operation activities.	Anticipate the need for additional local and county police, fire, and medical facilities and/or personnel to accommodate the influx of construction and facility operation workers. Anticipate the need for a site-specific wastewater treatment facility/system – either on site or municipal system if available, to accommodate the added increase in population. Anticipate the need for additional education and social services facilities to accommodate the increase in population. Construction and operation activities should not have long-term, adverse impacts to recreational use of the surrounding area. Neither technical developments nor recreational enhancements are anticipated at this time from the construction and operation of the proposed nuclear facility. In addition, minor road improvements would occur near the proposed nuclear facility, on an as-needed basis, to support construction and operation activities.	Anticipate the need for additional local and county police, fire, and medical facilities and/or personnel to accommodate the influx of construction and facility operation workers. Anticipate the need for a site-specific wastewater treatment facility/system - either on site or municipal system if available, to accommodate the added increase in population. Anticipate that the existing education and social services facilities can accommodate the increase in population. Construction and operation activities should not have long-term, adverse impacts to recreational use of the surrounding area. Neither technical developments nor recreational enhancements are anticipated at this time from the construction and operation of the proposed nuclear facility. In addition, minor road improvements would occur near the proposed nuclear facility, on an as needed basis, to support construction and operation activities.	Anticipate the need for additional local and county police, fire, and medical facilities and/or personnel to accommodate the influx of construction and facility operation workers. Anticipate the need for a site-specific wastewater treatment facility/system - either on site or municipal system if available, to accommodate the added increase in population. Anticipate that the existing education and social services facilities can accommodate the increase in population. Construction and operation activities should not have long-term, adverse impacts to recreational use of the surrounding area. Neither technical developments nor recreational enhancements are anticipated at this time from the construction and operation of the proposed nuclear facility. In addition, minor road improvements would occur near the proposed nuclear facility, on an as needed basis, to support construction and operation activities.

Table 10.4-1— Benefit and Costs of the Proposed Project Summarized
[Proprietary Information - Withheld Under 10 CFR 2.390 - See Part 9 of the COL Application]
(Page 9 of 9)

Cost Category	CCNPP Site	Thiokol Site	EASTALCO Site	Bainbridge Site
Environmental Enhancement	Reduction in carbon emissions with the use of nuclear power. The CCNPP site demonstrated an advantage over the alternative sites due to Constellation-owned property The need for transmission line upgrades is significantly less for the CCNPP site than for the alternative sites. If possible, existing transmission lines and corridors would be used and/ or expanded for the proposed reactors.	Reduction in carbon emissions with the use of nuclear power.	Reduction in carbon emissions with the use of nuclear power.	Reduction in carbon emissions with the use of nuclear power.

10.5 CUMULATIVE IMPACTS

Sections 10.1 through 10.3 summarize the adverse environmental impacts from construction and operation of Calvert Cliffs Nuclear Power Plant (CCNPP) Unit 3 that are potentially unavoidable, irreversible or irretrievable. Measures to mitigate these impacts are also discussed. Section 10.4 compares the environmental and economic costs and benefits of the facility. This section summarizes the potential cumulative adverse environmental impacts to the CCNPP region. Cumulative impacts include those that are incremental to past and ongoing activities on the site, along with those that are reasonably foreseeable in the future.

This evaluation of cumulative impacts is based on a comparison between the existing environmental conditions presented in Chapter 2 and the potential adverse environmental impacts of construction and operation detailed in Chapter 4 and Chapter 5, respectively. The evaluation also considers continued operation and license renewal of CCNPP Units 1 and 2.

CCNPP Unit 3 will be co-located on the existing nuclear power plant site currently occupied by CCNPP Units 1 and 2. CCNPP Units 1 and 2 occupy approximately 220 acres (89 hectares), while CCNPP Unit 3 construction is expected to utilize approximately 460 acres (186 hectares) of which 320 acres (129 hectares) will be permanently committed to structures and roads.

The CCNPP site consists of approximately 2,070 acres (838 hectares) located in Calvert County, Maryland, on the west bank of the Chesapeake Bay. Other major facilities located nearby include the Patuxent Naval Air Test Center 10 mi (16 km) south of the CCNPP site, and the Dominion Cove Point Liquefied Natural Gas site 3.6 mi (5.8 km) to the south. The 50 mi (80 km) radius surrounding the site includes parts of Maryland, Virginia, Delaware and Washington D.C.

Land use in Calvert County is predominantly farm, forest and residential housing. The CCNPP site consists mostly of mixed deciduous forest in various stages of succession, with a smaller percentage occupied by fields associated with an employee recreational campground and an area consisting of dredge spoils. None of the construction area is farmland. Topography is gently rolling, with steeper slopes along water courses. The site average height above sea level is approximately 100 ft (30 m).

The eastern boundary of the CCNPP site is the Chesapeake Bay. The Chesapeake Bay is approximately 195 mi (313 km) long and varies in width from 3 to 35 mi (5 to 56 km). Freshwater input comes from several major tributaries throughout its length, the largest being the Susquehanna River. The average depth is approximately 21 ft (9 m).

The Chesapeake Bay is a valuable natural resource in that it sustains active commercial and recreational fisheries for blue crab, oyster and several migratory fish species. Harvest, transport and marketing these resources are culturally and economically important to the region.

10.5.1 Cumulative Impacts from Construction

Construction impacts associated with CCNPP Unit 3 include grading and clearing, allocation of land to material lay-down and parking, use of ground and surface waters, equipment noise and emissions, increased traffic and use of public resources. These activities are consistent with those conducted during the construction of CCNPP Units 1 and 2. Many of the impacts will be temporary and most can be mitigated through the use of best management construction practices and stormwater pollution prevention planning required under State and Federal regulation.

Groundwater is currently utilized by CCNPP Units 1 and 2 for domestic, plant service and demineralized makeup water needs. Groundwater use conforms to an allocation imposed by the Maryland Department of the Environment. Of the 450,000 gpd (1,700,000 lpd) allocated, CCNPP Units 1 and 2 utilize, on average, approximately 388,000 gpd (1,470,000 lpd). Groundwater use during construction will remain within that allocated and its use will eventually be replaced with an onsite desalinization plant for CCNPP Unit 3. However, to date, neither saltwater intrusion nor land subsidence has been reported.

Additional impacts on wetlands, surface waters and groundwater resources may occur due to excavation or other activities that change flow patterns such as construction of sedimentation impoundments, stormwater runoff and dewatering, or that receive construction related waste effluents. It is anticipated that several vernal streams and impoundments will be affected by these activities. Environmental controls will conform to applicable regulations to minimize these effects. Efforts to reclaim areas not occupied by permanent structures or to provide offsetting habitat such as constructed wetlands will also be undertaken.

Protection of important or otherwise unique terrestrial habitats, flora and fauna were also considered in developing the construction plan for CCNPP Unit 3. Surveys of the site were undertaken to identify sensitive locations and protected species and efforts made to limit encroachment on these areas. Examples include the Chesapeake Bay Critical Area that encompasses lands within 1,000 ft (305 m) of mean sea high tide, locations with federally or state designated threatened or endangered species, wetland buffers and contiguous forest blocks. While certain state or federal designated vegetation and faunal species were found onsite, their presence was not found to be unique to areas potentially affected by construction.

Impacts to aquatic organisms found within freshwater impoundments and streams may be realized to the extent these surface waters are removed or water quality is affected. A survey of aquatic resources identified no unique aquatic species occurring with the construction zone. Typical fauna included the eastern mosquito fish, bluegill sunfish, invertebrate larvae, and submerged vegetation. Construction activities that may affect these natural resources, such as erosion and waste water discharge, will be managed using best management practices in conformance with applicable State and Federal permits and regulations.

Because of the preventive measures and corrective actions identified above and the short-term nature of construction activities, the cumulative impact on surface and groundwater from CCNPP Unit 3 construction in conjunction with the continued operation of CCNPP Units 1 and 2 should be small. Further, use of the existing offsite transmission right-of-way will limit the amount of land and related natural resources potentially impacted by construction.

An archaeological survey identified one site eligible for listing on the National Register of Historic Places. This site is located within the construction footprint. Phase III Data Recovery investigations, and subsequent consultation with the Maryland State Historic Preservation Officer (SHPO) will be performed to mitigate adverse effects from project construction in the event that the site cannot be avoided.

Potential impacts to the Chesapeake Bay would be associated with construction of the cooling water intake and discharge structures and improvements to the barge unloading facility. The Circulating Water Supply System (CWS) and the Essential Service Water System (ESWS) (Ultimate Heat Sink) will utilize independent structures located in a forebay constructed on the shoreline terrace approximately 500 ft (152.4 m) south of the southern edge of the Units 1 and 2 curtain wall. Included will be the installation of two 60-inch diameter pipes that will deliver cooling water from the Unit 1 and 2 intake channel to the Unit 3 cooling water system intake forebay. Dredging of the areas approaching the new intake pipes and the installation of sheet pile during construction may create some suspended sediment and removal of benthic substrate. Similarly, the dredging required for installation of the subsurface multi-port discharge structure will also require removal of sediment. Refurbishment of the barge slip will include new sheet pile and widening of the slip to receive heavy equipment. Activities in navigable waters will conform to applicable State of Maryland and U.S. Army Corps of Engineers regulations.

Impacts to marine biota will be negligible as previous studies conducted for CCNPP Units 1 and 2 indicate that the benthic substrate will reestablish following construction and that benthic species will quickly recolonize. Further there are no endangered or threatened marine species in the CCNPP site area that could be affected by sedimentation or sediment removal. As a result, cumulative construction impacts in the Chesapeake Bay are not expected.

Potential adverse cumulative impacts to public health and wellbeing stem from construction related noise, increased vehicular traffic, aesthetics and emissions. Noise levels will increase during construction with operation of heavy equipment and vehicles. The State of Maryland has established maximum decibel levels for different land use zones, the most sensitive being residential housing. Estimated noise levels that may occur during construction indicate that due to distance, topography and surrounding forest, levels at the site boundary are expected to meet applicable criteria. For onsite workers, it will be necessary to meet Occupational Safety and Health Administration (OSHA) exposure limits through training and use of personal protective equipment. Cumulative impacts are not expected as construction related noise will cease upon completion of the construction activities.

Traffic will increase during construction as workers commute from within and outside Calvert County. The main highway, Maryland State Highway 2/4, will experience additional traffic during shift change over. A new access road and an additional perimeter road will be constructed onsite to accommodate the excess traffic resulting from CCNPP Unit 3 construction. The access road will remain the primary entrance for CCNPP Unit 3 during operation when the number of workers is dramatically reduced. Heavy equipment and plant components will be barged in avoiding temporary blockage of local highways. Construction of the access road, use of the barge slip for heavy equipment and the decrease in workers following construction will limit cumulative impacts of traffic.

Dust, engine exhaust and other facility operations will result in construction related emissions. Protective actions will be required to ensure that applicable ambient air quality and hazardous pollutant regulations are met. Applicable permits will be obtained and construction practices, such as dust control, will be implemented so that cumulative impacts onsite from emissions are limited and are discontinued following construction.

Topography of the site and its forest canopy will limit visibility of construction activities. The Chesapeake Bay shoreline consists of high 100 ft (31 m) vertical cliffs. Construction activities, except for activities related to intake and discharge construction, will occur inland of the 1,000 ft (305 m) set back further reducing visibility from the water surface. Following construction, the multi-port diffuser will be beneath the surface. The intake structures will be confined to the southern end of the intake embayment and will be visible from certain portions of the Chesapeake Bay but their appearance will be consistent with CCNPP Units 1 and 2 intake structure.

Socioeconomic benefits accrue from capital expenditures as well as the increased number of jobs created during construction and the additional spending the results. It is estimated that peak construction workforce will exceed 3,900 full time equivalents. While it is difficult to predict the number of new jobs created for local county residents compared to those from the greater Washington D.C. area and beyond, it is clear that spending will augment the regional economy.

For example, it is estimated that for each dollar spent an additional $0.69 of indirect revenue would be generated within the region of influence. However, the extent to which construction workers temporarily relocate to within a reasonable commuting distance, will place some added pressure on the availability of housing and public services. No disproportionate impact on minority or low income populations is expected since no specific minority populations were found to exist in Calvert County and St. Mary's County and only one of 55 census groups in St. Mary's County contained a low-income population. None were found in Calvert County.

During construction a total of approximately 410 households would move into Calvert County and 135 into St. Mary's (ER Section 5.8.2.2). The total number of individuals (CCNPP Unit 3 construction and operations workforce) would increase by about 2,466 in Calvert County and 834 in St. Mary's. This influx may impact various public service institutions such as fire, EMS, education and recreational facilities. However, as a percentage, the increase in population is small and existing Comprehensive County Plans are in place to address the needs of an expanding population base.

Construction workers onsite will receive some radiation dose from the continued operation of CCNPP Units 1 and 2. Doses were calculated based on exposure to direct radiation, gaseous effluents and liquid effluents. Total collective dose during the construction period from all onsite sources is calculated to be approximately 14.6 person-rem (0.146 person-Sieverts). The annual maximum dose was calculated to be 38.8 mrem per yr (388 μSv/yr) compared to the public dose criteria of 100 mrem/yr year (1,000 μSv/yr).

In summary, the construction of CCNPP Unit 3 will not result in long-term cumulative impacts that are inconsistent with existing land use. Activities that occur during construction will be managed using best management practices and compliance with applicable regulations to limit both short-term and long-term adverse impacts. Furthermore, impacts will cease following completion of CCNPP Unit 3 and efforts made to reclaim those areas not required for operations.

10.5.2 Cumulative Impacts of Operations

Potential cumulative adverse impacts from operations include the withdrawal of water from the Chesapeake Bay, discharge of cooling tower blowdown, radiological dose consequences, waste generation, noise from the new hybrid cooling tower and socioeconomic changes. Each of these potential impacts is discussed below.

Because CCNPP Unit 3 will utilize closed-cycle cooling, the amount of cooling water withdrawn from the Chesapeake Bay will be significantly reduced below that required for once-through cooling. The CWS cooling tower is a circular, wet-dry type, mechanical draft tower with drift eliminators, and is approximately 164 ft (50 m) high. It is estimated that the CCNPP Unit 3 CWS will withdraw approximately 34,800 gpm (143,00 lpm) on average to replace evaporative loss, drift, and blowdown from the one mechanical draft cooling tower. Blowdown from the CWS to the retention basin, and ultimately to the Chesapeake Bay will be approximately 17,400 gpm (65,700 lpm). Maximum CWS cooling water makeup demand is approximately 40,400 gpm (153,080 lpm).

The ESWS will utilize closed-cycle cooling, and will have 4 mechanical draft cooling towers. The ESWS cooling towers will each be rectilinear structures, 96 ft (29 m) high, by 60 ft (18.3 m) long, by 60 ft (18.3 m) wide. The ESWS cooling towers will typically be supplied with fresh water makeup from storage tanks that are supplied from a desalinization plant. Makeup flow to the ESWS cooling towers during normal operations will be approximately 629 gpm (2,381 lpm). Blowdown from the ESWS cooling towers will be routed to the retention basin, and ultimately the Chesapeake Bay, and will be approximately 61 gpm (231 lpm). Maximum ESWS cooling water makeup demand is approximately 1,490 gpm (5,640 lpm).

Physical impacts of cooling system water withdrawal could include alteration of site hydrology in the immediate vicinity of the intakes structures. Previous hydrodynamic modeling for CCNPP Units 1 and 2 indicated that their operation would represent less than 1% of tidal flow. Since the amount of cooling water to be used for CCNPP Unit 3 is a small fraction of the intake flow from CCNPP Units 1 and 2, there should be no incremental cumulative adverse impact to the Chesapeake Bay hydrology.

Aquatic impacts attributable to operation of the CCNPP Unit 3 intake structures and cooling water systems include impingement of organisms on the traveling screens and entrainment of fish and invertebrate eggs and larvae within the cooling system. Use of closed-cycle cooling systems at CCNPP Unit 3 will significantly reduce these impacts compared to power plants that operate open-cycle (once-through). In addition, CCNPP Unit 3 will incorporate additional design criteria to limit impingement including intake approach velocities to less than 0.5 ft/sec (0.15 m/sec) as well as a fish return system that is detailed in Section 3.4.

Although some small amount of entrainment will occur, studies indicate that the CCNPP site area is not a spawning area for key species of commercial or recreational value, and that entrainment at CCNPP Units 1 and 2 has not resulted in detectable changes in population levels. Further, the dominant species that occur in the CCNPP site area of the Chesapeake Bay have not been identified as requiring habitat protection.

Blowdown from the cooling towers is returned to the Chesapeake Bay through a submerged multi-port diffuser. The temperature of this discharge will be several degrees above ambient creating a small thermal plume. Modeling of this plume shows that its size and distribution will meet all State water quality criteria and will be sufficiently small that it is unlikely to cause impacts to marine benthos or motile organisms migrating through the area.

Included in the blowdown discharge are chemicals used in biocide treatment and in plant process control. The concentrations discharged will be in conformance with National Pollutant Discharge Elimination System (NPDES) permit conditions and applicable water quality criteria. Further the amount of water being discharge from the closed-cycle system will be small compared to tidal flow such that concentrations of chemicals discharged will rapidly disperse. Solids will be allowed time for settlement and chemical treatment in an onsite retention basin, if required.

Because the use of closed-cycle cooling will limit cooling water requirements, the incremental impact from operation of CCNPP Unit 3 should not result in cumulative adverse ecological impacts.

Excess heat within the CWS will be dissipated to the environment using a hybrid mechanical draft cooling tower with drift eliminators installed. No visible plume is created when a portion of the cooling water evaporates as it leaves the tower and undergoes partial condensation. Fogging is predicted to occur most frequently onsite and is expected to occur less than 38 hours annually in the vicinity of the cooling towers, reaching the site boundary less than 8 hours annually. Icing is likely to occur most frequently onsite, and is estimated to occur less than 2 hours in all directions on an annual basis. Cloud shadowing is predicted to occur for 38 hours during the spring season, and a total of 113 hours annually on Maryland State Highway 2/4. The relative small size of the four ESWS towers is not expected to contribute to offsite impacts.

Salt deposition from CWS cooling tower operations will occur since the source of makeup water is the Chesapeake Bay. The extent of deposition will be limited through installation of drift eliminators that restrict the amount and size of water particles released from the tower. Model predictions indicate that the maximum salt deposition from the condenser cooling water tower is expected to be below NUREG-1555 (NRC, 1999) significance levels for possible vegetation damage.

While the new cooling towers to be installed and operated as part of the CCNPP Unit 3 closed-cycle cooling water system will create a visible plume, the cumulative impact offsite is expected to vary by season and primarily be a function of viewpoint.

Elevated temperatures within cooling tower systems are known to promote the growth of thermophilic bacteria such as Legionella sp., amoeba such as Naegleria sp., and fungi. Thermophilic organisms are typically associated with freshwater and the Nuclear Regulatory Commission (NRC) has linked health issues to power plants that use cooling ponds, lakes and canals, and that discharge to small rivers. Given that Chesapeake Bay water withdrawn to supply the CWS cooling tower is mesohaline (salinity between 5 to 18 parts per thousand), the growth and dispersion of thermophilic organisms from the CWS cooling tower is not expected to create a public health issue at CCNPP Unit 3.

Makeup water for the ESWS cooling towers will be supplied by a desalinization plant. Biocide treatment will limit the propagation and dispersal of thermophilic organisms in this system including the four small mechanical ESWS cooling towers. Blowdown will combine with the saline discharge of the CWS cooling tower prior to its discharge to the Chesapeake Bay.

Cumulative impacts on land use and the terrestrial environment are expected to be minimal given that the final footprint of the CCNPP Unit 3 structures will be permanently established following construction and no new transmission corridors offsite will be required. Sensitive onsite species that require protection include the bald eagle.

Terrestrial vegetative and faunal species that are critical to structure and function have been identified and will be managed within the Site Management Program. Implementation of the Stormwater Pollution Prevention Plan will also serve to limit future impacts of erosion and inadvertent releases from industrial activities onsite.

Bird mortality from collision is a concern particularly at sites where tall structures such as natural draft cooling towers extend will beyond the tree canopy. The CWS cooling tower to be installed for CCNPP Unit 3 is a low-profile design that will extend 164 ft (50 m) above ground. This compares to the height of a natural draft tower that is typically in excess of 400 ft (122 m).

The sources of noise from operations include the switchyard, transformers, cooling towers and traffic. A baseline noise survey of existing conditions showed that there was no observed offsite audible noise from the operation of CCNPP Units 1 and 2. A modeled prediction of noise from the new CCNPP Unit 3 cooling towers shows that day and nighttime noise levels beyond the site boundary will be below maximum allowable levels. Traffic noise will be limited to normal work day business hours during shift changes. Noise from the new onsite switchyard and transformers will be similar to that currently associated with CCNPP Units 1 and 2. Taken together, the additional noise associated with CCNPP Unit 3 is not expected to alter predictions that noise levels offsite will not represent an adverse cumulative impact.

Air emissions are limited by U.S. EPA standards and permits as well as by OSHA worker health based standards. The primary sources of operational related emissions are the four emergency diesel generators and two station blackout diesel generators. Periodic testing of the diesels is required to ensure their operability. The diesel generator engines are designed to meet the increasingly stringent emission standards.

Additional emissions reductions from the diesel generators will be achieved through the purchase of low sulfur fuels. Carbon dioxide production will be limited to that small amount attributed to testing of the diesel generators. By contrast, CCNPP Unit 3 operation would avoid the emission of approximately 1,731,000 CO_2e (CO_2 equivalent) from coal combustion and 565,000 CO_2e from natural gas combustion.

Exposure of the general public to radiation from the operation of CCNPP Unit 3 is a function of meteorology, relative location, population density, land use practices, harvest and consumption of food sources, as well as the allowable radiological release limits. Dose consequences result from liquid and gaseous releases and from direct radiation. Each of these potential pathways has been analyzed to ensure that applicable public health exposure limits are met.

In addition, the potential dose from the operation of CCNPP Unit 3 has been combined with that predicted for CCNPP Units 1 and 2. Results show that applicable NRC exposure limits are met, and that while there will be dose consequences resulting from operation of CCNPP Unit 3, exposure will remain within applicable limits and will not represent an adverse cumulative impact.

Conservative estimates of radiological dose to biota also demonstrate that exposure to key selected species should result in no observable effects. An existing long-term radiological monitoring program will continue to verify that dose consequences to the general public are as low as reasonably achievable (ALARA).

The uranium fuel cycle will contribute to cumulative impacts from fuel production, transportation, storage and disposal. Related environmental impacts are attributed to land and water use, electrical consumption, chemical effluents, radioactive effluents and waste generation. The cumulative impacts from each of these sources has been reviewed based on an NRC mandated comparative assessment detailed in 10 CFR 51.51(a) (CFR, 2007).

Non-radioactive and mixed-wastes will be produced during CCNPP Unit 3 operations. Typically these consist of recyclables, solid waste debris, and sewage. Cumulative impacts will be managed through implementation of waste minimization practices including the procurement process, allocation of material for work, storage and recycling. Wastes that can not be recycled will be stored and disposed in accordance with applicable state and federal hazardous and non-hazardous waste regulations, and at licensed liquid and solid waste disposal locations. Properly sized and designed onsite facilities for storage will be provided and procedures put in place to deal with potential spills and emergency response.

Socioeconomic impacts (benefits) from long-term CCNPP Unit 3 operation result from the increased operational work force, facility taxes, and generation of competitively priced electricity. Approximately 363 additional employees will be required to support CCNPP Unit 3 operations. Most of these employees are expected to reside primarily within Calvert County and St. Mary's County. The CCNPP Unit 3 workforce will result in increased indirect employment of approximately 1,400 jobs or about 1.9% of the existing two-county work force.

An overall increase in population is expected as families relocate, acquire housing and utilize public services. It is estimated that the additional workforce will increase population within Calvert County and St. Mary's County by approximately 2,500 people compared to the existing 160,774 people. An analysis of available housing suggests that adequate supply is currently available to support the influx of operational employees.

Although some existing police, fire, EMS, and school districts are operating at, or near, capacity, operation of CCNPP Unit 3 would only add 545 direct and indirect households to the region of influence. Representatives of these agencies have indicated that this limited addition would either have no or small impact and would not require mitigation.

While there will be an overall socioeconomic benefit from the operation of CCNPP Unit 3, the cumulative impact, as a percentage, appears to be small. Further, because there are no minority populations prevalent in the area and only one small low-income population in St. Mary's County, there should be no disproportionate impact on these groups.

As described in Section 2.8, several projects have been identified within the CCNPP site area that may contribute to cumulative socioeconomic and environmental impacts. Dominion LNG is planning to expand the Cove Point Liquid Natural Gas Plant located approximately 3.6 mi (5.8 km) south of the CCNPP site. Construction is expected to be completed in 2008. Impacts include construction related activities, use of additional land for on and offsite infrastructure including pipeline expansion, increased shipping, emissions from additional onsite power generation and noise. In addition, approximately 38 new employees will be added to the operational workforce. Potential construction and operational impacts have been reviewed and mitigation measures identified (FERC, 2006).

In addition to expansion of the Dominion LNG facility, additional electrical capacity is being installed at two locations in the CCNPP site region. Two combustion turbine generating units are being added in Easton, Maryland and two at the Chalk Point Generating Station.

Since construction of the LNG facility is to be completed in 2008, there should be limited if any overlap in activities that might impact planned activities at CCNPP Unit 3. Operation of the LNG facility and the addition of additional electrical capacity in Easton and at Chalk Point will contribute to increased emissions but these facilities will be required to meet air quality standards. As a result, the cumulative impacts of these projects should be small.

10.5.3 Cumulative Impacts Summary

The potential adverse short-term and long-term impacts from the construction and operation of CCNPP Unit 3 have been identified and actions to mitigate those impacts proposed. Activities to be undertaken during construction and operation of CCNPP Unit 3 are consistent with those currently in place for CCNPP Units 1 and 2. Except for the construction footprint, available land use and the terrestrial environmental will remain unchanged.

Operation of the new unit will require the use of certain natural resources including water withdrawal from the Chesapeake Bay for cooling and will result in the release of process gaseous, liquid and solid wastes, all in conformance with applicable Local, State, and Federal permit requirements and standards. Economic benefits accrue from capital expenditures, additional tax revenue and the jobs created during construction and operation. The environmental assessment demonstrates that cumulative adverse impacts to the vicinity and to the region will be small.

10.5.4 References

CFR, 2007. Title 10, Code of Federal Regulations, Part 51, Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions, 2007.

FERC, 2006. Final EIS Dominion Cove Point LNG Project Expansion, Docket Nos. CP05-310-000 et al., U.S. Federal Energy Regulatory Commission, April 28, 2006, Website: www.ferc.gov/industries/lng/enviro/eis/04-28-06-eis-cove.asp, Date accessed: May 26, 2006

NRC, 1999. Standard Review Plans for Environmental Reviews for Nuclear Power Plants, NUREG-1555, Nuclear Regulatory Commission, 1999.

Enclosure 2
Calvert Cliffs Nuclear Power Plant, Unit 3
Summary of UHS Makeup Water Intake Structure Re-orientation Changes

Summary of UHS Makeup Water Intake Structure Re-orientation Changes

The purpose of this document is to provide a summary of the re-orientation of the UHS makeup water intake structure of Calvert Cliffs Unit 3. The re-orientation is the result of the maturing of the detailed design engineering process. The UHS makeup water intake structure and electric room, shown in Figure 1 below, which were originally two separate structures, will be re-oriented such that the electrical building is now on top of the UHS makeup water intake structure (see bubble in Figure 2).

No design basis process parameters (equipment, design basis loads, etc.) have been changed as a result of this re-orientation.

A direct environmental benefit of moving the separate UHS electrical building to the top of the UHS makeup water intake structure is a reduction of ground disturbance by 4500 ft^2. The resulting change to the UHS makeup water intake structure increases the structure height by 15 ft (26½ ft to 41½ ft elevation above ground level); however, it should not change the conclusion in ER Section 3.1, "EXTERNAL APPEARANCE AND PLANT LAYOUT." Specifically, that the Intake Structure and Pump House at the shoreline for CCNPP Unit 3 will continue to have <u>minimal</u> visual impact considering the proposed locations near the CCNPP Units 1 and 2 intake structure and barge slip facility, respectively.

No other visual impacts from nearby ground level vantage points are expected.

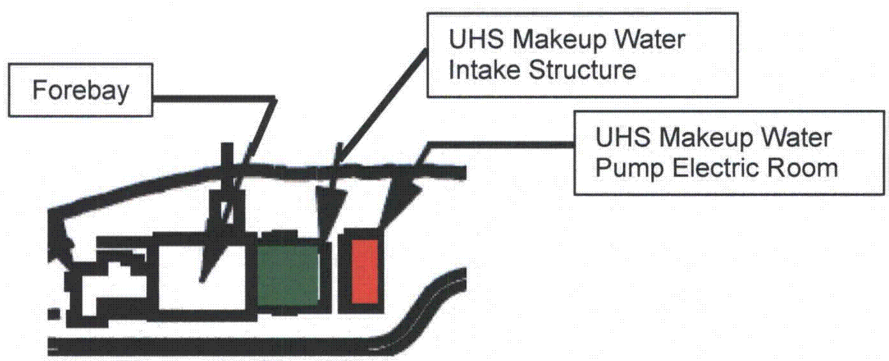


Figure 1 - Plan View

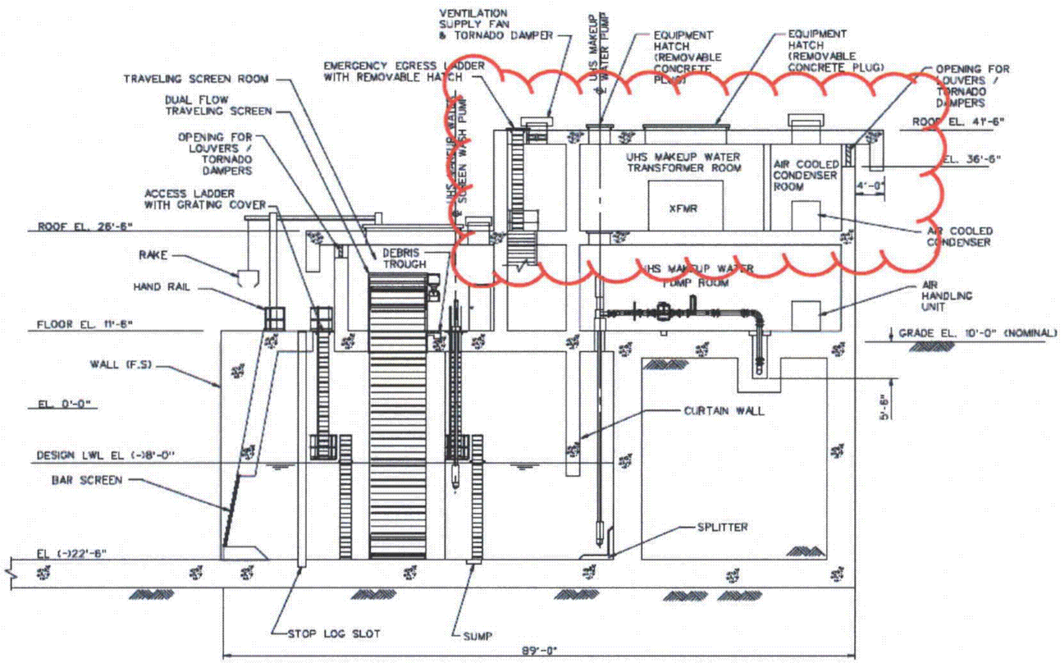


Figure 2 – Elevation View

Enclosure 3
Calvert Cliffs Nuclear Power Plant, Unit 3
Summary of Final Traffic Impact Study on COLA Part 3

Summary of Final Traffic Impact Study on COLA Part 3

The purpose of this document is to provide a summary of changes resulting from the updating of the first Traffic Impact Study (TIS) developed by KLD dated May 30, 2007, to the Final TIS, which is currently being finalized and provided to Maryland State Highway Administration (SHA) for approval and acceptance.

The content of the Final TIS is based on consultation, discussions, and working sessions with the SHA that have led to a set of understandings that define the scope and study methodology and to the mitigation plan contained therein.

The major scope and methodology differences are as follows:

1) The scope of the study area has been increased from six intersections to eight intersections. The two new intersections include MD 231 at MD 2/MD 4 and at the divergence of MD 2 and MD 4, thereby extending the northern bounds of the TIS scope.
2) The analysis in the present plan is based upon only one access point for the construction traffic, namely a signalized intersection at White Sands Road & MD 2/MD 4, using a triple southbound left turn. The intersection of Nursery Road & MD 2/MD 4 is to remain unsignalized and is not included in the analysis as an alternate or supplemental access point for the construction traffic.
3) Based upon agreement with SHA, a growth rate of 2.0% is used for all background traffic, and for bringing forward all traffic data to a common 2010 base year, to define the base condition. The 2007 report had used 2.5% and in interim discussions SHA had considered numbers as high as 4.0%.
4) Based upon SHA specification, the percent breakdown north/south split of construction workers arriving on site was changed from 70%/30% to 80%/20%.
5) Shift schedules were modified slightly, which beneficially impacted the traffic load during the peak hours.

It should be noted that the construction work force size has not changed and all evaluations and analysis have been completed in accordance to SHA-approved methodology and requirements. Operational-related traffic parameters have not changed.

The changes described above do not alter the conclusions or impact ratings contained in COLA Part 3, including but not limited to socioeconomics, traffic, and noise. Furthermore, these changes conform to SHA requirements, have been discussed with SHA, and are expected to be concurred with upon final discussions.

The mitigation scope defined in the Final TIS will be the basis for a Memorandum of Agreement (MOA) or equivalent document with SHA, which will formalize the mitigation actions and related costs and roll-backs if any (post-construction), and establish an implementation timetable that meets SHA requirements and minimizes traffic-related impacts of the project.